International Master Programme at
the Swedish Biodiversity Centre

Master theses
No. 50
Uppsala 2007
ISSN: 1653-834X

Inventory of phenotype diversity of landraces of common beans (*Phaseolus vulgaris* L.) in Kosova for a national gene bank

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CBM MASTER THESES SERIES

Swedish Biodiversity Centre
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Abstract

Common Bean **(Phaseolus vulgaris L.)** is cultivated all over Kosova in the home gardens and also in the fields. This country, with a very variable topography and climate is depending on a diversity of the landraces. During 2006 this inventory study showed varieties of common bean landraces which was gathered for a National Gene Bank. Five regions with 15 localities and five samples were collected at each locality. The 75 accessions found were documented, collected and preliminary evaluation was made in the field. 68 climbing accessions varieties and 7 bush varieties accessions were found. The characters shows high differences for particular parameters, e.g. growth habit, pods per inflorescence, seeds per pod, immature pod length, immature pod width, 100-seed weight, and germination. Also qualitative parameters were studied as colour, shape and taste.
The t-test analyses, except for bush bean growth habit, showed high signification for all parameters between different accessions on level $t_{0.01}$=2.660 and $t_{0.05}$=2.000.
In practice 2 out of 7 of the bush bean accessions were used as snap bean. All other accessions (73) are used as dry beans usually in soup or stew in the domestic cooking. An interview survey was also made with the 69 farmers (96% males) and showed that the beans are eaten in the household and sold at the local or regional market. Average farmers age was 49 years. Almost half of farmers were sceptic that next generation will cultivate bean and conserve their special variety. All of the farmers agree and strongly suggest saving the local seed varieties in a National gene bank.

Key words: common bean, diversity, ethnobotany, *Phaseolus vulgaris* L., landrace, gene bank, t-test.

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Introduction

Background

Kosovo has an area of 10,887 square kilometres or almost 1.1 million ha. About 430,000 ha are forested (39.1%) and 577,000 ha are agricultural land (52%). Of the latter, 31% are pastures and about 69% is arable. It is a geographical basin, situated at an altitude of about 500 metre, surrounded by mountains, and divided by a central north/south ridge into two sub-regions of roughly equal size and population. It is a part of the South East European (or Balkan) region and borders Serbia to the North and East, Montenegro on the West, Albania on the South West, and FYR Macedonia on the South East. There is a continental climate, recognized by temperature extremes and in winter thermal inversions occur frequently. Kosovo's climate is influenced by its proximity to the Adriatic and Aegean Seas as well as the continental European landmass to the north. The overall climate is a modified continental type, with some elements of a sub-Mediterranean climate in the extreme south and an alpine regime in the higher mountains. The winters are cold with an average temperature in January and February of 0 degrees centigrade and with significant accumulation of snow, especially at high altitude. Summers are hot, with extremes of up to 40 degrees. The average annual rainfall in Kosovo is 720 mm but can reach more than 1,000 mm in the mountains. Summer droughts occur now and then.

The varied altitude, climatic influences, and soils within Kosovo provide a wide diversity of microhabitats to which plant and animal species are adapted. The number of wild endemic plant species is 200 but 13 of them occurs a in few square kilometres only. Kosova contains the upper watersheds of four rivers that flow into three different Seas: the Adriatic, Aegean, and Black. The Iber/Ibar River flows into the Danube River, making it part of one of Europe's major river systems. Kosovo provides catchments for water flowing to neighbouring countries, but because of its elevated topography, does not receive water from outside its borders.

Challenges

Kosova is characterized as an agricultural land where, all plants excluding strict tropical ones, without any difficulties, could be cultivated. For this reason the people in Kosova is depending on the type of agricultural crops which has also the biodiversity between the landraces. Even though the work has started to gather seeds, there is no full stocktaking of the agricultural varieties. It is worth to mention that most of the vegetables that are cultivated have been grown in the country for a long time as: red pepper, onion, common beans. Also among other plants we have high biodiversity. For instance there exist fruit-trees and shrubs that are more than 100 years old i.e. apples, pears, quince and some grape varieties. Kosova is well-known for the grape-production and its products.

Genetic resources in general are spread throughout the word. It is always of interest to investigate in different countries. Kosova is a small geographical area in the heart of South East Europe with many characteristics, beginning in the cultural tradition, economical situation, historical past, and climatic condition, etc. Perhaps these characteristics can give rise to a specific trait that can be useful in future. Among crops and industrial plants our knowledge is least. There have been great reductions in old varieties because farmers are oriented in towards cultivation of new varieties and hybrids, with high production potential. Up to now research on biodiversity of agricultural crops has unfortunately been limited. The

scientific research in general until now has not included sampling of all genetic resources in this area. Even though some studies has been done in describing wild plants, almost nothing is known of the variation of garden and agricultural plants yet. This study is a good start in an important plant group.

General aspects and description

The Common Bean (*Phaseolus vulgaris* L.) is an herbaceous annual plant species domesticated independently in ancient Mesoamerica and now grown worldwide both for dry beans and as green bean. Among major food legumes the Common Bean is the third most important worldwide, superseded only by Soybean [*Glycine max* (L.) Merr.] and Peanut (*Arachis hypogaea* L.). Among the pulses (i.e., annual leguminous food crops that are harvested for dry seeds) the Common Bean is by far the most important (Singh, 1999).

The genus *Phaseolus* is of American origin and comprises 36 species (Mabberley 1997). Five of them, namely, *P. acutifolious* A. Gray (Tepary Bean), *P. coccineus* L. (Scarlet Runner Bean), *P. lunatu*s L. (Lima, Butter or Madagascar Bean), *P. polyanthus* Greenman (Year-long Bean), and *P. vulgaris* L. (Common Bean, Haricot, Navy, French or Snap Bean) were domesticated (Debouck, 1999). Among these species the Common Bean is the most widely distributed and has the broadest range of genetic variation (Singh, 1999).
The Common Bean mostly used as food crop throughout the word, particularly in developing countries as Mesoamerica, Africa, and other countries

The Common Bean (*Phaseolus vulgaris* L.) is a highly variable species. It is placed in the tribe Phaseoleae, subfamily Papilionoideae in the family Fabaceae (=Leguminosae). Cultivated forms are herbaceous annuals, which are determinate or indeterminate in growth habit. On germination, the plant is initially tap-rooted, but adventitious roots emerge soon thereafter, and dominate the tap root which remains 10-15 cm in length (Duke, 1981 & Gomez, 2004)

Research question and hypothesise

The research question is concerned with the genotypic and phenotypic diversity, which can occur within these landraces or varieties of our country. How can this diversity be described quantitatively and qualitatively and be preserved for the future?
Whereas, hypothesise was:

I. Due to different climatic condition, altitudes, many generations (annual) of cultivation, it is expected to find many different landraces/varieties.
II. Some of these landraces can be very interesting. In future they may be used for deeper investigation and plant breeding.

Objectives

The idea and aim for this study was to describe Common Bean (*Phaseolus vulgaris* L.). The primary aim of the study was to describe the qualitative and quantitative characteristics of Common Bean for its effective use and management.
This study has included inventory, collection, documentation and preliminary characterizing.

Material and Methodology of Work

Material

Base material in this investigation was varieties/landraces of Common Bean (*Phaseolus vulgaris L.*) which are cultivated in Kosova. The Common Bean is playing a crucial role in the feeding of people in Kosova. We choose to study genotype and phenotype Common Bean variation and conserve this important plant resource in a National Gene Bank.

Methodology of work

With the aim to include as much as possible, during the study and collection of plant genetic resources of Common Bean the Split-plot method were followed. The territory of Kosova was divided into five (5) sub-regions according to the climatic and territorial specifications. The sub-regions were divided into three (3) municipalities by five (5) localities (replications). The plots/farmers were chosen randomly.

Besides measurements which we did in the farmer's land, during first phase we prepared herbarium and passport data for each accession also (Appendix IV) according to IPGRI (International Plant Genetic Resources Institute) descriptors of characters for Common Bean. During the visit to a farm we interviewed the farmer following a survey questionnaire (Appendix I). Two kilogram of seed assembled from farmers and brought to Faculty of Agriculture at Prishtina University for analyses and conservation in the National Gene Bank. A panel of 5 taste panel persons tasted organoliptic attributes for 15 accessions. The study was done from beginning of Jun 2006 up to end of March 2007.

Controlled traits

Quantitative traits

1. Growth habit (cm), from 5 plants per accession,
2. Pods per inflorescence (No) from 2 plants per accession,
3. Seeds per pod (No), 10 pods from different plants per accession,
4. Pod length (cm), 10 pods from different plants per accession,
5. Pod width (mm), 10 pods from different plants per accession,
6. Weight of 100 seed (g), 4 samples by 100 seed per accession,
7. Germination (%), 4 samples by 100 seed per accession.

Qualitative traits

1. Colour of seed,
2. Shape of seed,
3. Organoleptic taste attributes.

Individual interviews and discussion

A survey questionnaire was carried out to compliment information from farmers regarding the management, maintaining and basic data for their household. The survey was semi structured and is made with 69 farmers' in- interviews and following-up on interesting issues that had surfaced during individual interviews, e.g. the effect of land scarcity, on the type of bean they grown and had grow earlier, reasons for monoculture or mixed cultivation, traditional uses, attitude to this resource, attributes associated with vernacular names were asked during individual interview and discussions with farmers. Key informants were selected based on their practical knowledge on the crop.

Statistic data analyses

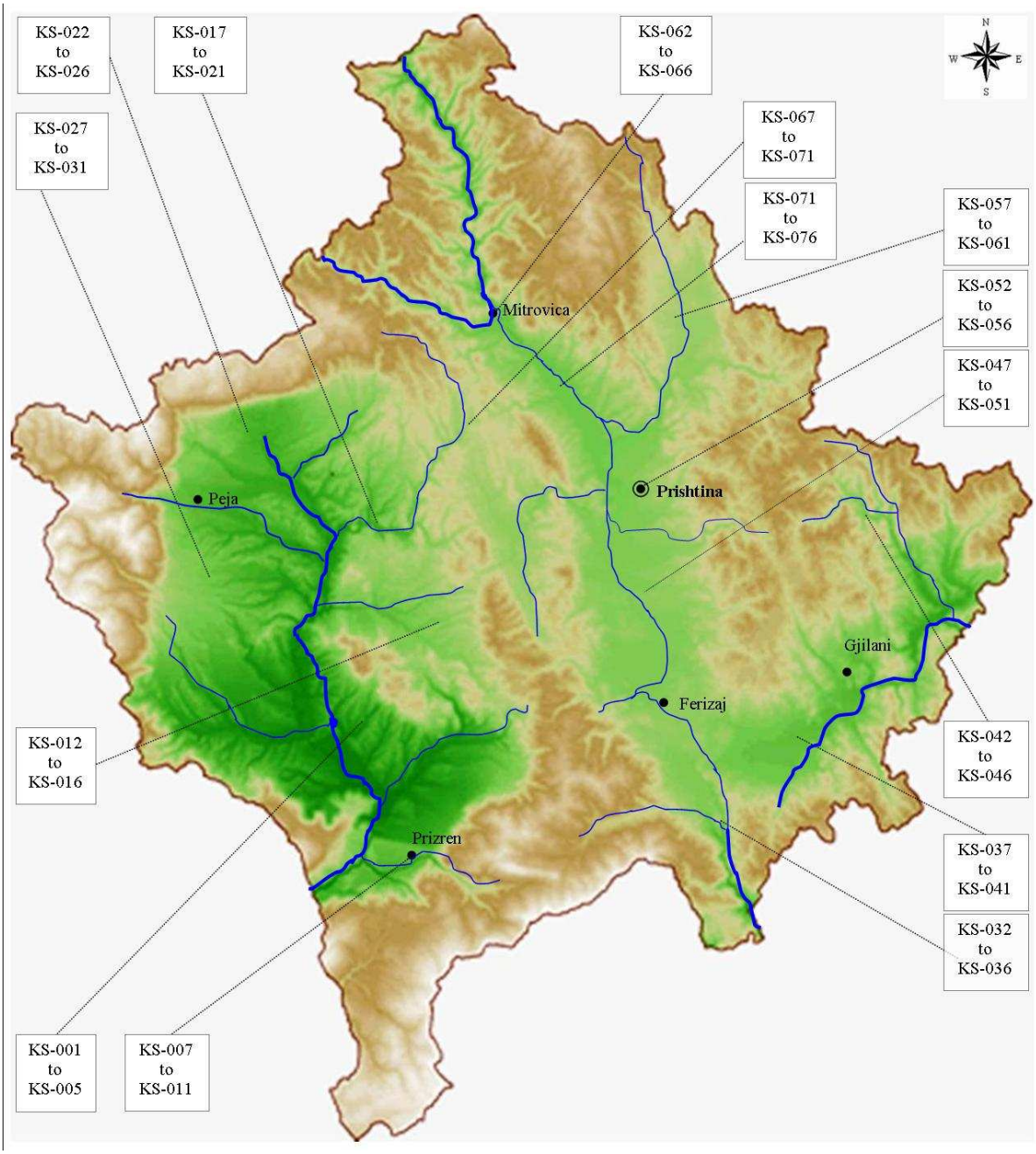
For comparison of data analyses methodology is used: Spearman's correlation, t-test, Excel programme, software Minitab 14 and SPSS 15.

Study site

The study was conducted in 15 municipalities out of 30 in Kosova. These areas vary in soil, altitude and climatic conditions.

Different types of agricultural soil were seen: sandy, sandy loam, alluvial, clay, rouge soils etc. There is even a small country climatic conditions between regions are different. The overall climate is a modified continental type, with some elements of a sub-Mediterranean climate in the extreme south and an alpine regime in the higher mountains.

Altitude in Kosova varies from 265 to 2656 above sea level; in this study samples were taken in elevation 317 to 1025 meters above sea level.



Map. 1 Kosova. Collections sites and accessions number

Number: KS-001 to KS-016 were visited between (01, 02 &03/07, 25, 26 & 27 /08 and 30 & 31/10/2006)
Number: KS-017 to KS-031 were visited between (04, 05 & 06/07, 28, 29 & 30/08 and 28 & 29/10/2006)
Number: KS-032 to KS-046 were visited between (07, 08 & 09/07, 31/08 & 01/09 and 22 & 24/10/2006)
Number: KS-047 to KS-061 were visited between (10, 11 & 12/07, 02, 03 & 04/09 and 25 & 26/10 2006)
Number: KS-061 to KS-076 were visited between (13, 14 &15/07, 04, 05 & 06/09 and 20 & 21/ 10 2006)

. Register of regions, municipality and localities from accessions and data were assembled

ACC. NO.	COLECTORS NO.	Region	Municipalities	Sampling Localities	Altitude (m)
KS-001	DIZ-1	Prizren	Rahovec	Celinë	321
KS-002	DIZ-2			Celinë	324
KS-003	DIZ-3			Krushe e Madhe	317
KS-004	DIZ-4			Fortesë	328
KS-005	DIZ-5			Fortesë	324
KS-007	DIZ-6		Prizren	Mamushë	339
KS-008	DIZ-7			Mamushë	350
KS-009	DIZ-8			Hoqa e Qytetit	364
KS-010	DIZ-9			Hoqa e Qytetit	364
KS-011	DIZ-10			Landovicë	322
KS-012	DIZ-11		Malishevë	Berishë	1025
KS-013	DIZ-12			Tërpezë	654
KS-014	DIZ-13			Bajë	542
KS-015	DIZ-14			Mleqan	604
KS-016	DIZ-15			Llozicë	650
KS-017	DIZ-16	Pejë	Klinë	Germnikë	392
KS-018	DIZ-17			Germnikë	392
KS-019	DIZ-18			Drenovc	388
KS-020	DIZ-19			Jashanicë e Poshtme	488
KS-021	DIZ-20			Shtaricë	455
KS-022	DIZ-21		Burim	Istog i Poshtëm	465
KS-023	DIZ-22			Cercë	470
KS-024	DIZ-23			Studenicë	484
KS-025	DIZ-24			Dobrushë	462
KS-026	DIZ-25			Dobrushë	462
KS-027	DIZ-26		Deçan	Lebushë	620
KS-028	DIZ-27			Llukë e Epërme	595
KS-029	DIZ-28			Llukë e Epërme	600
KS-030	DIZ-29			Priljep	546
KS-031	DIZ-30			Priljep	551
KS-032	DIZ-31	Gjilan	Kaçanik	Hani i Elezit	374
KS-033	DIZ-32			Hani i Elezit	374
KS-034	DIZ-33			Bob	498
KS-035	DIZ-34			Sopot	544
KS-036	DIZ-35			Kaçanik i Vjetër	558
KS-037	DIZ-36		Viti	Smirë	510
KS-038	DIZ-37			Mogillë	500
KS-039	DIZ-38			Kllokot	490
KS-040	DIZ-39			Shaqir Piraj	502
KS-041	DIZ-40			Fshati i ri	545
KS-042	DIZ-41		Dardani	Petrit	445
KS-043	DIZ-42			Novosellë	485
KS-044	DIZ-43			Topanicë	468
KS-045	DIZ-44			Berivojcë	488
KS-046	DIZ-45			Berivojcë	705

KS-047	DIZ-46	Prishtinë	Lipjan	Mirenë	695
KS-048	DIZ-47			Blinajë (Vershevc)	593
KS-049	DIZ-48			Grackë e Vogël	575
KS-050	DIZ-49			Banullë	575
KS-051	DIZ-45			Gadime e Epërme	617
KS-052	DIZ-51		Prishtinë	Hajvali	615
KS-053	DIZ-52			Hajvali	615
KS-054	DIZ-53			Grashticë	741
KS-055	DIZ-54			Bernicë e Epërme	620
KS-056	DIZ-55			Lebanjë	590
KS-057	DIZ-56		Besianë	Dumnicë e Poshtme	636
KS-058	DIZ-57			Dumnicë e Poshtme	636
KS-059	DIZ-58			Podujevë	620
KS-060	DIZ-59			Podujevë	616
KS-061	DIZ-60			Lupç i Poshtëm	595
KS-062	DIZ-61	Mitrovicë	Mitrovicë	Koshtovë	546
KS-063	DIZ-62			Shupkofc	592
KS-064	DIZ-63			Shipol	587
KS-065	DIZ-64			Lushtë	590
KS-066	DIZ-65			Brabaniq	600
KS-067	DIZ-66		Skenderaj	Runik	760
KS-068	DIZ-67			Qubrel	688
KS-069	DIZ-68			Klinë e Mesme	635
KS-070	DIZ-69			Polac	660
KS-071	DIZ-70			Rezallë	775
KS-072	DIZ-71		Vushtrri	Smrekovnicë	573
KS-073	DIZ-72			Svaraqak	540
KS-074	DIZ-73			Dervar	530
KS-075	DIZ-74			Dumnicë e Ulët	558
KS-076	DIZ-75			Lumë I Madh	527

Prizren and Peja regions belongs to Dukagjini plane and stretch in west and south-west part of Kosova, this country part has sub-Mediterranean climate, vegetation period is one month longer, in low altitude, compared to the other parts of the country. Soil quality is good, across Drini i Bardh river alluvium is the main type of soil, also in this region soil types as clay, rouge soils and sandy soils are present. The amount of rainfalls varies 700-750 mm per year.

Gjilani, Prishtina and Mitrovica regions belongs to Kosova plane and stretch in north (Mitrovica region), centre and east north (Prishtina region), and in east and east south (Gjilani region) part of Kosova. The climate is a modified continental type with long and hard winters, and hot summers. Rainfalls are, usually 650-700 mm per year, during vegetative period May-April the average of rainfalls is 410-450mm. Soil quality changes from place to place near rivers alluvium is present, clay is dominant, and rouge and sandy soil are present in highlands.

Results

Quantitative parameters

Number of pods per inflorescence

The number of pods of Common Bean varies a lot. It is determinated by three main factors:
Genotype: (bush, climbing)
Agro ecological conditions at the locality: (temperature, rainfall, altitude, land inclination, local micro climate)
Agro-technology applied: (cultivation methods, crop distance, irrigation, fertilization, planting time, etc)
The results gained for number of pods per inflorescence are presented in table 1. This observation is average number of pods per inflorescence from two plants per accession.

Table 1 Summary of statistics on pods per inflorescence

Parameter	No. of Acce.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Pods per inflorescence	75	2	6	3.36	3	1.00	0.116	29.76	22.66

The Common Bean collections assembled formed a range of 5 groups according to average number of pods per inflorescence; with variation from 2 to 6 pods per inflorescence (fig 1).

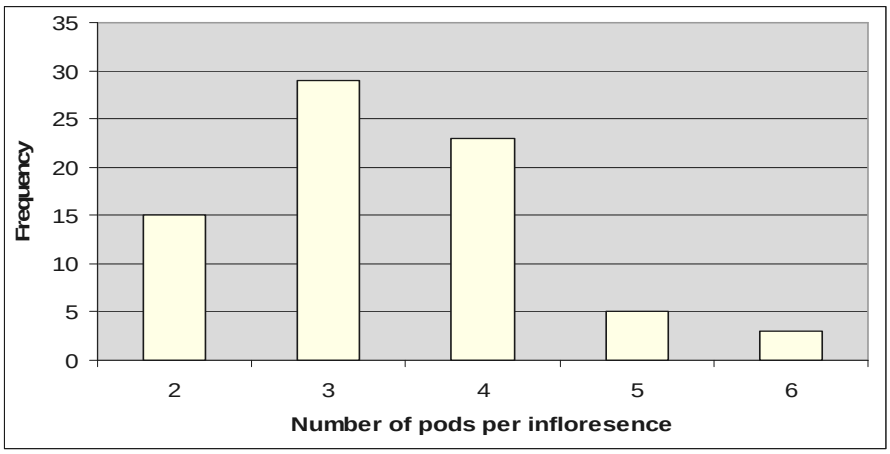


Fig 1. Distribution frequency of number of pods per inflorescence

The numbers of accessions within the classes group were determined. The lowest frequency was 3 for maximal values and 23 for minimal values. The variation for number of pods per inflorescence seems to be depended on soil quality, in this study all accessions with 6 pods per inflorescence were cultivated in qualitatively good soil (alluvium and clay), and also altitude could have had impact in this parameter. Genetic background should be a factor because even though accessions were studied from the same area with similar agro ecological conditions the number of pods per inflorescence varied.

Number of seeds per pod

This observation is the average number of seeds per pod for 10 pods from 10 plants per accession. The number of seeds per pod is variable due to genotype, agro ecological conditions and agro technology applied. Results for this parameter are presented in table 2.

Table 2 Summary of statistics on seeds per pod

Parameter	No. of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Seeds per pod	75	2.4	8.7	4.29	4.2	1.017	0.118	23.7	37.255

There is a range of 7 groups discerned according to average number of seeds per pod, with variation from 2.4 to 8.7 seeds per pod (fig. 2). In this parameter study the frequency within the classes group shows that the lowest frequency was 1 whereas highest frequency was 38. Variation of this parameter seems to be due to genetic background. Some of the farmers cultivated two varieties in the same conditions but number of seeds in pods showed differences. Also it is evident that all varieties with high number of seeds per pod were cultivated under irrigation.

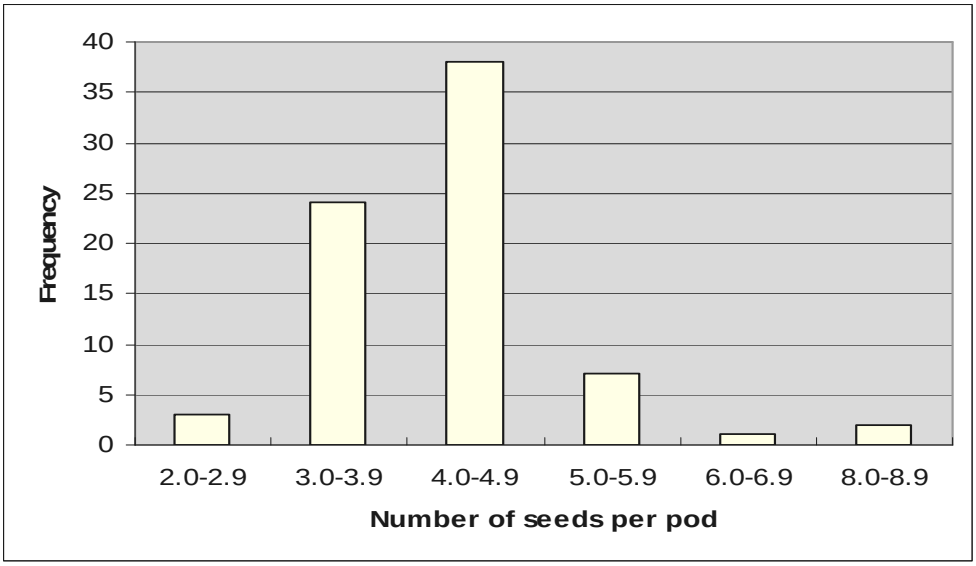


Fig 2. Frequency distribution of number of seeds per pod

Immature pod length

This observation is the average length (in cm) of teen randomly selected pods from 10 plants of each accession. This characteristic to Common Bean is variable and affected by length of growth season, soil fertility, and moisture availability. Table 3 shows results for this parameter.

Table 3. Summary of statistics on immature pod length (cm)

Parameter	No. of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Immature pod length	75	9.86	23.74	13.19	13.06	2.17	0.25	16.45	41.95

The material was divided in 4 groups according to average number of pod length, with variation from 9.86 cm to 23. 74 cm. The results show the frequency within the classes group. The lowest frequency was 3 for the maximal values 18-23.9 cm of pod length and highest frequency was formed in the group with pod length 12-14.9 cm (fig 3).
This parameter had correlation with number of seeds per pod, so genetic background and applied agro technology were main factors to have diversity in pod length (Photo 1).

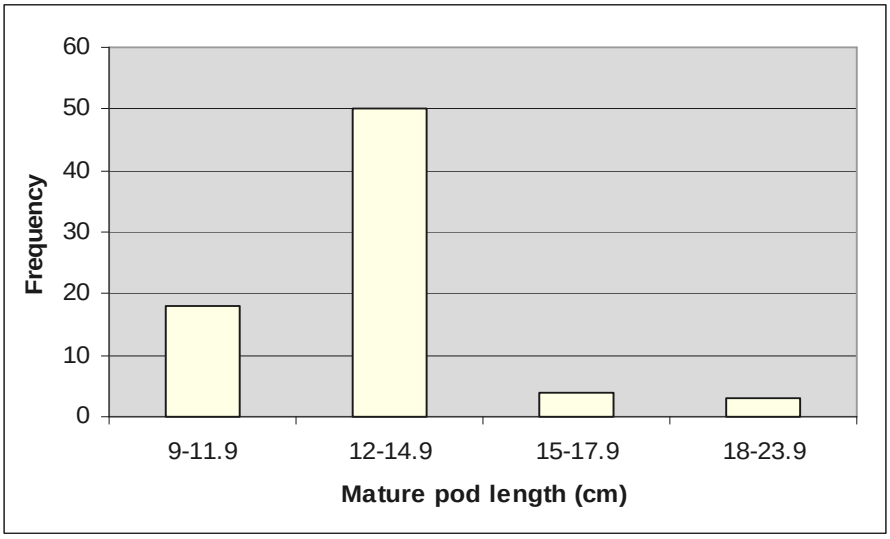


Fig 3. Distribution frequency of immature pod length (cm)

Immature pod width

This observation is an average of expanded immature pod width of ten randomly selected pods from each accession recorded in millimetres. This character is also affected by soil fertility, length of growths season, and moisture availability and other causes.
Results for immature pod width are presented in table 4.

Table 4. Summary of statistics on immature pod width (mm)

Parameter	No of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Immature pod width	75	9.6	20.5	14.29	14.3	1.73	0.02	12.1	30.96

The Common Bean collections assembled, formed a range of 6 groups according to average of pod width per accession, with variation from 9.6 to 20.5 mm of pod width (fig 4). Soil quality, irrigation, and way of cultivation and genetic background were factors which determine pod width.

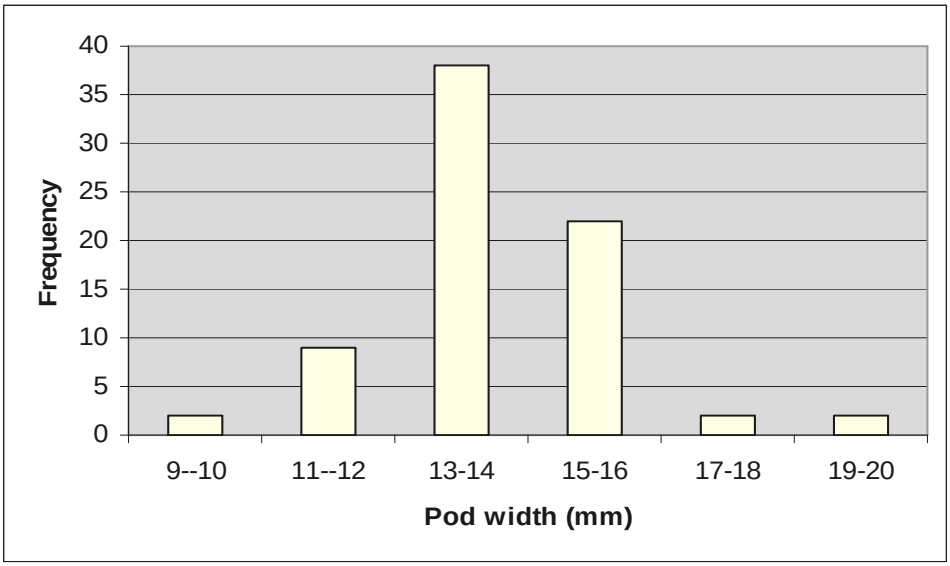


Fig 4. Frequency of distribution of immature pod width (mm)

Photo 1. Examples of pod diversity. From left collection number KS- 058, 044,056, 045, 057, 061, 059, 054 and 060 were selected. (Photo D. Zeka)

The colour of the pod varies, 044 and 045 are darker and number 061 has spotted surface. Also the length and bending of the style has a great variation.

100-Seed weight

This parameter was measured in laboratory. Out of each accession, we weighted 4 samples with 100 seed in each. The moisture of the seed (sun-dried) was 14 % measured by hygrometer.
Our results show a high variability among the accessions for 100 seed weight which is presented in table 5.

Table 5. Summary of statistics on 100 seed weight (g)

Parameter	No of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Seed weight	75	25.89	114.87	58.21	58.38	13.66	1.57	23.31	35.9

The material was divided in 8 groups according to average seed weight (fig. 5). The genetic influence seems to be the main factor in this parameter, two accessions from different places (appendix IV) had weight over 100 g. Irrigation was an important factor.

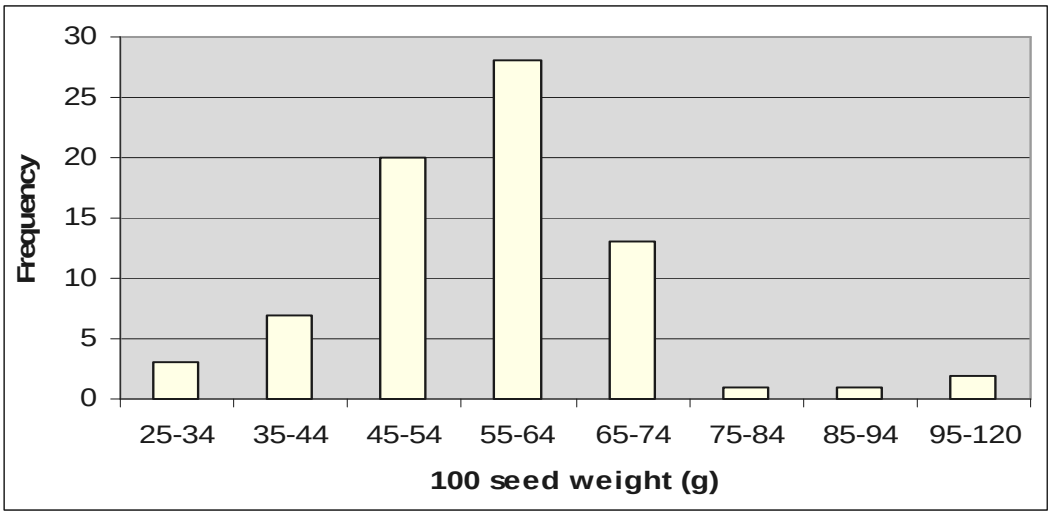


Fig 5. Frequency of distribution of 100 seed weight (g)

Photo 2. Seed diversity. The collection number KS- 049, 015, 045, 012, 053, 025, 020, 009, 044, 032,072 and 029 were selected. Number 025 was the only blackish-brown coloured bean found. (Photo: D. Zeka)

Germination

This parameter was also measured in laboratory started the 05 January till 20 February 2007. Seeds were germinated between two layers of paper at 22^0C germinator temperature. All seed were from 2006. For each accession 4 samples with 100 seeds were tested. The seeds were kept for 9 days in a germinator. Every day the samples were checked and water needed was added. After six days we began to count the proportion germinated seeds.
The results for germination are presented in table 6. A variation from 93.25 to 100 % was noted.

Table 6 Summary of statistics on germination (%)

Parameter	No of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Germination	75	93.25	100	98.88	99.25	1.3	0.15	1.31	7.46

7 groups were discerned according to average percentage of seed germination. Determination of the accessions frequency was done within the classes groups. The frequency was 23 for maximal values and 1 for minimal values (figure 6). Maybe variability for this parameter was the management of the pods after harvesting, and only one accession had germination percentage under 95 %. Even when seeds were sun-dried germination was excellent.

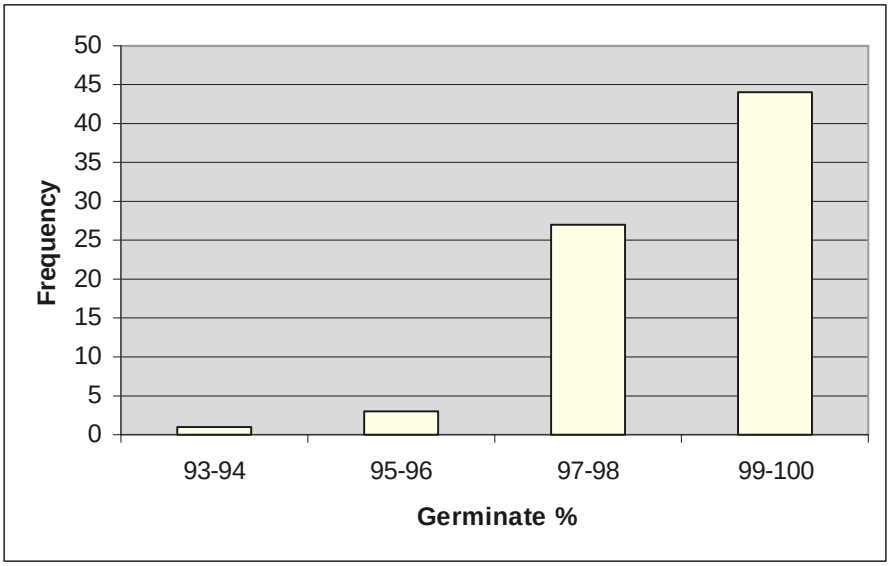


Fig 6. Frequency distribution of germination (%)

Growth habit

Growth habit is one of the most important characteristics for classifying bean varieties from the agronomic point of view. This characteristic is genetically controlled. CIAT (Centro Internacional de Agricultura Tropical) has designed a widely accepted classification scheme based on the former characteristic and on the type of plant development. The relationship between all these different classifications is shown below.

Table 7. Different Classification Criteria of Bean Growth Habits
Source: http://www.ciat.cgiar.org/beans/growththhabits.htm#home

Genetics	CIAT		Popular	
	Simplified	Refined	Refined	Simplified
Determinate	I	Ia	Erect Bush	Bush
		Ib		
Indeterminate	II	IIa		
		IIb	Semi Climbing	Climbing
	III	IIIa		
		IIIb	Climbing or Voluble	
	IV	IVa		
		IVb		

In this study data were recorded when the plants had reached full growth. This observation is the average, in centimetres, at maturity from 5 plants measured from cotyledon scare to tip of plant for each accession. When the top stem was hanging, it was lifted to straight position before measurements.
There are two types of Common Bean found.
Bush: 7 accessions and
Climbing: 68 accessions
Due to this reason the data analyzing were done separately. Our results did not show any significant value for growth habit to bush bean in statistical aspect (table 8), but from 7 accessions of bush bean 2 of them were used as snap bean.
This study showed highly significant values for climbing bean in statistical and practical aspect (table 10).

Table 8. Summary of statistics on growth habit cm (bush)

Parameter	No. of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Growth habit	7	44.6	66.6	58.48	63.40	9.36	3.53	16	1.38

Table 9. Accessions number of growth habit cm (bush)

Accession number	Growth habit cm	Accession number	Growth habit cm	Accession number	Growth habit cm
KS-012	44.6▼	KS-009	63.4	KS-015	66.6▲
KS-058	46	KS-044	63.4		
KS-065	59	KS-039	66.4		

Table 10. Summary of statistics on growth habit cm (climbing)

Parameter	No of Access.	Value				SD	SE	CV (%)	t-test
		Min.	Max.	Mean	Median				
Growth habit	68	76.2	328	209.68	218.5	79.29	9.62	37.53	12.3

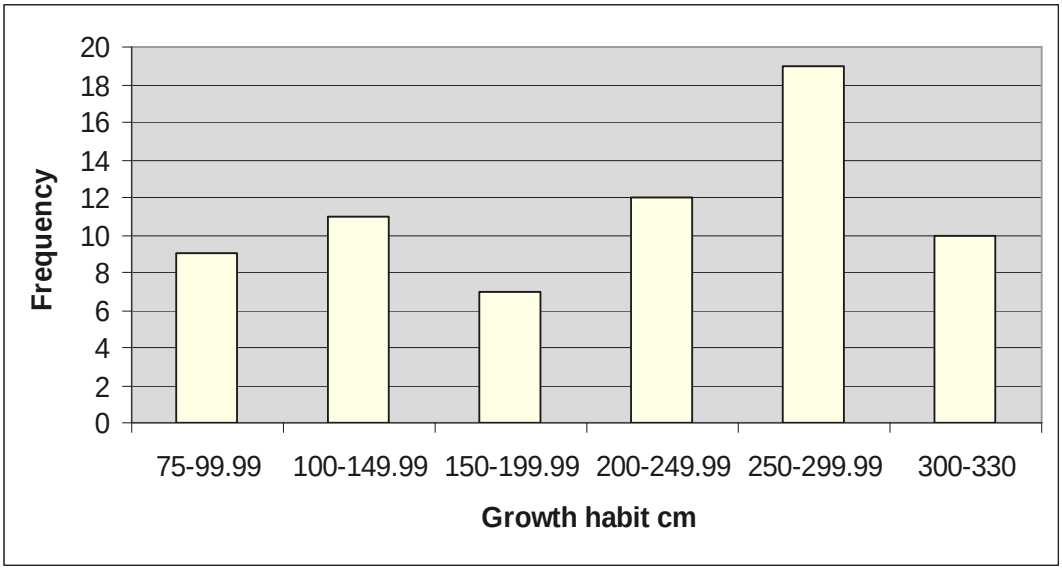


Fig 7. Frequency of distribution of growth habit of climbing bean (cm)

Photo 3. Growth habit at locality Prizren KS-009 (Photo: D. Zeka). The distance between the rows was 60 cm which make the picking of the pods easy.

In Prizren region where bush snap (photo 3) bean is obtained, the climatic conditions were most favourable compare to other places, also soil quality was good mixed clay and alluvium, whereas in Peja region where climbing dry bean (photo 4) occurred, climatic conditions were not as in previous case and soil quality was sandy. These, two examples show that growth habit is exclusively genetic controlled.

Photo 4. Climbing growth habit at locality Deçan KS-029 (Photo: D. Zeka). The distance between the sticks varies between 80 cm and 120 cm.

Correlation matrix of characters

Correlation coefficient was calculated from evaluation data of 75 accessions are shown in table 10.

- Number of seed per pod has a strong positive correlation with number of pods per inflorescence, pod length and growth habit.

- Pod length has a strong positive correlation with number of pods per inflorescence, number of seeds per pod and growth habit, and weak positive correlation with germination.
- Pod width had strong positive correlation with pod length, growth habit and seed weight.
- Growth habit has a strong positive correlation with number of pods per inflorescence, number of seeds per pod, pod length, pod width, weight of seeds but weak positive correlation with germination, and strong negative correlation with altitude. Which means that at high altitude growth habit is shorter.

Table 10. Correlation matrix of characters

Characters	Num. of pods per inflorescence	Num. of seed per pod	Pod length (cm)	Pod width (mm)	Growth habit (cm)	Weight of seed (g)	Germ. (%)	Altitude (m)
Num. of pod per inflorescence								
Num. of seed per pod	0.300(**) 0.009							
Pod length (cm)	0.309(**) 0.007	0.644(***) <0.0001						
Pod width (mm)	0.057 0.630	-0.070 0.548	0.445(***) <0.0001					
Growth habit (cm)	0.450(***) <0.0001	0.418(***) <0.0001	0.594(***) <0.0001	0.510(***) <0.0001				
Weight of seed (g)	0.240(*) 0.038	-0.198 0.089	0.196 0.091	0.0542(***) <0.0001	0.390(**) 0.001			
Germination (%)	-0.023 0.847	0.221 0.057	0.228(*) 0.049	0.124 0.290	0.290(*) 0.012	0.106 0.366		
Altitude (m)	-0.100 0.392	-0.021 0.860	0.049 0.677	-0.143 0.222	-0.356(**) 0.002	-0.183 0.116	-0.127 0.276	

Cell Contents: Spearman's rho correlation
P-Value

*** Correlation is significant at the 0.0001 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Qualitative traits

Colour

From 75 studied accessions 74 have had white seed colour and only 1 have brown, photo 2. During this survey we have tried to understand why the farmers do not cultivate coloured Common Bean. Answer from old farmers was usually that: the people preferred the white for cooking. And now all coloured beans are sorted away when the sowing seeds are selected. A colour variation in the pods can be noted in photo 2 but this character has not been dealt with in this study.

Shape

This study shows variably among the accessions for seed shape. All accessions which were cultivated under irrigation have had kidney shaped form. Even some of the accessions of beans grown without irrigation, had kidney form. The accessions which were cultivated at

high altitude and without irrigation have a circular form, whereas snap beans show an oval form.

Taste

This qualitative trait is subjective. For tastiness, we had made a panel of 5 taste test persons. The panel had 3 minutes to test an accession and to fill a scoring form. The scoring was from 4 to 20 (Appendix III), where 20 was the best tasting. The test of taste was done as a blind test for 15 accessions only. The accessions were chosen randomly per region: KS-001, KS-011, KS-012, KS-021, KS-022, KS-029, KS-035, KS-038, KS-045, KS-047, KS-056, KS-060, KS-066, KS-069 and KS-074.
100 g of the beans per each accession above was cooked for 75 min in 1.5 litre water. According to the scores three ranges was delimited. Range I score 17-20; range II score13-16 and below 12 became rank III.

Accession number of tasty (scoring)

Access. number	Score	Rank	Access. number	Score	Rank	Access. number	Score	Rank
KS-001	18	I	KS-029	20▲	I	KS-056	9▼	III
KS-011	14	II	KS-035	14	II	KS-060	14	II
KS-012	17	I	KS-038	17	I	KS-066	14	II
KS-021	20▲	I	KS-045	10	III	KS-069	18	I
KS-022	13	II	KS-047	14	II	KS-074	14	II

Ethnobotany

A survey of individual households was carried out during June to November 2006 with 69 farmers growing Common Bean in Kosova. The study was carried out when Common Beans was under cultivation until harvested. The aim of this survey was to find out traditional use and preservation of Common Bean. There was not any literature on production techniques and management of Common Bean in Kosova.

Management of Common Bean

Depending on the localities where Common Beans were cultivated, it is known with various vernacular names e.g. "*fasule* (sounds like *Phaseolus* translation: common bean, dialect: literary), *pasul* (translation: common bean, dialect: demotic) , *bathë* (translation: bean, region: Gjilani and Prishtina), *pasuli i jonë* (translation: our bean, region: Mitrovica), *pasul Mulliqi* (translation: Mulliqis' bean, region: Peja), *pasul i vadës* (translation: bean under irrigation cultivation, regions: all), *pasul i njomë* (translation: snap bean, regions: all), *pasul kokërr madh* (translation: bean with big seed size, regions: Peja, Prizreni&Gjilani), *pasul kokërr vogël* (translation: bean with small size seed, regions: all) , *pasul Istogu* (translation: Istogis' bean, region: Peja), *pasul Tetove* (translation: Tetoves' bean, region: Gjilani), etc".
Cultivation method was variable, in most cases Common Beans were mixed with Maize (*Zea mays* L.) and Squash (*Cucurubita pepo*), but some cultivated it as monoculture photo 6.

Photo 5. Mixed cultivation with maize (*Zea mays* L.) (Photo D. Zeka)

Photo 6. Monoculture cultivation (Photo D. Zeka)

Farmers know well which varieties they should cultivated mixed or as monoculture. In places without irrigation and in high altitude varieties which give less harvest, short in growth habit and droughts resistant were used. The farmers know that their beans are climbing and it is better to cultivate in monoculture but they use Maize instead of wood sticks. Soil quality and irrigation possibilities were main factors that motivated the farmers to cultivate in monoculture. Those farmers who have had climbing bean varieties used wood sticks generally to keep up the plants. Harvest of Common Bean in monoculture cultivation,

according to farmers, was extremely high (up to 5000 kg/ha), whereas in mixed cultivation and high altitude was 200-500 kg/ha.
Sowing is done by hand, where farmers sowed 2-6 seeds in one place. Distances between plants varied of cultivation way.
The pods were handpicked to harvest Common Bean by all farmers. Generally harvest is done successively in two to four times in one season, where farmers picked only ripe pods. Picking season varies at different site, but generally begun in the end of August and finished in the end of October. Afterwards some farmers left the pods on the ground or on any insole to get dry in open areas in the sun (photo 7) or threshed from pods and left the seeds indoor where natural ventilation was good (photo 8). There was not any use mechanic threshing. All farmers threshed beans by hand labour.

Photo 7. Drying of Common Bean pods under sun rays (Photo D. Zeka)

Photo 8. Drying of Common Bean seeds indoor (Photo D. Zeka)

Common Bean is propagated generatively using seeds. The propagated seeds were from previous harvest or bought from other neighbouring farmers. Farmers were aware of that if seeds are old they can fail to germinate. Usually the farmers saved a certain amount of seed for next sowing season, from last harvest until propagation time next year, farmers used different saving ways. Most of them saved the seed in paper bags but some kept seeds within the pods (photo 9) and only when cooked or at propagation time, separated the seeds from the pods. During harvest time, a farmer showed that she was using paper bags and among the seeds putting walnut (*Juglands regina* L.) leafs to protect seed from insects. 71 % of all interviewed farmers cultivated Common Bean for household consumption. The reason why they did not cultivate for market was that work in agriculture is difficult and especially Common Bean cultivation when it is mixed. One other problem was scarcity of agriculture land.

Photo 5 Pod storage (Photo D. Zeka)

Discussions

Common Bean (*Phaseolus vulgaris* L.) is one of the most important food crops in Kosova as it is very widespread and contains good nutrition. This crop is cultivated all over the country in the home garden and also as a field crop. It is used as a nutritious and delicious food mostly as ripe, dried beans. It should be cooked for more than one hour before used. The way of cultivation is variable and depended mostly on abiotic factors in the different regions. The present study looked at the phenotypic diversity of 75 accessions of Common Beans currently under cultivation in different farms. The study achieved to describe and collect these accessions for the National Gene Bank in Kosova. This study showed a great phenotype variation among the accessions.

The Common Bean is one of the 10 most important crops in the world, with a production of almost 20 million tons per year, ranking directly after soybean and peanuts in the world production of grain legumes (FAOSTAT 2001). It is calculated that more than 60% of world

production derives from domesticates of Mesoamerican origin (Tohme et al. 1996; Beebe et al. 2000).
The genetic diversity of landraces is thought to be the most economic valuable part of global biodiversity and is considered of paramount importance for future world production (Wood & Lenné, 1997, Gomez 2004).

The description of bean in this study is done through IPGRI descriptors. The using UPOV descriptor of bean was impossible because the study is done in split plot methodology.

According to our results, it is noticed high variability for pods per inflorescence between different accessions, contrast of average value of accessions compare to average value of all accessions (X =3.36), for accession number KS-029 with maximal average value variability was (d= 6-3.36=2.64) or 78.57 %, and minimal average value of accession number KS-075 was d= (3.36-2=1.36) or 40,47 %. However, contrasts between accessions with extreme values was (d=6-2=4) or 119.04%.

Similarly, large variation in growth habit, phenological traits, seed size, shape, colour, and canning and cooking. Qualitative variation is also found among dry bean cultivars (Singh, 1992; Voysest and Dessert, 1991).

We found high variability for number of seeds per pod between different accessions. Differences of average value of accessions compare to average value of all accessions (X =4.49), for accession number KS-064 with maximal average value variability was (d= 8.7-4.49=4.21) or 93.76 %, and minimal average value of accession number KS-075 was (d= 4.49-2.4=2.09) or 46.54 %. Differences between accessions with extreme values were (d=8.7-2.4=6.3) or 140.31 %.

According to our results it is noticed, high variability of pod length between different accessions, difference of average value of accessions compare to average value of all accessions (X =13.19), for accession number KS-060 with maximal average value variability was d= (23.74-13.19=10.55) or 79.98 %, and minimal average value of accession number KS-015 was d= (13.19-9.86=3.33) or 25,24 %.
Though, contrasts between accessions with extreme values was (d=23.74-9.86=13.88) or 105.23%, and we can conclude that differences between these were highly significant in statistical aspect.
Also it is noticed, high variability for pods width between different accessions, contrast of average value of accessions compare to average value of all accessions (X =14.29), for accession number KS-045 with maximal average value variability was d= (20.5-14.29=6.21) or 43.45 %, and minimal average value of accession number KS-010 was d= (14.29-9.6=4.64) or 32. 47 %. Contrast between accessions with extreme values was (d=20.5-9.6=10.9) or 76.27%.

Common bean was used to derive important principles in genetics. Mendel used beans to confirm his results derived in peas (*Pisum sativum* L.). Johannsen used beans to illustrate the quantitative nature of the inheritance of certain traits such as seed weight (Gepts, 2001). Genetic diversity in Common Bean is organized in large-seeded (>40 g 100-seed weight $^{-1}$) Andean and small- (<25 g 100-seed weight $^{-1}$) and medium- (25–40 g 100-seed weight $^{-1}$) seeded Middle American gene pools (Evans, 1973, 1980 & Gomez 2004).

Farmers in Kosova are cultivating bean with different seed size, depends on altitude, irrigation, soil and management. In this study contrasts from mean value of accession compare to mean value of all accessions (X =58.21) for 100 seed weight, for accession number KS-045 with maximal average value variability was d= (114.86-58.21= 56.65) or 97.32 %, and minimal average value of accession number KS-058 was d= (58.21-25.82=32.34) or 55.55%. The difference between accessions with extreme values was (d=114.86-25.82=89.04) or 152.96 %. Results show differences among accessions with high significance.

It is noticed small variability on seed germination between different accessions, contrast of average value of accessions compare to average value of all accessions (X =98.88), for accessions with maximal average value variability was d= (100-98.88=1.12) or 1.13 %, and minimal average value of accession number KS-055 was d= (98.88-93.25=5.63) or 5.69%. Contrast between accessions with extreme values was (d=100-93.25=6.25) or 6.82%, and can conclude that differences among these were significant in statistical aspect.

Growth and development of Common Bean is divided into vegetative and reproductive stages. The vegetative stages (V) are defined on the basis of the number of nodes on the main stem, whereas the reproductive (R) stages are defined on the basis of pod and seed characteristics in addition to nodes (Fageria, Baligar & Jones, 1997, Gomez 2004).

In this investigation it was noticed variability of growth habit between different accessions, contrast of average value of accessions compare to average value of all accessions (X=209.68), for accessions KS-062 with maximal average value variability was d= (328-209.68=118.32) or 56.42 %, and minimal average value of accession number KS-046 was d= (209,68-76.2=133.48) or 63.65%. Variability between the extreme values of climbing bean accessions was (d=328-76.2= 251.8) or 120.00 %.

The t-test analyses, except for bush bean growth habit, showed high signification for all parameters between different accessions on level $t_{0.01}$=2.660 and $t_{0.05}$=2.000.

This study has also investigated qualitative traits as colour, shape and tastiness. The colour of seeds in 74 accessions from 75 have had white colour and one accession have had brown colour. Also it was found that the accession with coloured seed had purple colour of flowers. During interviewing, farmers explained the reasons why they do not cultivate coloured bean. Almost all had same answer; people do not like to eat coloured beans.

All over the word social economic factors playing fundamental role on livelihood. People of Kosova is changing way of life very fast, the trend of movement of people from countryside to cities is increasing. Also, countryside is affected with lot of changes: new buildings, roads, rapid population growth, and education, etc. The interest for gardening and agriculture is decreasing day by day. Very few are aware of the importance of plant genetic resources and needs for its conservation.
A questionnaire survey was carried out during Jun and August 2006 to 69 farmers. The survey showed 96% of the household farmers were male. More than 50 % of them are more than 50 years old, figure 9, and for 62 % of farmers, agriculture was the primary profession.

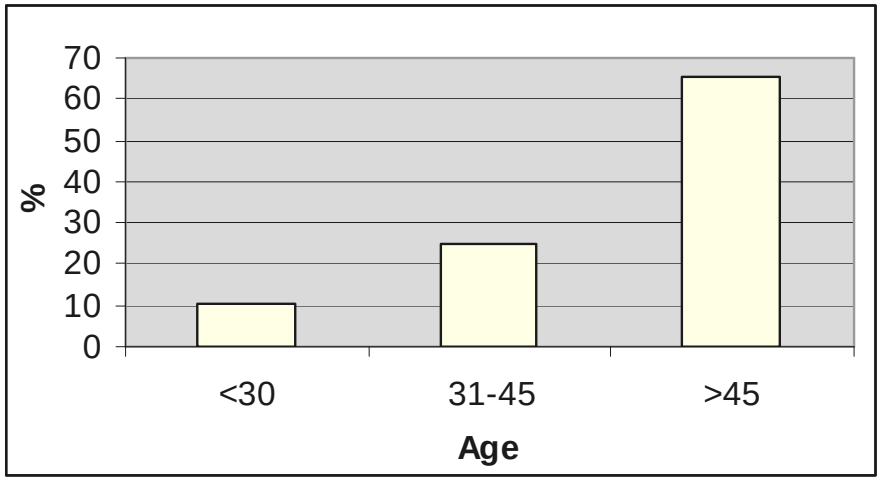


Fig 9. Age of farmers

This survey study showed also that all farmers thought that their seed variety was a landrace, but in this survey we found that only 46 % have had the same seed for more than 9 years. There is an explanation why seeds to 54 % of farmers are less than 9 years. In 1998-1999 Kosova suffered in a war, and people faced with many challenges as: survival, departure, destroys, etc. In this situation many farmers lost all their belongings and also their seeds. Farmers told that seeds were bought in local markets from other farmers or friends in neighbourhood villages.

Common Bean is cultivated under different cropping systems from the highly mechanized, irrigated and intensive production of mono-cropped bush beans to complex associations of indeterminate or climbing beans with Maize, other cereals, Sugarcane, Coffee or Plantain (Schoonhoven & Voysest, 1991).

Also results from this study showed farmers in Kosova cultivated bean under different cropping systems mainly associated with Maize.
Farmers use to select their own seeds from last harvest. Usually selection criteria are size and health of seed, this selection carried out in frame storage or on harvest time in farm land when first ripe, largest and healthy pods were selected. The storing of seed was done in different way at different places. Some of farmers saved their seeds in the pods and others saved threshed seed in paper bags.

In this survey, 45 % of farmers were sceptic that next generation will keep or cultivate any beans due to dramatic changes which are going on now in the society, but all respond a strong support for and suggested to save seeds in any safe place as is a gene bank.

Conclusions

Although Kosova is a small country this study of Common Bean showed a great diversity among the accessions, regions, localities and farmers. A wider diversity is available in the form of local cultivars if farmers in all Kosova's regions will be contacted. The farmers are still maintaining the diversity and are making efforts to sustain its cultivation.

This study showed a trend of losing genetic resources, in general, and particularly in our case, and it is increasing. Farmers were not so interested to continue with agriculture, even some of them would, but they are more then 50 years old, so the risk to lose diversity of this important resource for us is permanent. Until now, no research has been done except some studies in Maize (*Zea mays* L.) and Wheat (*Triticum spp.)* (Fetahu. 2004) in any agricultural or garden plants neither its conservation in Kosova
Our recommendations are:

- Research for other characteristics of assembled common bean accessions is necessary to see genetic variation, adaptation of bean in different conditions and breeding possibilities. This study should be done on beans cultivated under the same and controlled conditions.
- A detailed inventor and the associated local knowledge should be developed.
- An integrated research and development programme on Common Bean is required.
- Preparing and implementing of a strategy for *ex situ* and *in situ* conservation is necessary.
- Public awareness is not sufficient, so scientists and others who know about genetic resources should inform farmers and others.
- Gene bank should initiate immediate action for conservation and management.
- Participatory conservation should take in account, in farm conservation and supporting farmers to keep/cultivate some of accessions in different localities.

Acknowledgements

First of all, I would like to thank my supervisors, Mr. Mattias Iwarsson and Mr. Shukri Ftahu, for their valuable professional and scientific support in preparing and formulating this thesis. I am highly indebted to my major supervisor Dr. Mattias Iwarsson.
I would like to thank staff in the CBM, Dr. Torbjörn Ebenhard, Dr. Malin Almstedt, Dr. Åke Berg, and the staff in the SLU library. I am grateful to SIDA for financing my study and research through South East European Network (SEEDNet) project. I want to extend my appreciation to my teachers in Faculty of Agriculture at Prishtina University and colleagues in Ministry of Agriculture, Forestry and Rural Development (MAFRD) in Kosova. I would like to thank Mr. Elez Krasniqi, who assisted me all the time with professional and practical advices during field work and especially Ms. Burbuqe Haziri who gave me inspiration during thesis writing! Particularly thanks to the numerous farmers who kindly provided free seed samples and valuable information during the collection expeditions. My parents and grandmother (Lokja) gave me everything. They always have great expectations on me and never hesitate to sacrifice for any good of my life. Thanks to my sisters and brothers for their love! Finally, I would like to thank my wife and son, Tija and Erjoni, for their love and support!

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Appendix 1 Questionnaire

Questionnaire number _____

Date of interview……....
Location……
Altitude……..
Coordinates……
Interviewer……..
Farmer's name…… Contact……..…..

	No.	Questions	Responses	Remarks
Information on farmer household	1.	Gender of interviewee	Male ☐ Female ☐	
	2.	Age of interviewee	.....	
	3.	Level of formal education	Primary School ☐ Secondary School ☐ Tertiary education ☐ No formal education ☐	
	4.	Number of household members	.....	
	5.	On-farm employment	.....	
	6.	Is agriculture your primary profession?	Yes ☐ No ☐	
Information on locally adapted common bean cultivars [landraces] and their associated traits	7.	Which varieties do you growth? (local names)	....	
	8.	What type of variety is it? (one at a time)	a. modern variety..... b. locally adapted cultivar	
	9.	For how long have you growth this cultivar?(years)	....	
	10.	Why do you growth this cultivar?	....	
	11.	What Qualitative do you like with this cultivar?	....	
	12.	Is there any disadvantage with this cultivar?	....	
	13.	Do you growth it for household consumption or for sale?	a. household consumption b. sale in the local market c. sale in the commercial market....., etc.	
	14.	Where do you sell it? (location)	.....	
	15.	How big is the field (area in ha) with this seed?	.....	
Information on practices used for	16.	Is it your own field?	Yes ☐ No ☐	

maintenance of common bean cultivars [landrace] on-farm	17.	Way of cultivation.	a) Mixed b) Monoculture	
	18.	How can you describe this field in terms of topography, slope aspect, soil characteristics, drainage, etc?	…… …… …… ……	
	19.	Can you growth this cultivar under different environmental conditions or it needs specific conditions?	…… …… …… ……	
	20.	Where did originally you get the seed?	a. from farm store (own seed), b. from neighbour (within village), c. from a neighbouring village, d. bought from the local market., etc.	
	21.	What crop was planted last year?	……	
	22.	How is the seed-harvest made?	……	
	23	How much yield do you get?	……	
	24.	Do you select/save the seed for the next cropping season? (every year)	Yes ☐ No ☐	
	25.	When do you select the seed?	a. in the field before harvest. b. during harvest. c. in the farm store before planting., etc.	
	26.	Who is doing the selection?	…… ……	
	27.	What is the criterion used for seed selection and why?	…… ……	
	28.	Other than seed selection, what else do you do to manage the seed, in different stages of the cultivation cycle until seed storage?	…… …… …… ……	
	29.	At which stage do you apply each practice?	…… ……	
	30.	Why do you apply this practice?	…… ……	
	31.	How is it done?	……	
	32.	Do you think you would be able to achieve this seed without these practices?	…… …… ……	
	33.	Is any practice in the cultivation cycle more important than others? If so, mention which and how it is.	…… …… …… ……	
	34.	Do you encounter any problems during the cultivation cycle?	…… …… ……	

	35.	How do you solve your problems?	…… ……	
	36.	Do you get any assistance?	…… ……	
	37.	What do you suggest to be done?	…… ……	
	38.	Do you think the next generation will continue to growth this seed?	Yes ☐ No ☐ I don't know! ☐	
	39.	Why do you think so?	…… ……	
	40.	What is not included in this survey which you think is important to discuss?	…… …… ……	
	41.	What is your general opinion?	…… ……	
	42.	Do you want to get results from this investigation?	Yes ☐ No ☐	

Appendix 2 Summary for quantitative characters

Acc. number	Number of pods per inflorescence	Number of seeds per pod	Pod length (cm)	Pod width (mm)	Grow habit (cm)	Wight of 100 seeds (g)	Germination (%)
KS-001	3	4.60	13.61	15.3	278.6	66.69	99.75
KS-002	4	2.90	11.87	15.4	257.4	86.45	100.00
KS-003	3	4.50	14.01	15.0	264.2	66.89	99.75
KS-004	4	4.80	13.97	15.0	281.4	57.67	99.25
KS-005	5	4.70	12.94	14.3	299.8	52.77	98.00
KS-007	3	4.50	12.50	14.1	246.0	54.99	98.25
KS-008	3	3.00	9.92	13.0	181.4	67.13	98.25
KS-009	5	4.80	12.70	9.6	63.4	29.20	97.25
KS-010	5	4.00	12.84	14.3	256.0	61.77	98.00
KS-011	2	2.40	10.15	14.7	220.0	58.98	98.25
KS-012	4	3.50	10.37	11.6	44.6	44.59	97.75
KS-013	3	4.40	11.98	13.5	168.8	40.21	97.50
KS-014	3	4.10	12.95	14.0	266.6	51.74	99.25
KS-015	2	3.50	9.86	11.7	66.6	36.23	100.00
KS-016	4	5.20	12.35	12.2	150.8	59.47	99.25
KS-017	4	4.90	13.91	14.7	277.0	57.92	99.50
KS-018	4	4.60	13.31	13.8	241.0	54.87	98.50
KS-019	3	3.40	12.85	15.1	219.6	67.32	100.00
KS-020	2	4.00	13.05	15.0	222.8	53.99	100.00
KS-021	3	3.50	12.70	15.7	314.6	65.90	99.75
KS-022	3	2.80	10.88	15.0	269.4	66.05	100.00
KS-023	5	4.30	14.30	15.2	272.8	67.42	99.75
KS-024	4	3.90	13.25	15.1	285.2	71.39	99.50
KS-025	2	6.40	18.06	19.0	273.2	44.93	100.00
KS-026	3	4.20	14.45	14.3	276.4	58.09	100.00
KS-027	4	5.10	14.82	14.9	290.0	64.41	100.00
KS-028	4	4.60	14.65	15.3	309.2	54.44	99.75
KS-029	6	4.30	14.63	15.6	306.6	73.94	100.00
KS-030	4	4.70	15.00	15.4	306.2	69.50	100.00
KS-031	4	5.60	15.55	16.4	254.4	76.82	99.75
KS-032	3	5.50	11.39	11.3	271.0	33.10	98.50
KS-033	4	5.80	13.87	13.5	290.0	50.69	100.00
KS-034	3	4.00	13.36	15.2	260.6	62.78	98.00
KS-035	4	3.30	13.39	17.5	217.4	74.18	95.50
KS-036	2	4.30	12.26	12.8	141.2	48.16	100.00
KS-037	3	3.70	12.27	14.3	140.6	60.39	100.00
KS-038	3	4.00	13.18	15.7	158.8	69.13	100.00
KS-039	2	4.00	10.55	13.3	66.4	64.25	99.75
KS-040	3	3.80	11.58	13.2	117.2	48.96	99.00
KS-041	2	4.00	10.70	12.6	80.8	56.12	100.00
KS-042	6	4.20	14.03	13.6	305.0	59.99	98.75
KS-043	3	4.40	13.06	13.5	202.0	55.73	97.25
KS-044	4	3.80	10.09	13.0	63.4	41.15	100.00

KS-045	6	4.20	13.82	20.5	308.0	114.87	98.75
KS-046	3	3.30	11.87	12.4	76.2	58.06	97.00
KS-047	2	4.90	13.69	13.8	108.8	53.01	99.00
KS-048	2	4.60	14.18	13.8	209.2	58.44	99.25
KS-049	4	4.40	11.29	13.3	200.6	69.02	98.25
KS-050	4	3.90	12.43	14.1	109.4	59.29	97.75
KS-051	4	4.00	13.08	13.7	109.2	58.53	98.75
KS-052	2	3.60	11.80	13.7	95.0	44.76	97.50
KS-053	4	3.00	10.82	18.6	287.0	103.30	98.25
KS-054	2	3.60	12.32	15.8	106.0	62.25	98.00
KS-055	3	3.60	12.66	14.2	95.6	64.23	93.25
KS-056	4	3.80	12.47	12.6	84.0	45.09	99.75
KS-057	3	3.90	12.25	13.3	133.6	47.48	100.00
KS-058	3	4.40	10.08	10.6	46.0	25.89	100.00
KS-059	4	5.70	15.07	14.8	327.0	60.23	100.00
KS-060	4	8.60	23.74	16.2	311.6	48.86	100.00
KS-061	3	4.40	13.63	14.0	120.0	58.77	99.25
KS-062	3	4.60	14.62	13.9	328.0	62.56	100.00
KS-063	3	4.30	12.72	14.3	97.4	42.12	96.25
KS-064	5	8.70	21.55	11.2	302.0	46.22	98.75
KS-065	3	3.70	13.07	13.2	59.0	63.08	99.00
KS-066	4	5.10	14.52	13.5	209.0	53.73	100.00
KS-067	4	4.30	13.44	13.0	195.0	58.38	98.00
KS-068	3	4.50	15.06	15.5	209.0	56.59	99.75
KS-069	3	4.30	14.01	14.6	206.6	64.47	100.00
KS-070	3	3.60	13.48	15.4	166.0	61.86	97.25
KS-071	3	3.90	13.75	15.2	143.2	46.06	95.75
KS-072	2	4.30	13.85	13.8	98.4	54.52	97.00
KS-073	2	3.00	11.51	14.8	90.6	51.64	98.50
KS-074	2	3.30	12.93	16.1	83.0	53.47	98.75
KS-075	2	3.80	12.89	14.0	114.0	54.13	99.25
KS-076	3	4.70	14.10	14.6	161.0	58.64	99.25

Appendix 3 Form of tasty estimation

Scoring table

Acc. Num:_____	Scores			Remarks
	1	3	5	
Colour				
Size				
Cooked				
Tasty				
Total of scores:				

Ranking into categories

Rank	Scores	
	Min	Max
I	16	20
II	11	15
III	4	10

Name: _____

Appendix 4 Passaport data form

1. Accession number KS-_____
2. Crop species _____
3. English name_____
4. Local name _____
5. Municipality_____
6. Collector's number_____
7. Collector's name_____
8. Donor's name _____
9. Village_____
10. Municipality_____
11. Region_____
12. Altitude_____
13. Latitude_____
14. Longitude_____
15. Soil: Sandy, Sandy loam, Silt loam, Clay, Silt, Black, _____
16. Topography: Swamp, Floodplain, Level, Undulating, _____
17. Status: Landraces, Primitive cultivar, Breeder's line.
18. Sample source: Field, Farm store.
19. Habitat: Cultivated.
20. Materials: Herbarium, Live plants, Inflorescence, Seeds.
21. Cultivating practices: Rained, Irrigated, Arid, Wet.
22. Associated Crop: Mono, Mixed with_____
23. Sampling method: Random, Selective.
24. Insect: _____
25. Disease: _____

Date: _____