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Full Length Article

Multicrop Legume Germplasm Collection in Oman

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Abstract

A wide range of indigenous varieties of different legume crops has been available in Oman since time immemorial, as these crops are preferred by farmers for their cooking quality and affinity. This paper focuses on the outputs of a collecting expeditions of indigenous legume germplasm for their conservation to avoid extinction due to new emerging edaphic (temperature, salinity, drought etc.) and biotic (insects, pests, diseases etc.) stresses being faced as a result of climate change and to ensure food security of the country. In all, 303 seed samples of land races/accessions in nine legume crops were collected from seven governorates, 187 of which were from seven food legume crops collected from 110 sites. The highest number of accessions was found in cowpea (*Vigna unguiculata* subsp. *unguiculata*) (64) followed by faba bean or broad bean (*Vicia faba*) (41), field peas (*Pisum sativum*) (27), mung bean (*Vigna aureus*) (25), chickpea (*Cicer arietinum*) (13), lentil (*Lens culinaris*) (11) and pigeon pea (*Cajanus cajan*) (6). South Batinah had the most legume accessions collected (70), mainly from w*ilayat* Rustaq, followed by Interior (66), Sharqiya (63) Dhahira and Buraimi (46), Dhofar governate (23) and North Batinah (15). In alfalfa (*Medicago sativa*), 67 seed samples/accessions were collected from 62 sites, with the most (25) from Sharqiya, 20 from Interior, 8 each from North Batinah and Dhahira and Buraimi, 6 from South Batinah and none from Dhofar. In fenugreek (*Trigonella foenum-graecum*), 49 seed samples/accessions were collected from 43 sites, with the most from Batinah South (14) represented mostly by Rustaq, followed by Interior (13), Sharqiya (12) and Dhahira and Buraimi (10). The seed accessions were diverse with respect to the seed characters studied i.e., seed length (cm) and width (cm), 100-seed weight (g) and seed color. The diverse nature of the legume seed accessions and their genetic erosion are discussed.

Keywords: Landraces; Accessions; Seed characters; Diversity; Legumes

Introduction

The Sultanate of Oman has three physiographic regions resembling coastal plain- Batinah Plain in the north, which is the principal agricultural area (more than 50%), the Salalah Plain in the south mountain ranges with peaks from 1,000 to 3,000 m that occupy 15% of the total area (309, 500 km^2) of the country and Interior parts between the coastal plain and the mountains in the north and south, consisting of several plains with elevations not exceeding 500 m. The cultivatable area is about 2.2 million ha, which forms 7% of the total area of the country. The cultivated area was 72,299 ha in 2010, of which fruits occupied up to 53.07% followed by perennial and annual fodder crops (30.41%), vegetables (10.73%) and field crops (5.79%) (MAF, 2010).

The Sultanate is characterized by diversified crops, fruits, fodders and medicinal plants, which are adapted to unique ecological conditions and varied climates. Oman considers annual food legumes and alfalfa, as national strategic crops for food security. Among the annual food legumes, chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), faba bean or broad bean (*Vicia faba*), field peas (*Pisum sativum*) and pigeon pea (*Cajanus cajan*) are grown in winter and mung bean (*Vigna aureus*) in summer for grains whereas dual purpose multicut-cowpea (*Vigna unguiculata* subsp. *unguiculata*) is grown in summer for green fodder and food grains. Alfalfa (*Medicago sativa* L.) is the only perennial fodder legume that forms an integral part of farm life in the Sultanate as every farmer desires to grow it to feed his goats, sheep, cattle or camels, which is common throughout the Arabian Peninsula (MAF, 2010). Fenugreek (*Trigonella foenum-graecum*) is another important winter grain legume among only a few farmers who are aware of its medicinal importance (MAF, 2005). Due to varied ecological conditions, a wide range of indigenous varieties

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of different legumes crops is grown in Oman. In alfalfa, different agro-ecotypes have been recognized over time, mainly on the basis of longevity throughout the agricultural areas of the country.

Of late, climate change at a global level is threatening biodiversity, which provides indigenous plant genetic resources, which are used as raw materials for breeding high yielding elite genotypes, upon which present day agriculture depends. Thus, climate change not only affects ecosystem function, but also leads gradually to extinction of indigenous plant genetic resources.

In Oman, due to changing land use patterns resulting from climate change and the gradual introduction of high-yielding varieties, local indigenous germplasm of legume crop species is slowly disappearing. In the past 30 years, several collecting missions have been undertaken in collaboration with international organizations/institutes and national stakeholders like Ministry of Agriculture and Fisheries and the Sultan Qaboos University (Guarino, 1990; Ferguson, 1999; Osman *et al*., 2002; Jaradat *et al*., 2004a, b) to collect more than 1000 germplasm accessions of crops grown in Oman. In view of above, series of joint-collecting missions were undertaken between April 2008 and October 2009 under His Majesty Grants Project entitled "Conservation and Utilization of Legume Diversity in Oman—A Molecular Approach", to explore diversity of indigenous accessions of different legume crops from different sites within seven governorates of Oman namely Al-Batinah (coastline) governorates (South and North), Al-Dakhliya (interior), Al-Sharqiya governorates (North and South), Al-Dhahira and Buraimi and Dhofar (southern Oman), document such resources, study their seed variability and conserve them.

Materials and Methods

Seven exploration trips for the collection of indigenous germplasm of alfalfa and food legumes like chickpea, faba bean, cowpea, lentil, field pea, mung bean and pigeon pea, and the medicinal legume fenugreek were undertaken from April 2008 to October 2009 in different Governorates of Oman with the support of the staff of Agriculture Development Centers of the Ministry of Agriculture and Fisheries following standard method of collecting missions (IPGRI, 1995; Hay and Probert, 2011) from individual farmers, farmers-fields and stores, and Agriculture Development Centers with passport data and site descriptions including GPS data, electrical conductivity and pH of soil and water samples (Table 1). The area covered during the trips lies between coastal and interior plains from 12 m to 1,983 m altitude. In all, 156 collecting sites were visited. Indigenous accessions of food legumes viz. chickpea, faba bean, lentil, cowpea, field pea, mung bean and pigeon pea, were collected from all 110 sites (Table 1) and that of alfalfa (Table 1) and fenugreek (Table 3) were collected from 62 and 43 sites, respectively.

Various seed characters such as seed length and width (cm), test weight (100 or 1,000 seeds respectively for large- or small-seeded legume species), seed color and nature of seed samples (pure or mixed) were determined in the laboratory. Seed color of samples of grain legumes have previously been studied: chickpea (Qureshi *et al*., 2004; Bishaw and van Gastel, 2007), faba bean (Bishaw and van Gastel, 2007), lentil (Vandenberg and Slinkard, 1970; Bishaw and van Gastel, 2007), cowpea (Ghalmi *et al.*, 2009), field pea (Dijkstra and van Soest, 1986), mung bean (Katiyar *et al*., 2007) and pigeon pea (Reddy *et al*., 2005), alfalfa (Anonymous, 1991) and fenugreek (Altuntas *et al*., 2005; McCormick *et al*., 2009).

Results

Food Legumes

Seed samples of 187 land races of seven food legume crops were collected from the seven governorates of the country (Table 2). Wide diversity was found in cowpea (64) in terms of the most accessions collected, followed by faba bean (41), field peas (27), mung bean (25), chickpea (13), lentil (11) and pigeon pea (6). South Batinah area represented the most legume accessions (70), which were collected mainly from the mountainous parts of Rustaq, followed by the areas of Interior (66), Sharqiya (63), Dhahira and Buraimi (46), Dhofar (23) and North Batinah (15). Tables 3 to 9 show the range of diversity among the collected accessions, based on several seed characters for chickpea, faba bean, cowpea, lentil, field pea, mung bean and pigeon pea. Variability studies focused on cowpea, faba bean, field pea and mung bean since more genotypes/accessions were collected, with wide diversity in terms of seed characters.

Chickpea (*Cicer arietinum* L.)

Despite chickpea being one of the main winter grain legumes in Oman, only 13 seed samples/accessions were collected from three governorates i.e., Interior (7) and Batinah South represented by Rustaq (5) and Dhahirah (1) (Tables 2 and 3). Seed accessions were diverse with respect to all seed characters studied (Table 3). Seed length varied from 0.645 cm (No. 34) to 1.210 cm (No. 69); seed width ranged from 0.505 cm (No. 8) to 1.005 cm (No. 69); 100-seed weight ranged from 12.6 g (No. 8) to 67.9 g (No. 69). With respect to seed color, five accessions were homogeneous (pure) and eight were heterogeneous (mixture). Accession no. 58 collected from interior was unique with its homogeneous light brown seeds, whereas nos. 143 and 144 collected from Batinah South had interesting Heterogeneous seed samples, with seed colors of bright light straw, pinkish and greenish (Table 3).

Table 1: Governorates, *wilayats* and villages along with latitude (N), longitude (E), Northing, Easting and altitude of each site where indigenous legume accessions were collected

Sr. No	Site No	Governorate	*Wilayat*	Village/location	Latitude (N)	Longitude (E)	Altitude	Crop of collections
1	1	Interior	Nizwa	Tanouf	23° 02.00'	57° 43.45'	604	Chickpea, Fenugreek, Faba bean, Alfalfa
2	3	Interior	Nizwa	Nizwa city	22° 57.80'	57° 31.67'	508	Chickpea, Alfalfa, Cowpea
*3	4	Interior	Manah	Mhuol	-	-	-	Mung bean
*4	5	Interior	Manah	Al Mamarah	-	-	-	Cowpea
5	7	Interior	Manah	Manah Al Blaad	22° 47.88'	57° 35.98'	430	Fenugreek
6	8	Interior	Nizwa	Jabel Akhdar	23° 04.35'	57° 39.62'	1,927	Fenugreek, Chickpea, Field pea, Cowpea
7	9	Interior	Nizwa	Jabel Akhdar	23° 04.07'	57° 39.29'	1,829	Faba bean
8	10	Interior	Adam	Alsmeerat	22° 22.38'	57° 31.95'	278	Fenugreek, Field pea
9	11	Interior	Adam	Al Belad	22° 22.65'	57° 31.70'	308	Alfalfa, Faba bean
10	12	Interior	Adam	Seih A slam	22° 31.05'	57° 31.20'	325	Alfalfa, Cowpea, Fenugreek
11	13	Interior	Bahla	Al-Khtwah	22° 59.32'	57° 17.91'	363	Mung bean
12	14	Interior	Bahla	Alfeth Old village	22° 55.27'	57° 18.51'	555	Chickpea, Fenugreek, Cowpea
13	15	Interior	Bahla	Tawee A Nuseif	22° 57.66'	57° 12.63'	583	Chickpea, Alfalfa
*14	17	Interior	Al Hamra	Musfat Al Abreen	-	-	-	Chickpea, Fenugreek, Alfalfa
15	18	Interior	Al Hamra	Al Qlaah	23° 05.28'	57° 17.40'	647	Cowpea
16	20	Interior	Al Hamra	Ghamour	23° 05.02'	57° 16.45'	663	Cowpea, Fenugreek
17	21	Interior	Bahla	Bilad Sait	23° 01.98'	57° 16.00'	723	Chickpea
18	21b	Interior	Bahla	Bilad Sait	23° 01.88'	57° 15.93'	605	Faba bean, Alfalfa
19	22	Interior	Al Hamra	Jabel Shams	23° 15.52'	57° 09.95'	1,680	Lentil
20	23	Batinah South	Rustaq	Haat	23° 11.34'	57° 24.52'	1,978	Fenugreek, Field peas, Faba bean
21	24	Batinah South	Rustaq	Balad Sait	23° 11.16'	57° 23.51'	1,983	Chickpea, Faba bean, Fenugreek, Field peas,
22	25	Dhahira	Ibri	Bilad Al-Shahoom	23° 23.26'	56° 57.57'	884	Field peas, Mung bean, Lentil
23	26	Dhahira	Ibri	Bilad Al-Shahoom	23° 23.94'	56° 57.91'	793	Fenugreek, Field peas, Faba bean
24	27	Dhahira	Ibri	Bilad Al-Shahoom	23° 23.71'	56° 59.01'	924	Field peas
25	28	Dhahira	Ibri	Bilad Al-Shahoom	23° 22.96'	57° 00.57'	947	Field peas, Lentil, Mung bean, Chickpea, Faba bean, Pigeon pea
26	29	Dhahira	Ibri	Bat	23° 15.22'	56° 45.23'	508	Alfalfa, Fenugreek, Cowpea, Faba bean, Lentil
27	30	Dhahira	Ibri	Alablaah	23° 04.84'	56° 54.14'	580	Cowpea, Fenugreek, Alfalfa, Field peas
28	31	Dhahira	Ibri	Baroot	23° 14.55'	57° 02.47'	716	Alfalfa, Cowpea
29	32	Interior	Bahla	Sint	23° 07.96'	57° 04.64'	952	Alfalfa, Fenugreek, Faba bean, Lentil
30	33	Dhahira	Dank	Aqaib-Kumairah	23° 56.15'	56° 16.87'	860	Fenugreek, Field peas
31	34	Dhahira	Dank	Mazraa alfateh	23° 46.21'	56° 10.32'	456	Pigeon pea
32	35	Dhahira	Yanqul	Dhahar Faris	23° 38.72'	56° 38.44'	480	Lentil
33	36	Dhahira	Yanqul	Al-Bouwerdah	23° 38.72'	56° 38.44'	480	Lentil
34	37	Dhahira	Yanqul	Al-Bouwerdah	23° 38.06'	56° 29.76'	586	Alfalfa, Field peas, Fenugreek, Lentil
35	38	Dhahira	Yanqul	Al-Bouwerdah	23° 41.89'	56° 30.33'	623	Mung bean, Fenugreek, Field peas, Faba bean
*36	42	Batinah South	Rustaq	Amq	-	-	-	Faba bean, Alfalfa, Fenugreek
37	43	Batinah South	Rustaq	Amq	23° 17.45'	57° 19.72'	285	Faba bean, Field peas
38	44	Batinah South	Rustaq	Al-Ayeer	23° 12.79'	57° 27.56'	723	Fenugreek, Faba bean, Field peas, Mung bean, Chickpea
39	45	Batinah South	Rustaq	Azammah	23° 13.48'	57° 24.79'	614	Cowpea, Alfalfa
*40	46	Batinah South	Rustaq	Fasah	-	-	-	Faba bean
41	47	Batinah South	Rustaq	Al-Hajeer	22° 12.32'	59° 30.39'	655	Chickpea
42	48	Batinah South	Rustaq	Al-Hajeer	23° 12.38'	57° 30.66'	659	Chickpea
43	49	Batinah South	Rustaq	Stal	23° 12.67'	57° 33.32'	655	Faba bean
44	50	Batinah South	Rustaq	Al Hodineeyah	23° 11.15'	57° 37.81'	769	Faba bean, Field peas
45	51	Batinah South	Rustaq	Al Ghasahb	23° 24.97'	57° 25.92'	274	Alfalfa, Field peas, Faba bean, Chickpea
46	52	Batinah South	Rusaq	Almari	23° 27.89'	57° 02.19'	678	Faba bean, Fenugreek, Field peas
47	53	Batinah South	Rustaq	Dhabaa	23° 26.99'	57° 06.82'	632	Mung bean, Fenugreek
48	54	Batinah South	Rusaq	Dhabaa	23° 26.86'	57° 06.86'	626	Faba bean
*49	55	Batinah South	Rusaq	Al Dahir	-	-	-	Mung bean, Cowpea, Faba bean, Field peas, Fenugreek
50	56	Batinah South	Rustaq	Atayeeb	23° 25.40'	57° 09.78'	557	Alfalfa, Lentil, Faba bean, Field peas, Mung bean, Fenugreek
51	57	Batinah South	Rustaq	Almahdooth	23° 30.52'	57° 11.42'	482	Alfalfa, Faba bean, Cowpea, Field peas
52	58	Batinah South	Rustaq	Almahdooth	23° 30.57'	57° 11.36'	476	Lentil, Cowpea, Field peas, Fenugreek, Mung bean
53	61	Batinah South	Rustaq	Nezooh	23° 28.92'	57° 17.21'	344	Cowpea, Field peas, Faba bean
54	63	Batinah South	Rustaq	Salm	23° 28.36'	57° 17.95	366	Cowpea, Mung bean
55	64	Batinah South	Wadi Al-Maawel	Alghubrah	23° 16.41'	57° 41.78'	536	Faba bean, Cowpea
56	66	Batihah South	Nakhal	Alqoorah	23° 05.38'	57° 44.20'	1,322	Field peas
***57**	67	Batinah South	Rustaq	Algroof (Jabel Daw)	-	-	-	Faba bean
***58**	68	Batinah South	Rustaq	Al Helah	-	-	-	Faba bean

Table 1: Continued

Table 1: Continued

59	69	Batinah South	Rustaq	Makham	23° 25.93'	57° 07.39'	602	Faba bean
60	70	Batinah South	Rustaq	Alkhoof	23° 08.29'	57° 08.29'	579	Fenugreek, Faba bean, Pigeon pea, Mung bean
*61	72	Batinah South	Rustaq	Mori Wadi Bani Ghafer	-	-	-	Fenugreek, Faba bean, Alfalfa
62	73	Interior	Bid'bid	Al-Buwareed	23° 31.55'	57° 16.15'	230	Fenugreek
63	74	Interior	Bid'bid	Al-Rujh	23° 33.40'	57° 21.52'	277	Alfalfa,
64	75	Interior	Bid'bid	Nidab	23° 12.78'	58° 8.02'	454	Alfalfa
65	76	Interior	Bid'bid	Lizzak	23° 18.75'	58° 06.01'	287	Alfalfa
66	77	Interior	Bid'bid	Al-Hazam	23° 19.20'	58° 07.01'	401	Alfalfa, Pigeon pea
67	78	Interior	Sumail	Tawi Dahman	23° 18.11'	58° 22.22'	305	Alfalfa
68	80	Interior	Sumail	Al-Ayanah	23° 02.59'	57° 57.68'	736	Alfalfa, Pigeon pea
69	81	Interior	Izki	Imty	23° 0.58'	57° 47.01'	585	Alfalfa
70	82	Interior	Izki	Zukait	22° 21.43'	57° 44.24'	466	Alfalfa
71	83	Interior	Izki	Al-Humedian	22° 47.14'	57° 52.91'	422	Cowpea, Pigeon pea
72	84	Interior	Izki	Al-Aqil	22° 47.01'	57° 51.23'	432	Alfalfa
73	85	Buraimi	Buraimi	Hamasah	24° 14.78'	55° 46.14'	269	Alfalfa
74	88	Buraimi	Buraimi	Al-Hail	-	-	-	Alfalfa
75	89	Buraimi	Buraimi	Al-Hail	24° 12.31'	56° 13.94'	501	Fenugreek, Cowpea
*76	90	Buraimi	Buraimi	Al-Raabi	-	-	-	Fenugreek, Alfalfa
77	91	Buraimi	Mahdah	Mukteebyyah	24° 54.35'	55° 50.55'	421	Alfalfa
78	92	Buraimi	Madhah	Al Khabeen	-	-	-	Fenugreek
79	96	Sharqiya	Al-Qabel	Bateen	22° 45.42'	58° 41.40'	442	Cowpea, Alfalfa, Fenugreek, Pigeon pea
80	97	Sharqiya	Al-Qabel	Bateen	22° 39.25'	58° 41.13'	442	Alfalfa, Cowpea, Fenugreek
81	98	Sharqiya	Al-Qabel	Al-Neba	22° 43.72'	58° 41.01'	411	Cowpea, Alfalfa
82	99	Sharqiya	Al-Qabel	Al-Dubaha	22° 35.89'	58° 10.97'	625	Alfalfa, Fenugreek, Mung bean
83	100	Sharqiya	Wadi Bani Khalid	Al-Raaki	22° 36.13'	59° 04.48'	857	Fenugreek, Alfalfa
84	101	Sharqiya	Wadi Bani Khalid	Al-Raaki	22° 36.13'	59° 04.48'	835	Alfalfa
85	102	Sharqiya	Ibra	Al-Yahmadi	22° 46.59'	58° 31.24'	49	Alfalfa
86	103	Sharqiya	Ibra	Al-Hiamah	22° 48.58'	58° 26.70'	565	Fenugreek
87	104	Sharqiya	Ibra	Al-Hiamah	22° 48.76'	56° 25.93'	500	Alfalfa
88	105	Sharqiya	Ibra	Al-Hiamah	22° 49.97'	58° 25.72'	521	Alfalfa
89	106	Sharqiya	Ibra	Al-Khoodood	22° 52.02'	58° 25.93'	565	Cowpea, Alfalfa, Fenugreek,
90	107	Sharqiya	Mudhaibi	Al-Rawadah	22° 53.10'	58° 13.12'	610	Alfalfa
91	109	Sharqiya	Mudhaibi	Al-Rawadah	22° 53.05'	58° 13.25'	617	Alfalfa, Cowpea, Fenugreek
92	110	Sharqiya	Mudhaibi	Wadi Endam	22° 52.71'	58° 00.31'	576	Alfalfa, Fenugreek, Faba bean, Cowpea
93	111	Sharqiya	Mudhaibi	Al-Kreesheefah	22° 16.75'	58° 02.70'	245	Cowpea, Alfalfa
94	112	Sharqiya	Mudhaibi	Al-Kreesheefah	22° 16.52'	58° 02.83'	252	Alfalfa, Cowpea
95	113	Sharqiya	Mudhaibi	Al-Wafi	22° 37.19'	57° 59.89'	370	Alfalfa
96	114	Sharqiya	Wadi Atayeen	Asubal	23° 07.22'	58° 31.72'	439	Cowpea, Mung bean
97	115	Sharqiya	Wadi Atayeen	Asubal	23° 06.87'	58° 32.09'	434	Alfalfa, Fenugreek, Cowpea
98	116	Sharqiya	Wadi Atayeen	Alomsa	22° 58.82'	58° 31.87'	550	Cowpea, Alfalfa
99	117	Sharqiya	Wadi Atayeen	Sedab	22° 59.87'	58° 45.07'	320	Alfalfa, Cowpea
100	118	Sharqiya	Wadi Atayeen	Maqtaa	22° 49.33'	58° 59.33'	1,089	Mung bean, Cowpea, Fenugreek
101	120	Sharqiya	Wadi bani Khalid	Al-Qaryah	22° 35.97'	59° 05.37'	611	Cowpea
102	121	Sharqiya	Wadi bani Khalid	Al-Qaryah	-	-	-	Alfalfa
103	122	Sharqiya	Wadi Bani Khalid	Al-Hajrh	22° 35.93'	59° 04.87'	594	Alfalfa, Cowpea
104	123	Sharqiya	Wadi Bani Khalid	Al-Hajrh	23° 35.93'	60° 04.87'	595	Cowpea
105	124	Sharqiya	Wadi Bani Khalid	Halfah	22° 33.61'	59° 06.47'	529	Alfalfa, Cowpea, Fenugreek
106	125	Batinah North	Liwa	Helat Shaik	24° 30.94'	56° 33.91'	26	Alfalfa
107	126	Batinah North	Liwa	Helat Alhassan	24° 30.30'	56° 33.03'	28	Cowpea, Alfalfa
108	127	Batinah North	Liwa	Helat Shaik	24° 30.42'	56° 33.33'	20	Alfalfa
109	128	Batinah North	Sohar	Wadi Aheer	23° 59.35'	56° 28.93'	467	Cowpea, Fenugreek
110	129	Batinah North	Sohar	Wadi Aheer	23° 59.35'	56° 28.93'	467	Mung bean
111	130	Batinah North	Sohar	Wadi Hibi	23° 53.19'	56° 32.27'	615	Field peas
112	131	Batinah North	Sohar	Al-Mehab	24° 00.59'	56° 41.56'	228	Alfalfa, Cowpea
113	132	Batinah North	Saham	Shedah	23° 59.41'	56° 38.85'	343	Alfalfa
114	133	Batinah North	Saham	Al-Muntafah	24° 02.68'	57° 00.24'	12	Alfalfa
115	134	Batinah North	Saham	Haret Al Gahafel	-	-	-	
116	135	Batinah North	AL-Khabourah	Al-Sahrah	23° 51.81'	56° 38.36'	544	Alfalfa
117	136	Batinah North	Suwaiq	Al-Musaifiah	23° 36.66'	57° 08.16'	382	Cowpea
118	137	Batinah North	Suwaiq	Al-Musaifiah	23° 36.61'	57° 08.16'	382	Faba bean
119	138	Dhofar	Salalah	Wadi Nahees	-	-	-	Cowpea
120	139	Dhofar	Salalah	Wadi Naheez Jyam	17° 10.03'	54° 05.15'	295	Cowpea
121	140	Dhofar	Sheheet	Sheheet	17° 12.35'	54° 07.53'	513	Cowpea

Table 1: Continued

Table 1: Continued

122	141	Dhofar	Rakhyoot	Kazaat	-	-	-	Cowpea
123	142	Dhofar	Rakhyoot	Felkatta	-	-	-	Cowpea
124	143	Dhofar	Rakhyoot	Haar	-	-	-	Cowpea
125	144	Dhofar	Thalkoot	Farooq	-	-	-	Cowpea
126	145	Dhofar	Thalkoot	Khazrafee	-	-	-	Cowpea
127	146	Dhofar	Thalkoot	Al-Ghaythoot	16° 43.36'	53° 13.63'	749	Cowpea
128	147	Dhofar	Taqah	Shehat	17° 06.37'	54° 24.57'	452	Cowpea
129	149	Dhofar	Taqah	Shebdate	17° 07.19'	54° 25.68'	487	Cowpea
130	151	Dhofar	Taqah	Geloy	17° 11.10'	54° 27.28'	628	Cowpea
131	152	Dhofar	Mirbat	Qadeeh	17° 04.53'	54° 27.80'	356	Cowpea
132	153	Dhofar	Mirbat	-	17° 06.94'	54° 32.58'	625	Cowpea
133	154	Dhofar	Mirbat	-	17° 06.21'	54° 33.70'	606	Cowpea
134	155	Dhofar	Mirbat	Tharbad	17° 05.13'	54° 34.88'	504	Cowpea
135	156	Dhofar	Mirbat	-	17° 5.61'	54° 33.84'	630	Mung bean

*The team did not visit these sites as seed samples were supplied by Agriculture Development Centers

Table 2: Number of food legume accessions collected from different governorates of Oman between September 2008 and October 2009, together with their vernacular and botanical names

Governorate	Legume Crop Species									
	Chickpea *(Dengo)*	Faba bean *(Baqal)*	Cowpea *(Lobia)*	Lentil *(Adas)*	Field pea (*Gourgour)*	Mung bean *(Ming)*	Pigeon pea *(Toriyan)*	Fenugreek (*Helba*)	Alfalfa (Qat)	Total
	Cicer arietinum	*Vicia faba*	*Vigna unguiculata* Subsp. *unguiculata*	*Lens culinaris*	*Pisum sativum*	*Vigna aureus*	*Cajanus cajan*	*Trigonella foenum-graecum*	*Medicago sativa L.*	
North Batinah	0	0	5	0	1	1	0	0	8	15
South Batinah	5	28	9	3	15	9	1	14	6	90
Interior	7	8	10	2	2	2	2	13	20	66
Sharqiya	0	1	19	0	1	4	1	12	25	63
Dhahirah & Buraimi	1	4	4	6	8	3	2	10	8	46
Dhofar (South)	0	0	17	0	0	6	0	0	0	23
Total	13	41	64	11	27	25	6	49	67	303

Table 3: Variation among seed characteristics of top 10 of 13 indigenous chickpea genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorate
1	69	1.21	1.005	67.9	Homogeneous	Bright light straw	Batinah South
2	139	1.16	0.915	63.5	Homogeneous	Bright light straw	Batinah South
3	144	0.925	0.52	39.3	Heterogeneous	Bright light straw, pinkish, greenish	Batinah South
4	143	0.805	0.76	37.8	Heterogeneous	Bright light straw, pinkish, greenish	Batinah South
5	85	0.885	0.8	36.4	Heterogeneous	Bright light straw, brownish, greenish	Dhahira
6	18	0.735	0.605	22.6	Heterogeneous	Bright light straw, greenish	Interior
7	151	0.745	0.65	18.8	Heterogeneous	Bright light straw, green	Batinah South
8	42	0.705	0.605	18.5	Heterogeneous	Bright light straw, green	Interior
9	38	0.665	0.59	17.1	Homogeneous	Bright light straw	Interior
10	34	0.645	0.56	14.5	Heterogeneous	Bright light straw, green	Interior
Statistical Parameters							
Minimum		0.645	0.505	12.600			
Maximum		1.210	1.005	67.900			
Mean		0.820	0.672	30.208			
S.E.(±)		0.055	0.047	5.533			

Faba Bean (*Vicia faba* L.)

Faba bean is a winter grain legume in Oman grown mostly in mountainous wilayats. As many as 41 seed samples/accessions were collected of faba bean, with the most from Batinah South (28), followed by Interior (8), Dhahira and Buraimi (4) and Sharqiya (1) governorates (Tables 2 and 4). Seed accessions were diverse with respect to all seed characters studied (Table 4). Seed length varied from 1.18 cm (No. 27) to 1.50 cm (no. 22); seed width ranged from 0.75 cm (No. 323) to 1.01 cm (No. 22); 100-seed weight ranged from 33.20 g (No. 27) to 55.40 g (No. 22). With respect to seed color, 38 accessions were homogeneous (pure) and 3 were heterogeneous (mixture). Among the homogeneous accessions, all were dark purple except nos. 70, 91, 152 and 158, which had light to dark purple seeds. Three heterogeneous accessions i.e., nos. 73, 179 and 202 had dark purple seeds with few yellowish white seeds (Table 4).

Cowpea (*Vigna unguiculata* L.)

Cowpea is a summer legume crop grown throughout Oman for food and fodder. In cowpea, 64 seed samples/accessions

Table 4: Variation among seed characteristics of top 10 of 41 indigenous faba bean genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorate
1	22	1.5	1.005	55.4	Homogeneous	Dark purple	Interior
2	21	1.42	0.995	53.2	Homogeneous	Dark purple	Interior
3	177	1.415	0.93	51.3	Homogeneous	Dark purple	Batinah South
4	133	1.275	0.86	51.2	Homogeneous	Dark purple	Batinah South
5	80	1.375	0.925	50.5	Homogeneous	Dark purple	Dhahira
6	189	1.32	0.95	50	Homogeneous	Dark purple	Batinah South
7	194	1.22	0.89	49.2	Homogeneous	Dark purple	Batinah South
8	199	1.29	0.865	49	Homogeneous	Dark purple	Batinah South
9	192	1.415	0.87	48.2	Homogeneous	Dark purple	Batinah South
10	80	1.375	0.925	50.5	Homogeneous	Dark purple	Dhahira
Statistical Parameters							
Minimum		1.180	0.750	33.200			
Maximum		1.500	1.005	55.400			
Mean		1.313	0.862	44.218			
S.E.(+)		0.012	0.008	0.816			

Table 5: Variation among seed characteristics of top 10 of 64 indigenous cowpea genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorate
1	327	0.82	0.52	16.3	Heterogeneous	Cream, pinkish cream, black	Dhofar
2	336	0.82	0.52	16.3	Heterogeneous	Light green, cream, pinkish brown, black	Dhofar
3	324	0.84	0.56	15.8	Heterogeneous	Light cream, cream, light brown, dark brown	Dhofar
4	330	0.85	0.52	15.4	Heterogeneous	Light green, cream, light purple, dark brown	Dhofar
5	325	0.795	0.555	15.1	Heterogeneous	Cream, light purple, black pinkish	Dhofar
6	333	0.795	0.555	15.1	Heterogeneous	Cream, light brown, black	Dhofar
7	326	0.74	0.5	14.1	Heterogeneous	Light green, light pinkish, cream	Dhofar
8	334	0.74	0.5	14.1	Heterogeneous	Light green, light brown, dark brown	Dhofar
9	340	0.765	0.51	13.8	Heterogeneous	Light green, light brown	Dhofar
10	347	0.745	0.315	13.7	Heterogeneous	Light green, light pinkish cream, black	Dhofar
Statistical Parameters							
Minimum		0.425	0.295	3.800			
Maximum		0.850	0.560	16.300			
Mean		0.638	0.425	8.767			
S.E.(+)		0.012	0.008	0.457			

Table 6: Variation among seed characteristics of top 10 of 11 indigenous lentil genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorates
1	83	0.45	0.4	32.5	Heterogeneous	Green, tan, brown, mottled	Dhahira
2	174	0.43	0.405	32.3	Heterogeneous	Green, tan, pink, brown	Batinah South
3	162	0.42	0.4	32.2	Heterogeneous	Green, tan, pink, mottled	Batinah South
4	92	0.4	0.35	29.7	Heterogeneous	Green, tan, light brown, mottled	Dhahira
5	103	0.39	0.37	29.1	Heterogeneous	Green, tan, brown, mottled	Interior
6	171	0.42	0.39	27.6	Heterogeneous	Green, tan, pink, brown, mottled	Batinah South
7	120	0.4	0.4	26.1	Homogeneous	Tan, green, mottled	Dhahira
8	116	0.395	0.365	24.9	Heterogeneous	Green, tan, light brown, pinkish, mottled	Dhahira
9	115	0.405	0.385	23.1	Heterogeneous	Green, tan, pink, brown, blackish, mottled	Dhahira
10	62	0.395	0.38	22.9	Heterogeneous	Green, tan, pink, brown, blood red	Interior
Statistical Parameters							
Minimum		0.330	0.320	22.500			
Maximum		0.450	0.405	32.500			
Mean		0.404	0.379	28.000			
S.E.(+)		0.010	0.009	1.193			

were collected, with the most from Sharqiya (19), followed by Dhofar (17), Interior (10), South Batinah (9), North Batinah (5) and Dhahira and Buraimi (4) governorates (Tables 2 and 5). Seed accessions were diverse with respect to all the seed characters studied (Table 5). Seed length varied from 0.425 cm (No. 219) to 0.850 cm (No. 330); seed width ranged from 0.295 cm (No. 219) to 0.560 cm (No. 324); 100-seed weight ranged from 7.900 g (No. 90) to 16.3 g (No. 327 and No. 336). With respect to seed color, only one accession i.e., No. 10 from Interior was homogeneous (pure) with tan, light green seeds whereas the rest (63) were heterogeneous (mixture) with seeds of various colors ranging from light green, cream, light brown, dark brown, black to white mottles. There were 31 groups of seed color of which the largest group had 16 seed accessions followed by a group with 4 accessions, 2 groups with 3 accessions

each and 9 groups with 2 accessions. There were 19 seed accessions bearing nos. 193, 197, 251, 269, 276, 280, 293, 297, 301, 303, 325, 327, 328, 331, 332, 333, 339, 343 and 347 that formed groups of their own due to a unique combination of seed colors (Table 5).

Lentil (*Lens culinaris* Medik)

Lentil is a traditional winter grain legume in Oman which is now restricted in cultivation to a few farmers. Only 11 seed samples/accessions were collected from three governorates: Dhahirah and Buraimi (6), South Batinah represented by Rustaq (3) and Interior (2) (Tables 2 and 6). Seed accessions were diverse with respect to all seed traits studied (Table 6). Seed length varied from 0.33 cm (No. 76) to 0.45 cm (No. 83); seed width ranged from 0.32 cm (No. 76) to 0.41 cm (No. 174); 100-seed weight ranged from 22.5 g (No. 76) to 32.5 g (No. 83). With respect to seed color, two seed accessions i.e., no. 76 and no. 120 were homogeneous (pure) with tan, green, mottled seeds, while the rest (9) were heterogeneous (mixture) with seeds of various colors ranging from green, tan, light brown, brown, pink, mottled. There were eight groups of seed color of which one group had two seed accessions with green, tan, brown, mottled color and the remaining seven seed accessions i.e., nos. 92, 115, 116, 120, 162, 171 and 174 formed groups of their own due to a unique combination of seed colors (Table 6).

Field Pea (*Pisum sativum* L.)

Field pea is a winter legume crop grown in Oman. In field pea, 27 seed samples/accessions were collected, of which the most were from South Batinah represented by Rustaq (15), followed by Dhahira and Buraimi (8), Interior (2), Sharqiya (1) and North Batinah (1) governorates (Tables 2 and 7). Seed accessions were diverse with respect to all seed traits studied (Table 7). Seed length varied from 0.305 cm (No. 78) to 0.720 cm (No. 25); seed width ranged from 0.295 cm (No. 78) to 0.690 cm (No. 25); 100-seed weight ranged from 4.500 g (No. 78) to 21.9 g (No. 25). With respect to seed color, six accessions i.e., No. 25 (tan-light), No. 78 (dark green, mottled), No. 82 (light green), Nos. 173 (dark green, dark brown, mottled) and 178 (brownish green, mottled) and No. 314 (cream, light pink)

Table 7: Variation among seed characteristics of top 10 of 27 indigenous field pea genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorates
1	25	0.72	0.69	21.9	Heterogeneous	Green, tan	Interior
2	314	0.685	0.645	21.2	Homogeneous	Cream, light pink	Batinah North
3	19	0.67	0.635	20.6	Homogeneous	Tan light	Interior
4	82	0.715	0.65	20.4	Homogeneous	Light green	Dhahira
5	72	0.66	0.61	19.5	Heterogeneous	Light green, tan	Batinah South
6	137	0.655	0.615	19.5	Heterogeneous	White cream, green	Batinah South
7	185	0.65	0.64	17.8	Heterogeneous	White cream, light green, light brown, dark brown	Batinah South
8	105	0.62	0.585	16.8	Heterogeneous	Pinkish, cream, green	Dhahira
9	96	0.645	0.585	16.3	Heterogeneous	Green, white cream, tan, pinkish	Dhahira
10	64	0.69	0.405	16.2	Heterogeneous	Green, tan, white cream, black	Batinah South
Statistical Parameters							
Minimum		0.305	0.295	4.500			
Maximum		0.720	0.690	21.900			
Mean		0.597	0.548	14.104			
S.E.(±)		0.016	0.016	0.872			

Table 8: Variation among seed characteristics of top 10 of 25 indigenous mung bean genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorates
1	345	0.76	0.495	12.4	Homogeneous	Green	Dhofar
2	346	0.41	0.39	5.6	Heterogeneous	Green, black	Dhofar
3	338	0.435	0.365	5.1	Heterogeneous	Green, brown, black	Dhofar
4	337	0.45	0.355	5	Heterogeneous	Green, brown, black	Dhofar
5	121	0.44	0.32	4.8	Heterogeneous	Green, black	Dhahira
6	84	0.455	0.35	4.6	Heterogeneous	Green, black	Dhahira
7	176	0.465	0.335	4.6	Heterogeneous	Green, black	Batinah South
8	341	0.455	0.375	4.6	Homogeneous	Green	Dhofar
9	313	0.465	0.335	4.5	Homogeneous	Green	Batinah North
10	183	0.48	0.365	4.4	Heterogeneous	Green, black, brown	Batinah South
Statistical Parameters							
Minimum		0.350	0.245	1.800			
Maximum		0.760	0.495	12.400			
Mean		0.451	0.337	4.371			
S.E.(±)		0.015	0.009	0.388			

were homogeneous (pure). The remaining 21 seed accessions were Heterogeneous (mixture) with seeds of various colors ranging from white cream, cream, light green, tan, light brown, dark brown, black, mottled. There were 18 groups of seed color, of which three groups had two seed accessions whereas 15 seed accessions bearing Nos. 25, 64, 72, 96, 105, 134, 137, 147, 149, 154, 159, 164, 185, 198 and 267, formed groups of their own due to a unique combination of seed colors (Table 7).

Mung Bean (*Vigna radiata* (L.) R. Wilcz)

Mung bean is a winter legume crop grown throughout Oman. In mung bean, 25 seed samples/accessions were collected, of which South Batinah represented the highest (9) followed by Dhofar (6), Sharqiya (4), Dhahira and Buraimi (3), Interior (2) and North Batinah (1) governorates (Tables 2 and 8). Seed accessions were diverse with respect to all seed characters studied (Table 8). Seed length varied from 0.350 cm (No. 335) to 0.760 cm (No. 345); seed width ranged from 0.245 cm (No. 33) to 0.495 cm (No. 345); 100-seed weight ranged from 1.800 g (No. 33) to 12.400 g (No. 345). With respect to seed color, six accessions with Nos. 284, 295, 313, 335, 341 and 345 were homogeneous (pure) with their characteristic green color. The remaining 19 seed accessions were Heterogeneous (mixture) with seeds of various colors such as green, brown and black. There were four groups of seed color, of which the largest group had 12 seed accessions with green, black seed color followed by one group of three seed accessions with green, brown and black seed color and two groups of two accessions, each with green, black, brown and green seeds (Table 8).

Pigeon Pea (*Cajanus cajan* L. (Millsp))

Pigeon pea is a traditional winter grain legume in Oman which is now cultivated by only a few farmers. Six seed samples/accessions were collected from four governorates, i.e., Interior (2), Dhahirah and Buraimi (2), South Batinah (1) and Sharqiya (1) (Tables 2 and 9). Seed accessions were diverse with respect to all seed characters studied (Table 9). Seed length varied from 0.475 cm (No. 247) to 0.6 cm (No. 227a); seed width ranged from 0.210 cm (No. 247) to 0.45 cm (No. 227a); 100-seed weight ranged from 10.3 g (No. 247) to 18.7 g (No. 227a). In respect of seed color, only one accession i.e., No. 206 was Heterogeneous (mixture) with seeds of various colors ranging from tan, light brown, dark brown. The remaining five accessions were homogeneous (pure) with tan, light brown and dark brown seeds. There were three groups of seed color of which two had two seed accessions each with either dark brown (Nos. 87 and 247) or tan, light brown (Nos. 113 and 227a) whereas one seed accession No. 218 had unique brown to dark brown seeds (Table 9).

Variation in Collection Sites

Collection sites varied in their characteristics and altitude. Altitude ranged from 12 m at site No.133 to 1983 m at site No. 24. Soil characteristics also varied with sites ranging in soil texture, i.e. sands, sandy loam, sandy clay, sandy clay loam, clay and loam. Soils were hard, firm or loose, variable-loose to crust and friable. With respect to drainage, soils were imperfect, free or variable. Soil pH ranged from 2.1 (Site No.58 and Site No.65) to 9.9 (Site No. 87). Soil EC varied from 0.02 (Site No.42) to 22.7 (Site No. 51). Soil color ranged from light brown to dark brown).

Alfalfa (*Medicago sativa* L.)

Sixty seven seed samples of alfalfa were collected; the most (25) from Sharqiya, 20 from Interior, 8 each from North Batinah and Dhahira and Buraimi and 6 from South Batinah governorates, whereas none from Dhofar governorate (Table 2). The seed accessions were diverse with respect to all seed characters studied (Table 10). Seed length varied from 0.16 cm (No. 320) to 0.28 cm (No. 44) and seed width ranged from 0.12 cm (No. 289) to 0.26 cm (No. 228). 1000-seed weight varied from 2.7 g (No. 320) to 4.6 g (No. 307). Interestingly, all seed accessions were Heterogeneous (mixture) with seeds of various colors, i.e. tan, greenish yellow, dark yellow, brown to dark brown. Three groups were formed in respect of seed color: the largest group had 30 seed accessions with a mixture of tan, dark brown, dark yellow, yellow, greenish yellow seeds; followed by a group with 24 seed accessions with brown, tan, greenish yellow, dark yellow seeds; and third group had 13 seed accessions with dark brown, brown, yellow, green seeds (Table 10).

Variation in Collection Sites

Collection sites varied in their soil characteristics and altitude. Altitude varied from 12 m (Site No. 133) to 1983 m (Site No. 24). Sites were different in soil texture viz. sands, sandy loam, sandy clay, sandy clay loam, clay and loam. Soils were hard, firm or loose, variable-loose to crust and friable. With respect to drainage, soils were imperfect, free or variable. Soil pH ranged from 2.1 (Site Nos. 58 and 65) to 9.9 (Site No. 87). Soil EC varied from 0.02 (Site No. 42) to 22.7 (Site No. 51). Soil color ranged from light brown to dark brown.

Fenugreek (*Trigonella foenum-graecum*)

49 seed samples/accessions were collected, with the most from Batinah South (14) followed by Interior (13), Sharqiya (12) and Dhahira and Buraimi (10) governorates (Table 2). Seed accessions were diverse with respect to all the seed characters studied (Table 11). Seed length varied from 0.305 cm (No. 71) to 0.420 cm (No. 209); seed width ranged from 0.245 cm (No. 260) to 0.385 cm (No. 02); 1000-seed weight ranged from 8.900 g (No. 49) to 19.7 g (No. 212). With respect to seed color, only one accession i.e. No. 160 was homogeneous (pure) with light green to light brown seeds,

Table 9: Variation among seed characteristics of 6 indigenous pigeon pea genotypes/accessions collected based on 100 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	100 seed weight (g)	Seed color nature	Color	Governorates
1	227 a	0.6	0.45	18.7	Homogeneous	Tan, light brown	Interior
2	206	0.55	0.425	11.5	Heterogeneous	Tan, light brown, dark brown	Batinah South
3	218	0.495	0.365	11.5	Homogeneous	Brown to dark brown	Interior
4	113	0.545	0.25	11.3	Homogeneous	Tan, light brown	Dhahira
5	87	0.5	0.31	11	Homogeneous	Dark brown	Dhahira
6	247	0.475	0.21	10.3	Homogeneous	Dark brown	Sharqiya
Statistical Parameters							
Minimum		0.475	0.210	10.300			
Maximum		0.600	0.450	18.700			
Mean		0.533	0.340	12.660			
S.E.(±)		0.022	0.047	1.526			

Table 10: Variation among seed characteristics of top 10 of 67 indigenous alfalfa genotypes/ accessions based on 1000 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	1000 seed weight (g)	Seed color nature	Color	Governorates
1	307	0.28	0.165	4.6	Heterogeneous	Dark brown, brown, yellow, green	Batinah North
2	252	0.28	0.2	4.5	Heterogeneous	Brown, tan, greenish yellow, dark yellow	Sharqiya
3	259	0.235	0.145	4.2	Heterogeneous	Dark brown, brown, yellow, green	Sharqiya
4	289	0.21	0.12	4.2	Heterogeneous	Brown, tan, greenish yellow, dark yellow	Sharqiya
5	230	0.24	0.17	4.1	Heterogeneous	Tan, dark brown, dark yellow, yellow, greenish yellow	Dhahira (Buraimi)
6	253	0.27	0.18	4.1	Heterogeneous	Tan, dark brown, dark yellow, yellow, greenish yellow	Sharqiya
7	44	0.285	0.175	4.0	Heterogeneous	Tan, dark brown, dark yellow, yellow, greenish yellow	Interior
8	56	0.24	0.15	4.0	Heterogeneous	Brown, tan, greenish yellow, dark yellow	Interior
9	244	0.175	0.2	4.0	Heterogeneous	Brown, tan, greenish yellow, dark yellow	Sharqiya
10	317	0.225	0.15	4.0	Heterogeneous	Tan, dark brown, dark yellow, yellow, greenish yellow	Batinah North
Statistical Parameters							
Minimum		0.160	0.120	2.700			
Maximum		0.285	0.260	4.600			
Mean		0.243	0.157	3.541			
S.E.(±)		0.003	0.003	0.046			

Table 11: Variation among seed characteristics of top 10 of 49 indigenous fenugreek accessions collected based on 1000 seed weight

S. No.	Collection No.	Length (cm)	Width (cm)	1000 seed weight (g)	Seed color	Color	Governorates
1	24	0.365	0.34	19.7	Heterogeneous	Light green, green, yellowish brown	Interior
2	212	0.38	0.25	19.7	Heterogeneous	Light brown, green	Interior
3	203	0.345	0.31	19.1	Heterogeneous	Green, tan, light brown, dark brown	Batinah South
4	272	0.355	0.33	18.0	Heterogeneous	Green, tan, light brown, dark brown	Sharqiya
5	43	0.415	0.385	17.9	Heterogeneous	Light green, dark green, yellowish brown, light brown, dark brown	Interior
6	155	0.35	0.325	17.1	Heterogeneous	Yellowish green, light brown	Batinah South
7	77	0.345	0.315	17.0	Heterogeneous	Green, yellowish green, light brown	Dhahira
8	13	0.4	0.275	16.3	Heterogeneous	Light brown, dark brown	Interior
9	182	0.355	0.335	15.4	Heterogeneous	Green, yellowish green, light brown	Batinah South
10	175	0.365	0.34	14.6	Heterogeneous	Yellowish brown, dark brown	Batinah South
Statistical Parameters							
Minimum		0.305	0.245	8.900			
Maximum		0.420	0.385	19.700			
Mean		0.003	0.005	0.381			
S.E.(±)		0.305	0.245	8.900			

whereas the remaining 48 accessions were Heterogeneous (mixture) with seeds of various colors. There were 16 groups of seed color of which the largest group of 10 seed accessions had green, yellowish green and light brown seeds, a group of 8 seed accessions had light green, dark green, yellowish green, light brown and dark brown seeds, a group of 6 accessions had light and dark brown seeds and a group of 5 accessions had green, light brown and dark brown seeds. There were three groups of 3 accessions each which had (1) green, tan, yellowish brown and dark brown seeds, (2) green, tan, light brown and dark brown seeds and (3) light brown, dark brown and green seeds. There were two groups of 2 accessions each which had (1) brown and dark brown seeds and (2) green, yellowish green, light brown and dark brown seeds. There were seven accessions i.e. Nos. 2, 24, 52, 155, 160, 175 and 212 that formed

groups of their own due to a unique combination of seed colors (Table 11).

Variation in Collection Sites

Collection sites varied in their characteristics and altitude. Altitude ranged from 12 m at site No. 133 to 1,983 m at site No. 24. Soil characteristics also varied. Sites were different in soil texture viz. sands, sandy loam, sandy clay, sandy clay loam, clay and loam. Soils were hard, firm or loose, variable-loose to crust and friable. With respect to drainage, soils were imperfect, free or variable. Soil pH ranged from 2.1 (Site Nos. 58 and 65) to 9.9 (Site No. 87). Soil EC varied from 0.02 (Site No. 42) to 22.7 (Site No. 51). Soil color ranged from light brown to dark brown).

Discussion

A range of germplasm from nine legume crops was collected during the collecting mission through seven governorates of the Sultanate. In the case of food legumes, South Batinah represented 37.43% of collections, followed by Interior (17.65%), Dhahirah and Buraimi (14.97%), Sharqiya (13.90%), Dhofar (South) (12.30%) and North Batinah (3.75%). The lack of collections from North Batinah may be due to non-coverage of its mountainous regions during the collection mission (Table 2). For alfalfa, Sharqiya contributed 37% of collections, followed by Interior (30%), North Batinah and Dhahirah and Buraimi with 12% each, and South Batinah contributing 9%. Interestingly, no samples were collected from Dhofar (South) during this mission. This may be due to its typical edaphic factors and climate including a disease complex known to force perennial Omani ecotypes of other regions to lose their perennial nature and behave like annuals during *Kharif* season (June to November) as they succumb to crown rust. For fenugreek, South Batinah represented the most collections (28.57%), followed by Interior (26.53%), Sharqiya (24.49%) and Dhahirah and Buraimi (20.41%). Interestingly, no samples were collected from North Batinah and Dhofar (South) during this mission, which is attributed to edaphic factors and climate change.

Critical examination of seed samples in the laboratory revealed wide variation in respect to seed coat patterns (color) and seed weights among the collected accessions of leguminous crops. Villages in the vicinity of collecting sites had different seed samples of these leguminous crops. With seed accessions changing from village to village, it is possible that uncollected landraces still exist in other unvisited areas. Seed accessions with Heterogeneous seeds with respect to seed color need to be subjected to intensive purification into sub-groups.

The widespread movement of landraces of these food legumes between *wilayats* and neighboring regions indicates that these landraces are the outcome of centuries of selection for adaptation to local climatic, edaphic and cultural selection forces and consist of unique gene complexes reflecting local agro-climatic evolution (Frankel and Bennett, 1970; Smith *et al.,* 1991; Prosperi *et al.,* 2006; Mathur, 2010). Such landraces may have been more prevalent in subsistence agriculture over 50 years ago; according to one of the farmers, his chickpea and lentil samples were the products of continued harvesting of seed from his forefathers for at least five to seven decades. This was also true for cowpea, faba bean, field peas, mung bean and fenugreek. For alfalfa, one farmer claimed that his seed sample was the product of continued seed harvesting from his forefathers since at least 70 years. This collecting mission provided some evidence regarding the adaptation of Omani landraces based on relatively small samples available with farmers and illustrated the importance of associating the socio-economic context in relation to the collection of germplasm (Vavilov, 1951).

Omani farmers gradually neglected to grow their own indigenous ancestral cultivars/landraces, preferring to grow higher-yielding varieties as evidenced by the comparatively fewer collections of cowpea (13), lentil (11) and pigeon pea (6). On many occasions, we observed that the cooking quality (taste) of food prepared off indigenous Omani cultivars played a significant role in the retention of these landraces with the farmers particularly in case of food legumes. Availability of landraces with farmers indicated a local conservation strategy for sustainable production.

Genetic erosion of landraces of food legumes was observed in all the governorates especially with respect to chickpea and lentil—traditional ancient crops of Oman—which had the least number of collections. Genetic erosion of alfalfa was obvious in Dhofar governorate as the crop continually suffers from an unknown disease complex that recurs every year, killing perennial alfalfa cultivars. In fenugreek, genetic erosion was apparent in both North Batinah and Dhofar as no seed was collected there.

Increasing competition of introduced and locally-released new varieties is a common threat to all landraces. Invariably, farmers prefer landraces for their specific traits, but are gradually compelled to replace their resources due to production constraints, abandonment of traditional agriculture and an apparent shift towards growing cash crops such as vegetables in greenhouses and soil-less culture, all of which lead to loss of genetic diversity in legumes in Oman. Land fragmentation is another reason, particularly for small-scale farmers that selectively grow these landraces. Other factors include changes in land use pattern due to prolonged drought and erratic irregular rainfall resulting from global warming and climate change, and population movement and resettlements, as well as the lack of interest among current farmers to grow low yielding indigenous legume accessions and non-commercial crops like fenugreek as it has only medicinal value.

The Sultanate has been distinguished as a center of origin and domestication of these and many other crops, because of the wide array of agro-ecologies and

socio-cultural diversities (Reddy *et al.*, 2005). Nevertheless, leguminous crop species with small populations, taxa or genotypes with restricted distributions like chickpea, lentil, pigeon pea, alfalfa and fenugreek are most at risk, particularly from changes in socioeconomic and agricultural status of the people. Under such threats of genetic diversity, in an area where and when *in situ* conservation methods are not in use, collection of germplasm is still needed. This is also true with respect to areas subjected to changes in agro-ecologies due to climate change to capture genetic diversity of threatened crops and also those areas where diversity is not sufficiently represented in *ex situ* germplasm collections. The use of nitrogenous fertilizers in crop husbandry practices for these leguminous crops, as observed at most collection sites, suggests that nitrogen fixation might not be well understood by farmers or that there could be local hindrance to biological nitrogen fixation.

Indigenous legume crop accessions collected in this mission may help to conserve diversified legume accessions across the Sultanate and protect them from environmental degradation and from the negative impact of varieties introduced from abroad. Further, such germplasm would be useful in national plant breeding activities to create high yielding elite cultivars with or without resistance traits to both biotic (diseases and pests) and abiotic (salinity, drought, high temperature etc.) factors, and adverse climatic conditions for the purpose of achieving food security, which is one of the recent global challenges.

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