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Cowpea (*Vigna unguiculata* (L.) Walp.) (Fabaceae) landrace diversity in Northern Ethiopia

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This study was carried out to identify and document the landrace (farmers' variety) diversity and ethnobotany of cowpea (*Vigna unguiculata* (L.) Walp.) (Fabaceae) in Northern Ethiopia. A total of 54 germplasm accessions and six representative voucher specimens of cowpea were collected from different geographical locations of Ethiopia ranging from 1260–2140 m a.s.l. within the grid references of 10° 00' to 14° 00' N and 38° 00' to 40° 00' E. Of these, 45 (83%) were local farmers' varieties and 9 (17%) were commercial varieties introduced by the Ethiopian Ministry of Agriculture and the Melkassa Agricultural Research Center (MARC). The majority of farmers (60) (75%) preferred the erect type of cowpea (*Vigna unguiculata* subsp. *cylindrica* (L.) Verdc. farmers' variety locally named KIMITE (short drought resistant) and subsp. *cylindrica* (L.) Verdc. farmers' variety CHEKELE (dry season crop). The spreading type of cowpea (subsp. *unguiculata* farmers' variety JERGADIE - stretched type) produces much more vegetative parts than grains. Farmers mainly used it for improving soil fertility and for animal feed. In Amhara Region, cowpea is mainly used for human food in the form of boiled grains (NIFRO), bread (KITA) and as ingredient for various sauces (SHIRO WET). There are high potential areas for cowpea production; but the actual production by local farmers is restricted to only few areas. Given the current paucity in making use of the locally available germplasm by farmers, the responsible body (MARC) for cowpea research and development would need to mount an aggressive enhancement and/or distribution of the important cowpea landraces to the areas where the crop can be suitably grown by local small scale farmers.

Key words: Cowpea, Ethiopia, ethnobotany, farmers' knowledge, farmers' variety, landrace.

INTRODUCTION

Pulses have been recognized as a major source of proteins (20 - 35%) with essential minerals and vitamins (Abebe et al., 2005). Among the pulses, cowpea (*Vigna unguiculata* (L.) Walp.) (Fabaceae) is an important food legume growing in tropical and subtropical regions of Africa, Asia, and Central and South America Lemma et

al., 2009; Singh et al., 1997). According to Thulin (1989), in Ethiopia, cowpea is cultivated primarily for its edible seeds and the leaves that are sometimes used as human food in the form of cooked leafy vegetables. In Southern Ethiopia, cowpea young leaves, pods and seeds are used for human consumption and animal feed (Westphal 1974); and this was confirmed in a recent work (Sisay, 2015).

In addition to its importance for human food, the crop is also useful to enhance soil fertility through symbiotic nitrogen fixation and it also substantially contributes as a major source of animal feed due to the feed quality of the leaves. The species has a unique capacity to fix atmospheric nitrogen with its nodules and performs well even in poor soils with more than 85% sand, less than 0.2% organic matter and low levels of phosphorus (Bilatu Agza et al., 2012). Its world annual production is estimated at 5,249,571 tons of dried grains of which over 64% is produced in Africa. On the African continent, West Africa represents the largest production zone (Gbaguidi et al., 2013). Nigeria produces about 850,000 tons and is reputed as the highest producer of cowpea in the world (Ogbemudia et al., 2010).

Cowpea is an important grain legume in East Africa (Sariah, 2010). Pottorff et al. (2012) disclosed that cowpea is a multipurpose crop; the entire plant can be used for either human or livestock consumption while Islam et al. (2006) emphasized that all parts of the plant are used as food being nutritious as they provide protein and vitamins. Immature pods and seeds are used as vegetables while several snacks and main dishes are prepared from the grains (Agbogidi and Egho, 2012). Cowpea young leaves, pods and seeds contain vitamins and minerals which have popularized its usage for human consumption and animal feeding; and the scorched seeds are occasionally used as a coffee substitute (Ogbemudia et al., 2010).

Pulses as a group in Ethiopia constitute considerable number and diversity of crop species (Million Fikreselassie, 2012). The Ethiopian Biodiversity Institute has a total of 94 germplasm accessions of cowpea at the gene bank (EBI, 2014). Although Vavilov (1951) as cited in Westphal (1974) indicated that Ethiopia is a secondary center of diversity for cowpea, there is limited information regarding the genetic resource, there are major production challenges and social factors related to cowpea production in the country. In addition, there is no published document regarding cowpea landraces, the status of diversity and ethnobotany in Ethiopia.

Therefore, collecting and documenting cowpea landraces with the associated ethnobotanical information and landrace diversity are fundamental and urgent tasks. Hence, a study of cowpea landrace diversity and ethnobotany in northern Ethiopia, where it is an important component of the agricultural system and the food culture of the society, is crucial for better understanding, utilization, conservation and improvement of the crop. This study was initiated to gather, record and document the landrace diversity and ethnobotanical information of cowpea in its production range in northern Ethiopia, covering parts of the Amhara and Tigray regions.

MATERIALS AND METHODS

Materials

Representative cowpea voucher specimens and seed accessions were collected from different geographical provenances in northern Ethiopia. These materials were used for determinations of identities based on morphological characters, for germination tests and storage as gemplasm. Plant press, GPS, plastic bags, notebook, secateurs and a digital photo camera were used during the field-work.

Site selection

Based on the ecological requirements of the crop, assistance of district agricultural office workers, accessibility of the area and the availability of time, a total of five administrative zones comprising eight districts and 16 villages were purposively sampled for the study. Samples were collected from villages where cowpea is highly produced in order to obtain valuable information on landrace diversity together with the associated use values and the traditional production and management systems.

Informant selection

After selection of the study sites, a total of 80 informants (61 males and 19 females) aged 21 to 71 were randomly selected. Ten individuals from each wereda (district), that is, from each kebele 4-6 informants were interviewed using pre-prepared semi-structured interview guide. The selection of key informants and information regarding the knowledge of local farmers about cowpea was first gathered with the local guide and local agricultural extension experts of each wereda. Additionally, a total of 40 informants (five from each wereda local market place) were randomly selected for gathering information on the market value of cowpea.

Ethnobotanical data collection

Data were collected from September 2014 – January 2015. Semi structured interview, direct field observations and market surveys as described by Martin (1995) and Alexiades (1996) were conducted to collect both botanical and ethnobotanical data. Voucher specimens were collected from farmers' fields as described in IBPGR (1983) descriptor list for cowpea. The botanical information (passport data) of the crop was collected using GPS. Colored

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photos of cowpea accessions were also used to ease communication with farmers and local guides regarding the identity, distribution and local names of cowpea landraces before starting the interview. Both primary and secondary data were retrieved from the field. A total of 54 seed samples, six voucher plant specimens, and ethnobotanical information were collected from farmers' fields, threshing grounds, home gardens and local market places.

Official research permit was sought from the relevant local administrative offices and each informant gave free verbal consent to provide information upon providing the full details of the research (purpose, objectives and data utilization) to the local administration, the concerned community and the informants. Subsequently, verbal ethical clearance was secured in the traditional way where elders announced honoring the research through their blessings and the identified informants individually consented to provide information, all in the usual manner of traditional ethical clearance.

Sources for secondary data were both from offices of governmental and non-governmental organizations including agriculture and rural development offices and the National Meteorological Service Agency. Additional data were sourced from local communities and researchers. Voucher specimens were stored at the National Herbarium, Addis Ababa University while the seed samples were deposited at Melkassa Agricultural Research Center and at the completion of the research work, it was agreed, to be eventually transferred to the Ethiopian Biodiversity Institute (EBI) for proper conservation.

The collected ethnobotanical data were summarized in tables and figures and analyzed using both quantitative and qualitative approaches as recommended by Martin (1995), Cotton (1996) and Phillips (1996). Descriptive statistics, preference ranking and informant consensus tools were used to analyze the quantitative data. MS Excel 2010 was used to quantify and sort data, determine proportions, and draw bar graphs and tables.

RESULTS

Cowpea Landrace Diversity in Northern Ethiopia

A total of 54 cowpea germplasm accessions were collected (Table 1) in the 16 surveyed villages (Figure 1). Among these, 45 (83%) were local varieties and 9 (17%) were commercial varieties introduced by the Federal Ministry of Agriculture of Ethiopia, the Melkassa Agricultural Research Center (MARC) and the Sirinka Agricultural Research Center (SARC). Phenotypic diversity was observed in terms of growth habit, seed color, size and shape (Table 2).

Vernacular names of cowpea

Local farmers are generators and information base for modern taxonomy since indigenous knowledge is adaptive skill of the local farmers acquired informally through interaction with the natural environment. Accordingly, cowpea has different names in different areas of northern Ethiopia by local farmers based on the multiple purposes of the crop and the unique characteristics of each landrace type (Table 2) and information on morphological diversity of the landraces is given in Table 3.

Farmers' knowledge and utilization of cowpea

All the eighty farmers interviewed claimed to know modern agricultural production system especially in pre- and post-harvest technology. The majority of the farmers interviewed (75%) cultivated the erect type of cowpea in North Wello, Central Tigray and Waghimra zones. A reasonable number of farmers (25%) grew both the erect and prostrate or spreading types of cowpea mainly in Kalu and Bati districts. This is because in Bati and Kalu, local farmers grew cowpea when the soils are more degraded and/or where livestock are more important components of the farming system. The majority of farmers (60- 75%) preferred the erect type because they perceived that the ability to produce grains during famine season is due to its early maturing habit. Furthermore, local farmers preferred the erect types of cowpea for a variety of reasons such as high grain and straw yield, disease resistance, drought tolerance, adaptability to all types of soil, early maturity, market value, food quality, feed value and its multiple purposes. The spreading type of cowpea produced much more vegetative parts than grains and farmers mainly used this type for improving soil fertility and as animal feed. Grains, fresh vegetative parts and straw are the desired products of cowpea for all of the farmers who participated in the interview.

Based on results of the primary data, cowpea contributes to smallholders' income and to diet as a cost-effective source of protein intake especially in Central Tigray, South Wello and Oromia Special zones found in Amhara Region. On the other hand, in Amhara Region, cowpea is mainly used for human food in the form of boiled grains (NIFRO), baked as thin bread (KITA) mixed with other cereals and prepared into various sauces (SHIRO WET). The seeds are a major source of plant proteins and vitamins for humans, feed for livestock and also a source of income. The immature pods are occasionally eaten as raw vegetables in South Wello and Oromia Special zones. It is traditionally important as a source of protein especially in the leant (fasting) season of Christians in the northern part of the country. Moreover, cowpea also plays an important role in improving soil fertility in cereal crops (such as sorghum and maize) farming system when grown via intercropping and crop rotation. Informants, explanations about the use of cowpea as food, income source, forage, medicinal The best use of cowpea for a given wereda received the highest ranking value (5), while the least useful is assigned a ranking value of two (2) in this exercise.

Farming system and practices

The farmers in northern Ethiopia gave a description of the farming system and practices. They underlined that the rainy season commences in May and ends in October. They prepare the land between the months of March and May. Land preparation is mainly done by oxen plough

Table 1. Cowpea germplasm collected from northern Ethiopia.

Collection code	Latitude (dd mm ss)	Longitude (dd mm ss)	Altitude (m.a.s.l.)	Sources of collection	Status of collection
MAARC 19	N13 37 32.7	E38 59 59.0	1650 m	AARC (Abi Adi)	Improved
MAARC 20	N13 37 32.7	E38 59 59.0	1650 m	AARC (Abi Adi)	Improved
MAARC 21	N13 37 32.7	E38 59 59.0	1650 m	AARC (Abi Adi)	Improved
MAARC 22	N13 37 32.7	E38 59 59.0	1650 m	AARC (Abi Adi)	Improved
MAARC 23	N13 37 32.7	E38 59 59.0	1650 m	AARC (Abi Adi)	Improved
MAS 42	N12 58 38.7	E38 57 37.6	1260 m	Saka (Abergelle)	Landrace
MBB 35	N11 14 28.5	E40 00 27.4	1770 m	Bira (Bati)	Landrace
MBB 35A	N11 14 28.5	E40 00 27.4	1770 m	Bira (Bati)	Landrace
MBB 35B	N11 14 28.5	E40 00 27.4	1770 m	Bira (Bati)	Landrace
MD 04	N11 08 58.4	E39 54 30.0	1460 m	Arabu or Degan (Kalu)	Landrace
MD 05	N11 08 58.4	E39 54 30.0	1460 m	Arabu or Degan (Kalu)	Landrace
MDRM 07	N11 08 09.1	E39 38 27.5	Unknown	Desse Robit Market	Landrace
MDT 29	N13 42 57.2	E38 47 10.9	2130 m	Derene Tseb (Kola Temben)	Landrace
MEA 37	N10 20 25.9	E39 57 51.4	1420 m	Ataye (Efratanagidem)	Landrace
MEG 38	N10 56 41.0	E38 20 56.1	2000 m	Enebse Sarmidir (East Gojam)	Landrace
MEG 38A	N10 56 41.0	E38 20 56.1	2000 m	Enebse Sarmidir (East Gojam)	Landrace
MH 27	N13 13 56.9	E38 59 34.7	1633 m	Hadnet (Tanqua Abergelle)	Landrace
MH 06	N11 16 48.8	E39 40 51.0	2050 m	Haik (North Wello)	Improved
MHT 24	N13 31 09.7	E39 01 49.6	1490 m	Hadash Tekli (Tanqua Abergelle)	Landrace
MHT 24A	N13 31 09.7	E39 01 49.6	1490 m	Hadash Tekli (Tanqua Abergelle)	Landrace
MKA 36	N11 09 31.2	E39 53 23.9	1580 m	Abecho (Kalu)	Landrace
MKA 36A	N11 09 31.2	E39 53 23.9	1580 m	Abecho (Kalu)	Landrace
MLB 15	N12 10 02.4	E38 59 06.4	1990 m	Bilbala (Lasta Lalibela)	Landrace
MLG 18	N11 56 33.2	E38 53 21.6	2050 m	Gelesot (Lasta Lalibela)	Landrace
MLM 17	N12 03 18.6	E39 02 05.9	2040 m	Medage (Lasta Lalibela)	Landrace
MLS 08	N11 58 48.8	E38 58 53.1	1960 m	Shumshuha (Lasta Lalibela)	Landrace
MLS 09	N11 58 23.4	E39 03 08.5	2070 m	Berta (Lasta Lalibela)	Landrace
MLS 10	N11 59 25.4	E39 00 57.9	2140 m	Godu Memder (Lasta Lalibela)	Landrace
MLS 11	N11 59 21.5	E38 59 11.0	2000 m	Tinchoy (Lasta Lalibela)	Landrace
MLS 12	N12 00 37.4	E39 00 08.8	2090 m	Lawober (Lasta Lalibela)	Landrace
MLS 13	N12 00 54.1	E39 01 38.7	2100 m	Yohans Amba (Lasta Lalibela)	Landrace
MLS 14	N11 59 53.6	E38 58 01.1	2000 m	Enkuay Beret (Lasta Lalibela)	Landrace
MLSM 16	N12 03 30.3	E38 58 19.0	2030 m	Segno Gebeya (Lasta Lalibela)	Landrace
MM 25	N13 16 11.7	E38 59 47.7	1560 m	Maerey (Tanqua Abergelle)	Landrace
MM 25A	N13 16 11.7	E38 59 47.7	1560 m	Maerey (Tanqua Abergelle)	Landrace
MML 34	N11 14 04.6	E39 58 47.3	1750 m	Melka Lugo (Bati)	Landrace
MML 34A	N11 14 04.6	E39 58 47.3	1750 m	Melka Lugo (Bati)	Landrace
MML 34B	N11 14 04.6	E39 58 47.3	1750 m	Melka Lugo (Bati)	Landrace
MN 29A	N13 42 37.9	E38 45 28.8	2100 m	Newi (Kola Temben)	Landrace
MRKA 28	N12 04 09.2	E39 37 48.2	1470 m	Aradum (Raya Kobo)	Landrace
MSAN 33	N13 02 33.9	E38 59 01.7	1350 m	Maernet (Abergelle)	Landrace
MSH 32	N12 27 31.8	E39 09 08.1	2030 m	Hamusit (Sekota)	Landrace
MSRC 01	N10 00 22.5	E39 53 42.7	1290 m	Shewarobit	Improved
MSRC 01A	N10 00 22.5	E39 53 42.7	1290 m	Shewarobit	Improved
MSRC 01B	N10 00 22.5	E39 53 42.7	1290 m	Shewarobit	Improved
MSRM 02	N10 00 04.0	E39 54 09.5	1270 m	Shewarobit	Landrace
MSRM 02A	N10 00 04.0	E39 54 09.5	1270 m	Shewarobit	Landrace
MST 31	N12 31 13.0	E39 04 43.1	2110 m	Tiya (Sekota)	Landrace

Table 1. Contd.

Collection code	Latitude (dd mm ss)	Longitude (dd mm ss)	Altitude (m.a.s.l.)	Sources of collection	Status of collection
MSW 30	N12 32 56.7	E39 03 19.5	2040 m	Weleh (Sekota)	Landrace
MTAL 41	N13 14 39.3	E39 02 36.3	1610 m	Lemlem (Tanqua Abergelle)	Landrace
MWEC 39	N14 03 59.6	E39 01 33.4	2070 m	Enda Chewa (Werie Leke)	Landrace
MWZ 40	N14 01 45.0	E39 01 37.4	2020 m	Zongi (Werie Leke)	Landrace
MY 26	N13 17 13.1	E38 59 39.6	1560 m	Yechilla (Tanqua Abergelle)	Landrace
MY 26A	N13 17 13.1	E38 59 39.6	1560 m	Yechilla (Tanqua Abergelle)	Landrace

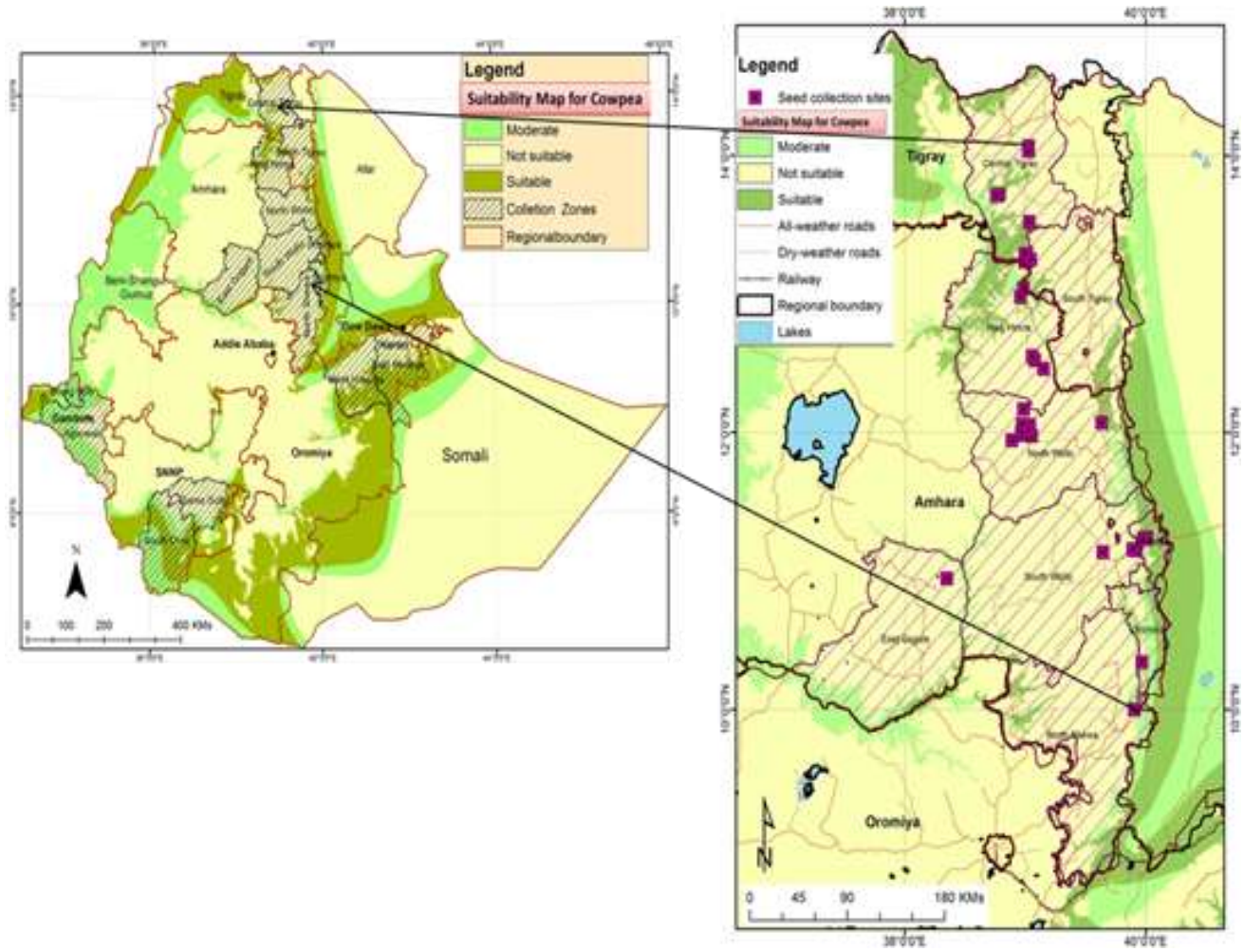

Figure 1. Map of Ethiopia showing Regional States and collection zones and districts for cowpea landraces (Map credit: Demeke Nigusse, GIS specialist, EIAR).

and weeding activity is done by manual hand-weeding and handheld hoeing. Planting commences towards the end of May, right after the first substantial rains have been received through to July and early August. By the end of November, all farmers harvested cowpea from the field.

The result of this study revealed that, cowpea is predominantly grown as a sole crop (48.75%) and followed by intercropping (35%) (Figure2).

Traditional cropping systems reported by farmers showed that farmers' perceptions was found cowpea is mostly intercropped with cereals.

Table 2. Diversity of cowpea landraces cultivated in northern Ethiopia as revealed by seed morphology (size, color, shape).

Seed sample of cowpea landraces with code	Local names (scientific name)	Language	Meaning of the name	Agroecology (Traditional zone)	Place of collection
A 	ADENGOR, ADAGURA, DEKAK ADAGURA, ADENGUARIE, DEKAK ADAGURA (*Vigna unguiculata* Subsp. *unguiculata*)	Tigregna	A pulse crop with small seed size mainly used for animal feeding Green pulse crop	Woina Dega (midlands) Kolla (lowlands)	Tanqua Abergelle and Kola Temben
B 	TEKEMICHE, KIMITE, SEREKULA (*Vigna unguiculata* Subsp. cylindrical)	Amharic	Drought resistant herb	Woina Dega and (midlands)	Bati and Kalu
C 	TEKEMICHE, KIMITE, SEREKULA *(Vigna unguiculata* Subsp. cylindrical)	Amharic	Drought resistant herb	Woina Dega and (midlands)	Bati and Kalu
D 	CHEKELE, EGOYLA (*Vigna unguiculata* Subsp. cylindrical)	Amharic and Agewgna	Drought tolerant herb grown in the dry season A crop mainly used when food in short supply	Woina Dega (midlands) and Dega (highlands)	Lasta Lalibela, Sekota, Abergelle and Enebse Sarmidir
E 	ADENGOR, ADAGURA, DEKAK ADAGURA, ADENGUARIE, DEKAK ADAGURA (*Vigna unguiculata* Subsp. *unguiculata*)	Tigregna	A pulse crop with small seed size mainly used for animal feeding	Woina Dega (midlands)	Tanqua Abergelle, Kola Temben and Werie Leke
F 	JERGADIE (*Vigna unguiculata* Subsp. unguiculata)	Amharic	A climber with large seed size	Woina Dega and (midlands)	Bati and Kalu
G 	ADENGOR, ADAGURA, DEKAK ADAGURA, ADENGUARIE, DEKAK ADAGURA *(Vigna unguiculata* Subsp. *unguiculata*)	Tigregna	A pulse crop with small seed size mainly used for animal feeding	Woina Dega (midlands)	Werie Leke
H 	CHEKELE, KIMITE (*Vigna unguiculata* Subsp. cylindrical)	Amharic	Drought tolerant herb grown in the dry season	Woina Dega (midlands) and Dega (highlands)	Bati and Enebse Sarmidir
I 	JERGADIE (*Vigna unguiculata* Subsp. unguiculata)	Amharic	A climber with large seed size	Woina Dega and (midlands)	Bati and Kalu

Table 3. Morphological diversity of collected cowpea landraces in northern Ethiopia (qualitative and quantitative traits).

Qualitative and quantitative traits	Collected voucher specimens of cowpea landraces					
	***Vigna unguiculata* Subsp. unguiculata farmers' variety JERGADIE, collected from Bati (Table 2, Code F)**	***Vigna unguiculata* Subsp. unguiculata farmers' variety JERGADIE, collected from Kalu (Table 2, Code I)**	***Vigna unguiculata* Subsp. cylindrica farmers' variety KIMITE, collected from Kalu (Table 2, Code B)**	***Vigna unguiculata* Subsp. cylindrica farmers' variety KIMITE, collected from Kalu (Table 2, Code C)**	***Vigna unguiculata* Subsp. cylindrica farmers' variety CHEKELE, collected from Lasta Lalibela (Table 2, Code D)**	***Vigna unguiculata* Subsp. cylindrica farmers' variety CHEKELE, collected from Sekota (Table 2 Code D)**
Growth habit	Climbing	Climbing	Erect	Erect	Erect	Erect
Growth pattern	Determinate	Determinate	Determinate	Determinate	Determinate	Determinate
Twinning tendency	Intermediate	Intermediate	None	None	None	None
Terminal leaflet shape	Sub-globose	Sub-globose	Globose	Globose	Hastate	Hastate
Plant hairiness	Glabrescent	Glabrescent	Glabrescent	Glabrescent	Glabrescent	Glabrescent
Raceme position	Throughout canopy	Throughout canopy	In upper canopy	In upper canopy	In upper canopy	In upper canopy
Pod attachment to peduncle	30-90^0 down from erect	30-90^0 down from erect	Erect	Erect	Erect	Erect
Pod curvature	Straight	Straight	Slightly curved	Slightly curved	Straight	Straight
Seed shape	Ovoid	Ovoid	Rhomboid	Rhomboid	Rhomboid	Rhomboid
Testa texture	Smooth	Smooth	Smooth to rough	Smooth to rough	Smooth	Smooth
Leaf color	Intermediate green	Intermediate green	Pale green	Pale green	Pale green	Pale green
Leaf marking	Absent	Absent	Absent	Absent	Absent	Absent
Splitting of testa	Absent	Absent	Absent	Absent	Absent	Absent
Terminal leaflet length (mm)	90	87	72	76	74	76
Terminal leaflet width (mm)	54	58	48	44	30	33
Number of pods per peduncle	2	2	3	3	3	3
Number of seeds (locules) per pod	18	17	12	13	10	10
Seed length (mm)	8	8	5	5	6	5
Seed width (mm)	6	5	2	3	3	3
Pod length (cm)	18	19	9.5	7.4	8.1	8.5
Pod width (mm)	9	8	5	4	5	5

Common combinations are sorghum with cowpea and maize with cowpea using different planting methods mainly broadcasting (85%) and row planting (13.75%) (Figure 2). Furthermore, farmers produce cowpea in sandy and marginal soil conditions since the crop has the ability to with-stand drought and poor soil fertility conditions. Farmers produce this crop in their entire farms (main field, 60%; home garden, 8.75% and at borders of farm fields, 31.25%) during the rainy season except farmers from Central Tigray (Wereie Leke) where they use irrigation. The majority of farmers (60%) used their home saved seed (Figure 3) for the next growing season except in Werie Leke District where they use mostly seed obtained from agricultural office and sometimes they used their own home saved seed for the next growing season. The secondary seed

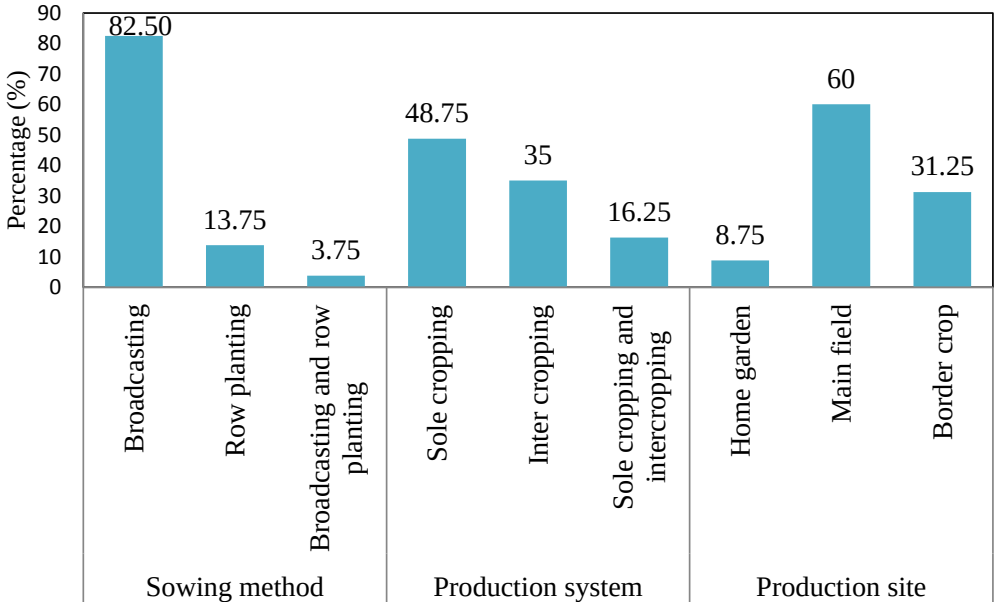

Figure 2. Agronomic practices for cowpea production in Northern Ethiopia.

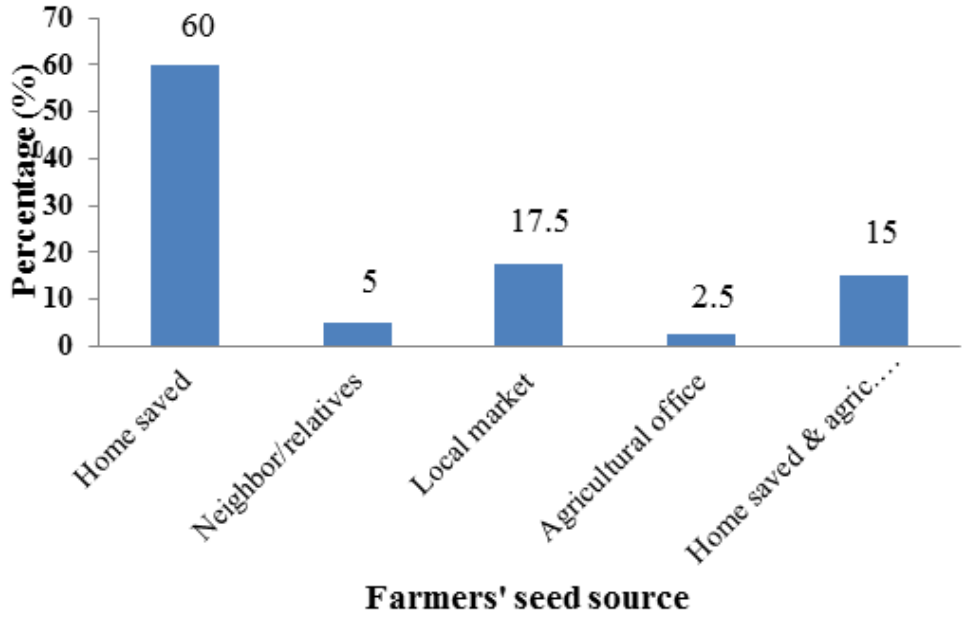

Figure 3. Farmers' seed source.

source for cowpea production has been found to be local market (17.5%) (Figure 3).

Gender roles for maintaining the landrace diversity of cowpea

Traditionally, in northern Ethiopia cowpea cropping is mostly done by men including the agronomic activities such as land preparation, planting, weeding, harvesting, threshing and drying. The major responsibilities of women are preparing processed the products of cowpea in the form of local recipes. Women also participate in many activities, together with their children, to support their husbands, including in weeding and harvesting. Women are also especially involved in variety selection, post-harvest treatment (during storage), marketing of the grain and processing for animal feed.

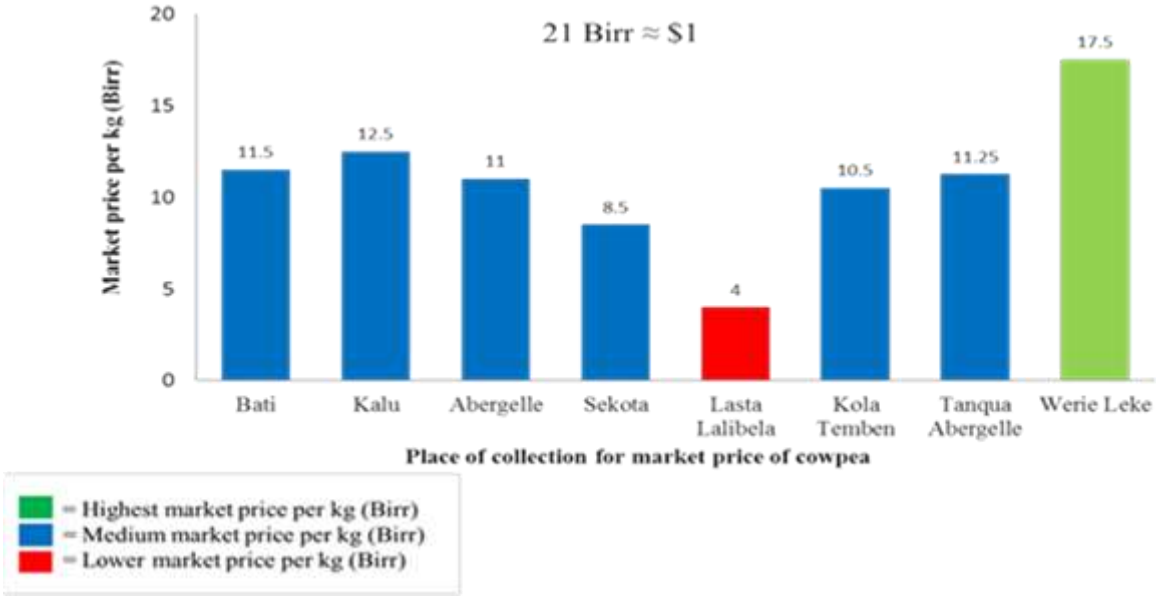

Figure 4. Market price of cowpea landrace varieties in localities within the study area.

Market value of cowpea

In addition to its food, soil improvement and forage values, cowpea has economic importance as income source; farmers often sell the grain in the local markets. The market price varied in the different districts of the study area (Figure 4). In Lasta Lalibela District, cowpea seed/grain had lower value, about Birr four per kg. Farmers in this area mostly use it as ground cover rather than for income generation. This is because farmers primarily focus on other legumes including: faba bean (*Vicia faba*), chickpea (*Cicer aritienum*) and field pea (*Pisum sativum*), which have higher demand than cowpea. They also mentioned some unpleasant organoleptic characters of cowpea as a factor discouraging its consumption by people. In Werie Leke District, cowpea has higher market price (Birr 17.5 per kg) than in other districts. This is because, in Werie Leke there is scarcity of livestock forage and the local farmers grew cowpea via intercropping with maize for livestock feed and for marketing.

The cowpea value chain consists of local exchanges and markets that ensure a movement of grain from producers to consumers. Therefore, exchange begins with the production of cowpea by small scale farmers. In northern Ethiopia, farmers typically sell their cowpea grains directly to consumers or some times to rural assemblers, who in turn sell it directly to consumers and bigger merchants.

Production constraints

In Northern Ethiopia, small holder farmers are facing different constraints on cropping, storage and consumption of cowpea including storage pests, field insects, parasitic weeds and diseases. However, farmers were unable to identify the names of insect pests and diseases. Nonetheless, according to the descriptions they provided aphids and pod borers were the most important insect pest problems for farmers. The primary insect pest causing losses to stored cowpea in northern Ethiopia according to the local farmers is storage weevil (*Callosobruchus maculatus*) locally called NEKEZ. Another menace is parasitic plant, locally called AKANCHIRA, a parasitic weed typically found in the study area causing yield losses as a root parasite.

DISCUSSION

Cowpea landrace diversity in northern Ethiopia

Landraces, also called farmers' varieties are the result of several years of natural and artificial selections by farmers for better adaptation to local growing conditions (Hegde and Mishra, 2009). Cowpea landraces collected from northern Ethiopia did not show much variation for plant growth pattern and growth habit. All local farmers grew determinate types with prostrate to erect growth habit. Such types are preferred by farmers because of their better performance under marginal conditions of rain fed environments where cowpea is commonly grown. Thulin (1989) reported that *Vigna unguiculata* subsp. *Sesquipedalis* and subsp. *dekindtiana* are mainly cultivated in northern Ethiopia. In the present study, landraces belonging to *Vigna unguiculata* subsp. *unguiculata* and *Vigna unguiculata* subsp. *cylindrica* were

found under cultivation as components of different cropping systems under marginal rain fed conditions. The local landraces (83%) are more popular than the released commercial varieties because of farmers' preference owing mainly to their multi-purpose nature, organoleptic characters and higher market prices. The majority of landraces collected from Bati and Kalu districts of Amhara Region belonged to *Vigna unguiculata* subsp. *unguiculata* farmers' variety JERGADIE having prostrate (climbing) nature with higher vegetative growth and long pods in contrast to the erect type of cowpea. The collected landrace accessions were found both in mixed and uniform seed colors. Similar results were reported by Sariah (2010) where landrace accessions are mostly found both in mixed and uniform seed colors. From it that they grow cowpea for home consumption, livestock feed, income source and improving soil fertility. Thus, almost all collections from each district were found to be uniform in seed color except in some areas where accessions with mixed seed colors were found ranging from white to black, with cream and light red colors dominating mainly in Bati and Kalu districts and these were described as large seeded JERGADIE. This landrace type is mainly produced in Tanqua Abergelle and Bati as a major crop.

Cowpea is an important component of diets in northern Ethiopia, thus widely cultivated in Central Tigray (Tanqua Abergelle, Kola Temben and Werie Leke), Waghimra (Abergelle), South Wello (Kalu) and Oromiya Special zones (Bati). This is not the case in North Wello Zone (Lasta Lalibela), farmers said cowpea is predominantly grown for income generation, contingency of land use (ground cover) and sometimes for food. The reverse is true for Central Tigray local farmers where cowpea has an equal value with sorghum in terms of price value and major uses for home consumption primarily grown for food, income generation and forage.

Farmers' knowledge and perceptions

Cowpea is a versatile food crop that contributes to food culture in many parts of Africa (Timko and Singh, 2008) and referred to as the "hungry-season crop" given that it is the first crop to be harvested before the cereal crops are ready (Carlos, 2004). The same is true for Waghimra and Central Tigray zones where the crop is used as hungry-season crop and obviously known and grown by all farmers. This reflects the importance of cowpea in the day-to-day life of farmers in northern Ethiopia, which might probably be due to the fact that cowpea has the ability to withstand the existing dry conditions in the study areas. In every growing season, almost all farmers grow cowpea by intercropping with sorghum and maize except in Sekota and Lasta Lalibela districts where the farmers mainly use sole cropping system at their main and boarder farm fields as minor cropping. Both climbing and erect types of cowpea were grown in northern Ethiopia to exploit the advantages provided by each type. As described by Carlos (2004), the fast growth and spreading habit of traditional cowpea farmers' varieties suppress weeds, and soil nitrogen is increased which improves cereal growth. Farmers' responses on the selection criteria were based on the crop's multipurpose nature being used for human consumption, animal feed, income source and improving soil fertility. Cowpea also contributes to the sustainability of cropping systems and soil fertility improvement on marginal lands through nitrogen fixation, provision of ground cover and plant residues, which minimize erosion and subsequent land deterioration.

Crop uses and purpose of production

As indicated by Westphal (1974), Thulin (1989) and Gbaguidi et al. (2013), vernacular names traditionally attributed to crop varieties vary more often across administrative districts and villages even sometimes between farmers within a single village. Similar results were reported by Singh et al. (2003) and Timko and Singh (2008). As reported by Phillips et al. (2003) and Timko et al. (2008) cowpea is a multi-purpose crop and it is used for food, forage, income generation and improving soil fertility as asserted by all respondents of the present study. In addition, Megersa et al. (2013) reported that, cowpea is traditionally used by smashing and rubbing on affected part of body to treat the disease known as Tinea Corporis. The present study results did not indicate the use of cowpea as a medicine. Almost all parts of the crop such as seeds, pods, leaves/stems and straw are used for various purposes as reported by Singh et al. (2003); Pottorff et al. (2012) and the present study. As reported by Carlos (2004), in southern Africa, cowpea is grown primarily for fodder, although it is also used for grain production, green manure, and weed control in forestry plantations and as a ground cover to prevent soil erosion. In this study, cowpea uses varied considerably between regions and some uses reported from other countries were not recorded in northern Ethiopia. As reported by Timko et al. (2007), the tender green leaves are an important food source in Africa and are prepared as a pot herb, like spinach. Cowpea green leaves and immature pods are consumed as green vegetables in southern and eastern Ethiopia (Westphal, 1974). Immature green pods are used in the same way as snap beans, often being mixed with cooked dry cowpea or with other foods. The consumption of nearly mature cowpea grains shelled and boiled as a fresh vegetable reported in other parts of Africa is recorded in the present study in Ethiopia. The study results further showed that the seed is a highly valued part of the crop for home consumption in the form of NIFRO, KITA and WET. Sometimes, the green mature pods were eaten by children in Bati and

Kalu districts. As stated by Singh and Tarawali (1997), in northern Ethiopia cowpea foliage is an important source of high-quality hay for livestock feed.

Cropping systems and management practices

As reported by Blade et al. (1997) and Timko et al. (2007), cowpea is usually grown as an intercrop with sorghum (*Sorghum bicolor* (L.) Moench) and less frequently as a sole crop or intercropped with maize (*Zea mays* L.), cassava (*Manihot esculenta* Crantz), or cotton (*Gossypium* sp.). In the present study, cowpea is mainly grown as a rain fed crop and sorghum is the major cereal crop with which cowpea is intercropped (95%) in all surveyed areas, except in Werie Leke District where maize is the major cereal in which cowpea is intercropped (5%) along irrigation channels. Carlos (2004) and Dugje et al. (2009) described a similar intercropping system in West and Central Africa under similar semi-arid conditions, where cowpea was also intercropped with cereal crops (maize and sorghum) with the recommended spacing of 75 cm x 50 cm. Dugje et al. (2009) and AFF (2011) reported that fertilizer application in cowpea production depends on anticipated yield and soil fertility. As a legume, cowpea does not require much nitrogen because of the symbiotic nitrogen fixation. Based on the results, the majority of farmers (60%) indicated that they never used fertilizer and/or chemicals in the surveyed areas especially in Tanqua Abergelle, Abergelle, Sekota and Lasta Lalibela districts. On the other hand, reasonable number of the farmers (40%) used compost to improve soil fertility and chemical pesticides for plant protection in Bati, Kalu, Kola Temben and Werie Leke districts.

Seed supply, selection and storage

The reliance of local farmers mainly on sources of home saved seed and exchanging with their neighbors is a good support in maintaining and conserving the distinct types, but at the same time there is little driving force to create new types and maintain a high level of diversity (Munisse et al., 2011). The present study result also showed that, the majority of farmers relied on their own home saved seeds, buying from local market, exchanging with neighbors or relatives, buying from agricultural office (only landraces) and sourced from both home saved and agricultural office. The most important farmers' criteria for selection are tolerance to drought, good taste, high grain yield, early maturity, feed value and market value of grain. For example, some farmers in Bati and Kalu districts preferred cowpea landrace having the climbing habit (JERGADIE) due to its leafy nature that improves soil fertility via nitrogen fixation and livestock feed value as compared to cowpea types with erect growth nature (KIMITE and CHEKELE).

Cowpea is highly vulnerable to insect attacks and damage due to storage pests. There are published data (Carlos, 2004; Dugje et al., 2009) providing evidence that insect pests cause devastating losses in cowpea yields and weevils (post-harvest pest) can destroy a granary full of cowpea grains within two or three months. In northern Ethiopia, some farmers stored the seed with special treatment using chemicals (malatine), botanicals and ash for the next growing season to escape storage pest problem. As a result, all farmers reported that storage pests are the major causes of post-harvest losses. As reported by Dugje et al. (2009), insect pests are major constraints to cowpea production in West Africa and damage by insect pests on cowpea can be as high as 80–100% if not effectively controlled. The most important storage pest of cowpea is the weevil (*Callosobruchus maculatus*) and severe infestation can lead to total grain loss in storage (Carlos, 2004; Dugje et al., 2009; Sariah, 2010). The storage life of cowpea depends on its moisture content before storage; and the lower it is the better the quality of seeds for storage (AFF, 2011). In developed countries, one alternative is the use of cold storage and that exposure to minus 18^0C during 6 to 24 h reduced pest numbers by more than 99% (Carlos, 2004).

Qualitative and quantitative traits

Earlier studies on cowpea showed that morphological traits were of great importance to distinguish genetic variability. As in previous studies (Hegde and Mishra, 2009; Sariah, 2010; Gbaguidi et al., 2013), this study also found that morphological traits (quantitative and qualitative) are valuable tools for cowpea genetic diversity studies. For example, some of the morphological traits such as growth habit, terminal leaflet length, terminal leaflet width, seed length, twining tendency, terminal leaflet shape, pod length, number of seeds per pod and seed shape had the uses for morphological identification and characterization. The results showed that landraces collected in Bati and Lasta Lalibela locally called CHEKELE and KIMITE were similar. Similarities of some characters were also observed between JERGADIE on the one hand and KIMITE and CHEKELE on the other. As for the qualitative traits, the existence of genetic diversity among the collections for most of the morphological traits studied, CHEKELE and KIMITE were more varied than JERGADIE. A high level of similarity was also observed among the collection of CHEKELE and KIMITE for most of the traits studied.

Conclusion

Traditional knowledge related to the cultivation and use of cowpea, particularly on the local landraces, still persists

in northern Ethiopia. There is great diversity in cowpea landraces in many traits. Local farmers' uses and value of different landraces according to their contexts and interests. Any cowpea development program should aim at maintaining its landrace diversity as a national and global germplasm pool. There is probably much more cowpea diversity to sample, collect and understand. This study has contributed to generation of general information about cowpea landraces as it occurs in the northern portion of Ethiopia and also supplied cowpea germplasm for conservation and future varietal improvement works. Hence, it will be of interest to study the diversity of the landraces further to be able to apply the local conservation strategies in a modern context and to identify potential genetic resources, to enhance food and nutrition security, and income generation. This study further indicates that integration of cowpea with the prevailing farming systems using native cowpea varieties could have significant importance in improving soil fertility and productivity, improving feed quality and withstands the impacts of climate change.

Conflict of interests

The authors have not declared any conflict of interests

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