Research Article

Landrace Diversity and Production Systems of Cowpea (*Vigna unguiculata* L. Walp.) in Southern Chad

Nadjiam Djirabaye*

*Chadian Institute of Agronomic Research for Development (ITRAD), BP: 5400, N’Djaména, Chad

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**Abstract**

In Chad, cowpea (*Vigna unguiculata* (L.) Walp.), is increasingly becoming a cash crop. The objective of this work is to assess the varietal diversity, analyze the traditional management of landraces and the production systems of cowpea in southern part of Chad. An inventory and an ethnobotanical survey was conducted through a participatory approach in 17 villages corresponding to two agro ecological zones. Thirty-four vernacular names and 45 landraces are inventoried. On average, 2 names are assigned per village. The number of landraces varies from 4 to 13 with an average of 9.00 per region and 2.70 per village. The highest diversity is observed in Mayo Kebbi. Sixteen morphotypes have been identified and their distribution varies according to the agro ecological zones. Productivity (31.10 %), taste (25.92 %) and grain size (18.34 %) are the farmer main preferred criteria. Farmers use leaves (47 %), pods (29.50 %) and seeds (14.75 %) to identify landraces. Cowpea cultivation is practiced on small areas and in intercropping system (78.60 %). Conservation of seeds (36.07 %), low fertility of the soils (27.85 %) and drought (17.77 %) were the main production constraints. Cowpea is stored mainly in traditional granaries (34.96 %) and on racks (22.93 %). For seeds treatment, farmers use mainly traditional means (32.37 %) and chemical products (6.67 %). Several cowpea-based dishes are identified. Cowpea has also therapeutic virtues. To improve cowpea production, appropriate actions must be considered against the constraints inventoried. The interesting landraces should also be used in a breeding program.

**Keywords:** Cowpea; diversity management; production constraints; conservation; landrace; Chad.

**Introduction**

The promotion of the local plant genetic resources in Chad is one of the main priorities of national research institutions. These resources have great potential that can be used in a breeding program. Better knowledge of these resources, the preservation, and integration of some of their traits in national varietal improvement program, will certainly contribute to achieve food security. Cowpea (*Vigna unguiculata* L. Walp.), is a main African leguminous in sub-Saharan Africa region. It is a well-isolated species within the genus Vigna, but it is very diverse (Pasquet *et al.*, 1997). Cowpea is a neglected crop with a strong potential allowing it to contribute to the major challenges of food and nutrition security and even in sustainable agriculture (Gomes *et al.*, 2021). In Chad, even if millet and sorghum constitute the staple food of the populations, cowpea, native of Africa (Padulosi and Ng, 1997) and which West Africa is said to be the first center of domestication (Baudoin and Maréchal, 1985), is one of the most cultivated crops. Its annual...
production worldwide is 8.9 million tons from 14.4 million hectares. In Africa, Nigeria is the largest producer with 3.5 million tons (FAOSTAT, 2019). In Chad, cowpea was initially considered as a lean crop but is increasingly becoming cash leguminous. At the national level, the average cowpea production over the past 10 years is 129,506 t. However, for the 2020-2021 season, the sown areas are 227,341 ha for an estimated production of 154,586 t, i.e., an increase of 25,080 t compared to the previous season. Regarding the main protein-oil seed crops, during the 2020 season, cowpea ranks third after peanuts, whose production is 840,035 t and 202,074 t for sesame (DPSA/ANADER, 2021).

Compared to research activities, unlike crops such as sorghum (Sorghum bicolor L. Moench) (Gapili and Djinodji, 2016; Nadjiam, 2020), and cassava (Manihot esculenta Crantz) (Nadjiam et al., 2016) which has been the subject of much work, little research was done on cowpea. It should be noted that in 1987, a few landraces were collected in the Sahelian zone of Chad. Subsequently, further surveys were carried out in part of the Sudanian zone in two regions where 60 cowpea cultivars were collected (Gapili et al., 2020). An ethnobotanical and genetic diversity study of these cultivars has identified the criteria for nominating cultivars and the relevant traits that may contribute to the creation of new early and productive varieties. Likewise, 44 local cultivars were characterized from an agromorphological point of view. The diversity revealed the importance of the local potential (Nadjiam et al., 2015). Moreover, in order to improve the agricultural production, improved varieties have been introduced through regional projects in different agroecological zones in Chad. An assessment of the precocity and productivity of improved varieties was also done and promising varieties for the semi-arid zones of Chad were identified (Nadjiam and Touroumngaye, 2014).

Concerning the local practices for the management of plant genetic resources, much work has been carried out on different crops (Gaouna et al., 2011; Nadjiam et al., 2016; Gapili and Djinodji, 2016; Nadjiam, 2020) except only one that focused on cowpea (Gapili et al., 2020). From these observations, it emerges at the national level that there has been less work on this subject on cowpea. Indeed, prospecting, collection, management practices and specific uses of cowpea landraces have not been sufficiently documented, listed, or valued. Although according to Baco et al. (2007), only few local knowledge as «cultural symbolism of varieties» based on anthro-economic parameters allowed to maintain diversity but it is no longer sufficient to conserve this diversity. However, a good knowledge of these traditional practices will make it possible to better understand their logic in order to propose solutions adapted to the improvement of agricultural production. Indeed, many authors have reported that most farmers use local cultivars for reasons of production stability (Willemen et al., 2007). Likewise, farmers prefer local cultivars instead of improved varieties for their organoleptic characteristics and high commercial value (Alemu et al., 2016).

All over the world, cowpea cultivation faces many production constraints. In addition, cultivation techniques, processing, conservation, storage techniques and means of combating pests remain the real problems of farmers. Cowpea is also considered as one of the leguminous whose uses are very varied because of its multiple qualities. In Benin, for example, a farmer management system tries to ensure the maintenance of varieties based on practices such as botanical treatments, seed multiplication and intercropping system (Baco et al., 2008). In terms of treatments for therapeutic uses, in a study conducted in Togo, Agbodan et al. (2020) identified local varieties of cowpea that help to fight against malnutrition because they have remarkable antioxidant potential compared to the introduced varieties. In Ethiopia, the green leaves and grains of cowpea are used in the treatment of liver disease, gastritis and malaria (Alemu, 2019).

The objective of the present study is to assess the varietal diversity, analyze the traditional management of landraces and the production systems of cowpea in southern part of Chad.

**Material and Methods**

**Study Area**

The study was conducted in the southern part of Chad which is situated between the latitudes 7°26’35” and 11°12’43” North and the longitudes 13°58’30” and 17°35’27” East. The area of this site is 81,070 square kilometers. Seventeen villages of the departments of Monts de Lam, Tandjilé Ouest and Centre, Lac Wey, Lac Léré, and Mayo Dalla from the regions of Logone Oriental, Logone Occidental, Tandjilé, Mayo Kebbi Est and Mayo Kebbi Ouest are involved in prospecting and collecting landraces. The geographic coordinates of the villages were recorded with a GPS and plotted on a map using ArcGIS version10.2 software (Fig. 1). The study area is located between the 8th and 10th parallel. The climate is tropical semi-humid, isohyets 900 to more than 1200 mm with a dry and a rainy season. Specifically, Monts de Lam department is located in the Guinean isohyets zone over 1200 mm, while the other departments are in the Sudanian zone in the 900 to 1200 mm (CNRD, 2018). Average temperatures vary from 24 to 38°C. The soils are ferruginous leached red in color, with a texture bought from clay and sand to clay. The vegetation is characterized by dense tree savannas with very sparse savannas in the flood zones in the Sudanese part, forest tree savannas and very clear forest tree savannas in the Guinean zone (CNAR, 2015).
Data Collection
After bibliographical research and an exploratory mission, the areas of major cowpea production were listed and the villages were identified in each of the departments. A questionnaire was developed and validated. The survey was conducted in a participatory manner by the research team made up of a researcher and a technician in charge of extension in each sector. In each village, the interview was done with a focus group made up of 15 farmers. Data collection include general information on the village, cowpea production systems, list of landraces of the village, their names and meanings, the selection and recognition criteria, the constraints linked to the production and conservation of crops as well as the uses of cowpea. Subsequently, the landraces were collected according to a collection sheet, in the form of pods or grains, numbered, processed, and stored in suitable packaging.

Data Analysis
Survey data were processed and analyzed using Sphinx software (Sphinx Plus 2- Ed. Lexica-V5). A morphological classification was done on the basis of the color of grains, the color and shape of the pods. The landraces were grouped into morphotypes and their distribution in the area of study was determined. The MS Excel 2007 table was used to process some quantitative data and tables and graphs were then produced.

Results
Profile of Respondents
The survey is conducted using a participatory approach in the targeted villages. For 255 farmers questioned, 79.05 % are men and 20.95 % are women. The most representative ethnic groups identified in the area are the Laka, Ngambaye, Moundang, Kado, Zimé, Lélé, and Toupouri. The majority of those surveyed are Protestants (63.80 %), Catholics (31.00 %) and animists (5.20 %).

Cowpea Landrace Diversity in Southern Chad
Forty-five cowpea landraces are inventoried. The number of landraces ranges from 4 to 13 with an average of 9.00 landraces region-wide. The greatest number is collected in Mayo Kebbi Ouest with 13 landraces for only 4 which are found in Logone Occidental. The greatest diversity are observed in Mayo Kebbi Est and Mayo Kebbi Ouest and Logone Oriental with 4.00 and 3.25 landraces per village respectively. On the other hand, this diversity is low in Logone Occidental. Across the entire study area, the average is 2.70 landraces per village (Table 1). Furthermore, for the farmers, the main preferences criteria are productivity (31.10 %), taste (25.92 %), and grain size (18.34%). As for the criteria of distinction, the leaves (47 %), the pods (29.50 %), the grains (14.75 %), and the habit of the plant (8.27 %) are the most used.

Cowpea Landraces Vernacular Names
The study revealed 34 vernacular names for 45 cowpea landraces collected (Table 2). The most common names identified in the different languages most spoken in the surveyed localities are Mindji, Mondjé, Moudjou, Ain, Euh, Tongou and Tikssa where a qualifier is added when it’s needed. There are 8 names in Logone Oriental, 10 in Logone Occidental, 4 in Tandjilé, and 12 in Mayo Kebbi. The main languages used for these names are Zimé, Lélé, Moundang, Kado, Ngambaye, Laka, and Toupouri. The average naming of landraces is 2 per village. Logone Occidental has an average of 3.33 per village and this is the highest rate of the regions studied. On the other hand, in the regions of Logone Oriental and Mayo Kebbi, there are 2 per village. In the Tandjilé region, on average per village, only one name was recorded according to the majority ethnic group of the village (Table 3).
Table 1: Rate of cowpeas’ landraces per village.

| Region              | Villages number | Number of landraces | Number of landraces per village |
|---------------------|-----------------|---------------------|---------------------------------|
| Logone Oriental     | 4               | 11                  | 2.75                            |
| Logone Occidental   | 3               | 4                   | 1.30                            |
| Tandjilé            | 4               | 9                   | 2.25                            |
| Mayo Kebbi Est      | 2               | 8                   | 4.00                            |
| Mayo Kebbi Ouest    | 4               | 13                  | 3.25                            |
| Study area          | 17              | 45                  | 2.70                            |

Table 2: Vernacular names of cowpea landraces and their meaning.

| Region              | Village | Ethnic group | Vernacular name | Mean                                                                                   |
|---------------------|---------|--------------|-----------------|----------------------------------------------------------------------------------------|
| Logone Oriental     | Dolloh  | Ngambaye     | Leltambâh       | It's so sweet and the stranger wants to eat more                                         |
|                     | Dolloh  | Laka         | Ngasang         |                                                                                        |
|                     | Dolloh  | Laka         | Mindjindoul     | Black grain cowpea                                                                      |
|                     | Dolloh  | Laka         | Mondjé Bé       | Cowpea from Land                                                                        |
|                     | Dolloh  | Laka         | Kembaydessel    | Chief must eat it                                                                       |
|                     | Bengar   | Laka         | Mbogdjo         |                                                                                        |
|                     | Bengar   | Laka         | Djarwai/Djogyo  |                                                                                        |
| Logone Occidental   | Goré    | Ngambaye     | Goladjé         | It sells fast                                                                           |
|                     | Goré    | Ngambaye     | Minji Teun      |                                                                                        |
|                     | Ndaba   | Ngamabaye    | Bugaotal        | Invisible to old people                                                                 |
|                     | Gari    | Ngamabaye    | Djiguidjé       | Millipede cowpea                                                                        |
|                     | Deli    | Moundang     | Ladamra         | Try it                                                                                  |
|                     | Deli    | Moundang     | Ugzalé          |                                                                                        |
|                     | Deli    | Ngamabaye    | Bugaotal        | The old man can eat before he dies                                                       |
|                     | Deli    | Ngamabaye    | Mindji nda      | Cowpea with white grain                                                                 |
|                     | Birambawelle | Ngamabaye | Godjé          | Coarse grains                                                                            |
|                     | Deli ferme | Ngamabaye | Allahadoum      | God gave me                                                                              |
| Tandjilé            | Debring  | Lélé         | Tongou          | Cowpea                                                                                  |
|                     | Debring  | Zimé/Mesmé   | Tikssa Kourdou  | Curved pod                                                                               |
|                     | Daraja   | Lélé         | Tongou Kourbian | Rainy season cowpea                                                                     |
|                     | Bereokou | Zimé/Mesmé   | Tikssa ndor     | Early cowpea                                                                             |
| Mayo Kebbi Est et Ouest | Bissi Mafou | Moundang | Euh phaï        | Cowpea with white pod and grain                                                          |
|                     | Bissi Mafou | Moundang | Euh fou         | Cowpea with long black pod                                                               |
|                     | Bissi Mafou | Moundang | Seygui          | Long and thin pod like a mouse tail                                                       |
|                     | Matégolé | Moundang     | Gouaring        | Curved pod                                                                               |
|                     | Matégolé | Moundang     | Ezalé           | Rainy / Early season cowpea                                                              |
|                     | Tamdja Kado | Kado     | Mednîdor        | Early cowpea                                                                             |
|                     | Tamdja Kado | Kado     | Redfouta        | Late cowpea                                                                              |
|                     | Youé ferme | Toupouri   | Ain waila       | Cowpea long pods                                                                        |
|                     | Toupouri | Ain yée      | Naou do duï duï | Cowpea 55 day cycle                                                                     |
|                     | Toupouri | Ma dé tchomrêh | Naou do duï duï | Sweet cowpea                                                                             |
|                     | Toupouri | Ain fiougou  | Cowpea with coils pod                                                                   |

Table 3: Landraces’ local name rate per village.

| Region              | Local names number | Villages number | Rate per village | Main ethnic group                           |
|---------------------|---------------------|-----------------|------------------|---------------------------------------------|
| Logone Oriental     | 8                   | 4               | 2.00             | Laka and Ngambaye                           |
| Logone Occidental   | 10                  | 3               | 3.33             | Ngambaye                                    |
| Tandjilé            | 4                   | 4               | 1.00             | Lélé, Zimé/Mesmé                            |
| Mayo Kebbi Est/Ouest| 12                  | 6               | 2.00             | Moundang, Kado, Toupouri                    |
| **Total**           | **34**              | **17**          | **2.00**         |                                             |
Evolution of Cowpea Varietal Diversity

According to 28 % of farmers, a certain number of landraces have disappeared. The locality where this loss is most significant is the village of Bengar in Logone Oriental. The most cited landraces are: Moudjou kla, Moudjou tournou, Moudjou kag, Mindjé-Tog and Mindjé ndoul. The main possible reasons for these disappearances mentioned by the farmers are the unavailability of seeds (41.28 %), their susceptibility to insects (21.10 %), diseases (15.60 %) and the late cycle of some landraces (11.93 %).

Traits and Distribution of Cowpeas’ Morphotypes

Based on morphological traits such as grain color, pod color and pod shape, landraces are grouped into 16 morphotypes (Fig. 2). Examination of the areas where these morphotypes are collected made it possible to determine the level of their extent throughout the study area (Table 4).

Farming System and Main Constraints in Cowpea Production

Sorghum is the dominant crop in this area as specified by 56.20 % of the farmers and 13.80 % for groundnuts. For cowpea, only 6.30 % of farmers say it is their main crop. In fact, cowpea is mainly cultivated in intercropping system at 73.30 %, by nearly 80 % of farmers. For the village Bereko, cowpea is cultivated in pure and out of season by 73.30 % of farmers and 13.80 % for groundnuts. Sorghum is the dominant crop in this area as specified by 56.20 % of the farmers and 13.80 % for groundnuts. For cowpea, only 6.30 % of farmers say it is their main crop. In fact, cowpea is mainly cultivated in intercropping system at 73.30 %, by nearly 80 % of farmers. For the village Bereko, cowpea is cultivated in pure and out of season by 73.30 % of farmers.

Regarding the areas allocated to cowpea cultivation, less than one hectare is intended for cowpea according to 29.10 % of farmers questioned and 31.90 % do so on 1 to 2 ha. Compared to the evolution of areas sown with cowpea, 42.40 % of farmers consider it stable and 34.30 % believe that it is increasing. Rather, around 9.50 % indicated that the areas intended for production have fallen sharply. As for the sources of seed supply, these are essentially made through exchanges between farmers in the same locality, as confirmed by nearly 95.06 % of them. Only 1 % of respondents reported that improved varieties have been introduced by research in recent years in rural areas. In addition, cowpea production is subject to many constraints. Thus 36.07 % of farmers believe that the main constraint is the difficulty of conservation of seeds. Others constraints, as the low level of soil fertility, drought, diseases and pests are also factors that negatively impact cowpea production (Table 5). Among these pests, the most cited by farmers, are bruchids, aphids, termites, ants, and hairy insects. For the most frequent diseases causing the decrease in cowpea production, they are mainly leaf wilting, multiple spots on leaves and pods, pod rot and damping-off (Table 6).

Table 4: Some traits and extend of cowpea morphotypes.

| Code | Traits | Distribution | Agroecological zone |
|------|--------|--------------|---------------------|
| A-01 | White grains, brown pod shaped as a half arch | LOR, LOC, TA, MKE, MKO | Sudanian and Guinean |
| B-02 | White grains, reddish and elongated pod | LOR | Guinean |
| C-03 | Red grains, white pod shaped like a half arch | LOR | Guinean |
| D-04 | White grains, white pod shaped as a half arch | LOR | Guinean |
| E-05 | Brown grains, whitish pod shaped as a half arch | LOR | Guinean |
| F-06 | Dark brown grains, brown and elongated pod | LOC | Guinean |
| G-07 | Brown grains, whitish and elongated pod | LOR, LOC, TA, MKE, MKO | Sudanian and Guinean |
| H-08 | Brownish grain, elongated brown pod | MKO | Sudanian |
| I-09 | Reddish grain, white, elongated pod | TA | Sudanian |
| J-10 | Dark brown grain, curved pod, white with brown speckles | TA, MKE | Sudanian |
| K-11 | White grain, white curved pod | MKE, MKO | Sudanian |
| L-12 | White grain spotted with gray, curved white pod | MKE | Sudanian |
| M-13 | White grain spotted with gray, elongated white pod | MKO | Sudanian |
| N-14 | White grain, reddish pod like a half arch | LOC, MKO | Sudanian |
| O-15 | White grain, white and elongated pod | LOR, LOC, TA, MKE, MKO | Sudanian and Guinean |
| P-16 | White grain, elongated pod, brown with white areas | MKO/MKE | Sudanian |

*LOR : Logone Oriental ; LOC : Logone Occidental ; TA : Tandjilé ; MKE : Mayo Kebbi Est ; Mayo Kebbi Ouest.

Fig. 2: Morphotypes of cowpea collected (From A to H and I to P).
Table 5: Main constraints in cowpea production.

| N° | Main constraints                        | Percentage of responses (%) |
|----|----------------------------------------|-----------------------------|
| 1  | Lack of land                           | 5.57                        |
| 2  | Low soil fertility                     | 27.85                       |
| 3  | Drought                                | 17.77                       |
| 4  | Seed conservation difficulty           | 36.07                       |
| 5  | Destruction by herds                   | 4.77                        |
| 6  | High susceptibility to diseases and pests | 6.63                   |
| 7  | Lack of manpower                       | 0.80                        |
| 8  | Others                                 | 0.54                        |

Table 6: Cowpea Pests and diseases reported by farmers.

| Pests        | Responses (%) | Diseases                      | Percentage of responses (%) |
|--------------|---------------|-------------------------------|-----------------------------|
| Bruchids     | 24.96         | Wilting leaves                 | 34.83                       |
| Aphids       | 25.38         | Spots on leaves and pods       | 29.53                       |
| Termites     | 18.47         | Rotting of pods                | 16.50                       |
| Ants         | 10.58         | Damping-off                    | 16.60                       |
| Hairy insects| 16.45         | No idea                        | 2.54                        |
| Others       | 4.16          |                                |                             |

Cowpea Seed Conservation and Storage Practices

The survey reveals that traditional granaries remain the most used places for the storage of grains of cowpea (34.96 %). This storage is also done on the racks (22.93 %) and hangars (10.90 %). Few farmers keep their cowpea stock in their rooms (13.16 %) or in community stores (18.05 %). However, with regard to seeds, their conservation is mainly done in bags (70 %), in jars (12.69 %) and in metal barrels (11.54 %). Traditional techniques are also recommended by the farmers, namely preserving cowpea with their pods (4.62 %), packing them in bales of straw (0.38 %) or put them in cans (0.77 %). Regarding the bags for conservation, the nature of these bags has not been specified but it said that the bags are imported from Nigeria (Baba Gana). The second kind of bag is a triple bagging bags called PICS bags.

In addition, about 60 % of farmers say they do not process their cowpea stock. The pepper is used by a significant number of farmers, 28.57 %. In total, 32.37 % of farmers use traditional means of struggle. On the other hand, chemicals are only used by 6.67% of respondents.

Consumption and other Uses of Cowpea

The uses of cowpea are varied and relate to human consumption, soil fertilization, livestock feed, botanical treatments and medicinal. In human consumption, 32.09 % of respondents indicate that the grains are usually eaten. For immature pods and fresh or dry young leaves, these proportions are respectively 31.15 % and 31.62 %. The lignified leaves are only appreciated by 5.14% of farmers.

As for cowpea-based dishes, it is mainly sauces made from ingredients of grains and fresh or dry leaves, which are cited by 32.80 % of respondents. The grains are also eaten after cooking by 24.85 %. It’s also used in the preparation of soup (14.91 %), pasta (11.93 %), porridge (7.95 %) and donuts (3.38 %). Cowpea haulm is used for livestock.

In addition, specific uses of cowpea grains and leaves have been reported by farmers who consider them as sources of “vitamin” (10.31 %) and therapeutic virtues. Indeed, 28.87 % of farmers use them to treat abscesses and 15.46 % for skin swelling. Porridge enriched with cowpea is also reported by 20.62 % of farmers. To a lesser extent, cowpea grains and leaves are used to treat certain diseases and even used as an aphrodisiac (Table 7).

Table 7: Cowpea stock processing products and medical uses.

| Modalities                     | Percentage of responses (%) |
|-------------------------------|----------------------------|
| Cowpea stock processing products |                           |
| Chemical product              | 6.67                       |
| Neem oil (Azadirachta indica) | 1.9                        |
| Pepper (Capsisum sp)          | 28.57                      |
| Without treatment             | 60.00                      |
| Threshing without winnowing   | 1.90                       |
| Others                        | 0.96                       |

| Medical uses of cowpea               | Percentage of responses (%) |
|--------------------------------------|----------------------------|
| Abscess                              | 28.87                      |
| Gastritis                            | 7.22                       |
| Enriched porridge                    | 20.62                      |
| Skin swelling                        | 15.46                      |
| ‘Vitamin’                            | 10.31                      |
| Chicken pox                          | 4.12                       |
| Nausea                               | 4.12                       |
| Wounds                               | 5.16                       |
| Aphrodisiac                          | 4.12                       |
Discussion

In Chad, cowpea, considered for a long time as a vital crop during lean periods, appear more and more like a second cash legume after peanuts. In the study area, the estimated production during 2020 is 38,418 t which is 61.23 % of the production of the entire Sudanian zone. However, even if cowpea production has increased over the past four years, its average productivity during the 2020-2021 seasons is still low, 627 kg/ha in rural areas (DPSA/ANADER, 2021). This low yield is due to several combined factors, as climate change, lake of technical itineraries, and the low coverage rate of the supervision of farmers.

Varietal diversity observed at the regional and village level is highly variable. Indeed, the regions of Mayo Kebbi Est and Ouest, present a significant diversity per village. Regionally, the average number of landraces in this part of southern Chad is almost similar to that of three regions located in the southwestern parts of Ethiopia (Alemu et al., 2019). However, the average of landrace collected per village which is 2.70 is low compared to 4.29 reported by Gapili et al. (2020). This diversity is even less than that observed in southern Benin (Gbagnudi et al., 2013). However, farmers continue to use their local varieties which are usually selected in the fields. This is not only for socio-cultural considerations but also as pointed out by Willemen et al. (2007) for reasons of stability of their production.

The study also made it possible to identify 34 vernacular names for 45 cowpea landraces collected. The languages which were used for these appellations are those which are mainly spoken in the localities surveyed. Thus, in both Logones, cowpea is designated by the words Mindji, Mondjé, and Moudjou. In Tandjilé, it is called Tongou in Lélé language and Tikssá in Zimé. On the other hand, in Mayo Kebbi, it is called Ain in the Toupouri language, Red in Kado and Eih in Moundang. According to several authors, farmers identify landraces of many crops, by naming them on the basis of criteria and parameters. Caillon et al. (2005), in a study on taro (Colocasia esculenta L. Schott), report that these local criteria are relevant. In this present study, the traits used by the farmers in the vernacular nomenclature, are based on the color and shape of the grains, the color and size of the pods, the taste, the cycle, the market value of the variety. Sometimes they even use expressions and proverbs. In the Maritime-East region of Togo, the farmer nomenclature of cowpea landrace is based on the color of the grains and their flavor (Agbodan et al., 2020). In general, local names are important socio-cultural traits used by these communities in the management and selection of plant resources (Missihoun et al., 2012). Likewise, Wembou et al. (2017) assert that this taxonomy is essential for the documentation of farmer knowledge linked to the management of the genetic diversity of cultivated plants. It thus plays an important role in the management of biodiversity (Manusset, 2006). Local names are most often given according to the dialects of the locality. Very often, same landrace have different names or different landrace have identical names. Sometimes a landrace can have more than one name. Indeed, many authors claim that these names vary from one ethnic group to another and from one locality to another (Elias et al., 2001; Mekbib, 2007).

In Chad, in the case of cowpea, specific selection and distinction criteria are commonly used by farmers. In terms of landrace recognition, they use in particular the color and texture of the grains, as reported by Ouedraogo et al. (2010). These criteria are important. In Senegal, a classification based on the color and shape of pods and grains from nine varieties named by the farmers, identified 18 variants corresponding to 18 varieties (Konan et al., 2007).

During the collection phase, interviews with the farmers enabled us to collect some information on the reasons which lead them to choose cowpea landraces. The choice criteria used are productivity, importance of biomass, earliness, resistance to drought and specific cooking skills such as grains that swell during cooking and their sweet taste. However, the main priority criteria are productivity, taste and grain size. As for the criteria of distinction, the leaves, pods, grains and the habit of the plant are the most used but other additional criteria such as the shape, color, and appearance allow the recognition device to be refined.

Moreover, the main reasons for landrace loss mentioned by farmers seem to be linked to their practice of conserving diversity. In fact, they preserve their landrace in situ, however, with climate change the rate of seed loss is quite high due to poor harvests. The survey showed also that farmers use very few chemicals regarding sensitivity of cowpea to insects and diseases. Although this loss has only been observed in Bengar village in the Logone Oriental region, five landraces have disappeared. The loss rate is 83.33 % at the level of this village. Over the entire study area, it is 10 %. Compared to previous work on cassava carried out in five regions of southern Chad (Nadjiam et al., 2016) and on sorghum (Gapili and Djinodji., 2016) in two regions of the same area, this rate is lower. Similar studies conducted in Togo on yams, have shown that for ecological, agronomic, socio-cultural, and economic reasons, their varietal richness has decreased in 78 % of the localities surveyed (Wembou et al., 2017). The decrease in productivity and the susceptibility to biotic factors are identical to those observed in the present study.

The survey also shows that sorghum is the dominant crop in the study area. However, cowpea occupies an important place in production systems. It is mostly cultivated in association mainly with sorghum, millet, maize, cassava and very little in pure. In the first case, it is a question of a strategy of crop diversification, improvement of soil fertility, especially during associations with cereals, but also...
to secure production. In association with cereals, late varieties of cowpea are maintained through these cropping systems which optimize labor productivity (Baco et al., 2008). In Niger, Harouna Issa et al. (2014) showed that 73 % of farmers produce voandzou (Vigna subterranea L.) in pure against 27 % who associate voandzou with millet and sorghum. In the cowpea production system practiced in Southwest Nigeria, cowpea, according to 55.1 % of farmers, is mainly cultivated in association with cassava (Saka et al., 2018). Likewise, in a study conducted in three states in northern Nigeria, Mohammed et al. (2021) showed that 42 % of farmers produce cowpea in traditional intercropping, 25 % do it pure while 23 % had cowpea fields in both single crop and intercrop. In the study area, single cowpea cultivation is practiced mainly in the plain of Zaguéré village during the off-season, after the waters of Lake Léré have receded. In Zaguéré, there are several varieties, each of which is grown on a small plot. This practice of polyvarietal cultivation is similar to that observed in Benin for yam (Dansi et al., 1997) and in some fields in Chad for cassava (Nadjiam et al., 2016).

Regarding the modes of exchange of plant material, the sources of seeds supply are mainly through exchanges up to 95% between farmers in the same locality. Nadjiam et al. (2016) reported in the case of cassava that the main modes of obtaining cuttings are 60.84 % in the same area. In Benin, Baco et al. (2007) reveal that the exchanges of varieties are practices of proximity, which mainly take place between farmers of the same village (70 %). These authors assert that these exchanges favor the mixing, conservation, and geographical distribution of varieties. In contrast, in the Kara region of Togo, in the case of yam, the proportions are 45 % as reported by Wembou et al. (2017) are rather low.

The cowpea production constraints, are practically the same compare to others crops. However, in this Sudanian part of Chad, the difficulty of saving seeds, the low level of soil fertility, drought, diseases, and pests, were identified as major constraints. In the Sudanian zone of Ethiopia, insects are one of the main constraints in cowpea production (Alemu et al., 2019). This parasitic pressure on cowpea was also mentioned by 31.6 % of cowpea farmers in the Maradi and Zinder regions in Niger (Abdourahamane et al., 2020). In relation to soil fertility, in Chad, cowpeas are generally grown without the addition of fertilizers. Cowpea is widely used in crop rotations where it improves soil fertility in symbiosis with bacteria of the genus Rhizobium spp. and Bradyrhizobium spp. (Zablotowicz et al., 1981; Quin, 1997). However, for a balanced level of soil fertility, it is necessary to add other mineral elements as well as organic matter. In order to improve the productivity of varieties under water deficit conditions, varieties adapted to drought have been also introduced. Various tests relating to the evaluation of the agronomic performance of cowpea varieties have been carried out, in the Sahelian zone (Nadjiam and Touroumgaye, 2014).

Regarding the management of cowpea stocks, the majority of farmers do not process their stocks contrary to the work of Gapili et al. (2020) which report that in the department of Barh-Kôh, region of Moyen Chari, 85 % of farmers use chemicals to preserve their harvest products while 15 % do so without treatment or with natural products. In the present study, farmers claim that processing chemicals for preserving cowpea grains are expensive and inaccessible. Likewise, the modes of use chemical products are not often mastered by the farmers. However, a third of the farmers questioned favored traditional techniques and methods of pest control based on pepper (Capsicum sp) and to a lesser extent neem oil (Azadirachta indica). In addition, it has been reported that farmers additionally use extracts from fresh neem leaves, dry tobacco leaves, and soap powder (Gapili et al., 2020). Treatments of cowpea using plants have also been reported by Baco et al. (2008). These botanical products are neem powder or oil (Azadirachta indica), shea ash (Vittellaria paradoxa) and caïledcrat bark powder (Caya senegalensis). Likewise, Touré et al. (2013) reported that in the Korhogo area in Côte d’Ivoire, nearly 42 % of farmers use chemicals and 24 % use ash for the conservation of Voandzou grains (Vigna Subterranea L.). The present study reveals also that bags are often used for the conservation of cowpea. One of them is called bag PICS. It is made of a woven polypropylene layer containing two other high density polyethylene (HDPE) bags of 80 microns each, which reproduces the conditions of hermetic storage (Murdock et al., 2012).

Cowpea is also very popular and consumed by the population. The grains, pods, and young fresh leaves are used in human consumption in the form of many derived products. The grains are particularly rich in proteins, the contents of which can reach a quarter of the dry matter (Bressani, 1985; Singh and Rachie, 1985). However, a significant variability was observed in the protein composition. Likewise, essential amino acids such as methionine, cysteine, and tryptophan have been identified in some varieties of cowpea (Bliss et al., 1973). In Chad, as in arid and semi-arid areas of Kenya, the leaves are also eaten as porridge, blanched, and dried as reported by Owade et al. (2020). Cowpea haulm, also rich in protein, are intended for livestock feed. Particularly in small ruminants, Azoutane et al. (2020) showed that the complementation with cowpea haulm increase intake and digestibility of Dactylolctenium aegyptiun L.

Medicinally, therapeutic uses of cowpea have also been reported. These results are similar to other previous work even if the types of diseases treated are sometimes different according to the studies. Indeed, according to 23 % of the farmers surveyed in the Gambella and Oromia regions in Ethiopia, two varieties of cowpea are mainly used as...
medicinal plants. The green leaves of cowpea are used for the treatment of yellow fever. The grains are used to treat malaria and gastritis (Alemu, 2019). In some localities of Niger, for 14 % of the populations surveyed, it is another legume of the same genus, Voadzou (Vigna Subterranea L.) which is used in the treatment of hemorrhages and also as an aphrodisiac (Harouna Issa et al., 2014).

Conclusion
The study showed the importance of cowpea cultivation in Chad and its various uses. The varietal diversity observed into the study area is significant. Thus, it is important, to preserve and enhance these landraces in order to reduce genetic erosion. Cowpea is mainly cultivated in intercropping system and on small areas. However, the major production constraints are conservation of seeds, low level of soil fertility, drought, diseases and pests. To remove these constraints, appropriate actions must be considered for farmers. It was also found that of various reasons, farmers continue to maintain their landraces in situ. Likewise, their preferred criteria are highlighted in the present study. In order to improve the production of cowpea, the identified landraces can be used as sources of interesting genes for breeding after agromorphological and molecular characterization.

Conflict of Interest
The author declares that there is no conflict of interest regarding the publication of this paper.

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References
Agbodan KML, Akpavi S, Agbodan KA, Kanda M, Amegnaglo KB, Adrou-Aledji A, Batawila K et Akpagana K (2020) Description agromorphologique et détermination du potentiel antioxydant des variétés sous-utilisées et nouvellement introduites de maïs, manioc, niébé et piment dans la région Maritime-Est du Togo. African Journal of Food Agriculture Nutrition Development 20(3): 15936-15953.DOI: 10.18697/ajfad.91.18625

Alemu M, Asfaw Z, Woldu Z, Fenta BA and Medvecky B (2016) Cowpea (Vigna unguiculata (L.) Walp.) (Fabaceae) landrace diversity in Northern Ethiopia. International Journal of Biodiversity and Conservation 8 (11): 297-309. DOI: 10.5897/IJBC2016.0946

Alemu S, Alemu M, Asfaw Z, Woldu Z and Fenta BA (2019) Cowpea (Vigna unguiculata (L.) Walp., Fabaceae) landrace (local farmers’ varieties) diversity and ethnobotany in Southwestern and Eastern parts of Ethiopia. African Journal of Agricultural Research 14(24): 1029-1041. DOI: 10.5897/AJAR2018.13641

Azoutane J, Tendonkeng F, Defang HF, Miegoue E, Lemoufouet JMouchili M, Abdelrazik IA and Bechir AB (2020) Effect of cowpea haulm complementation on the intake and in vivo digestibility of Daucylactonemum aegyptium L. (Willd) in small ruminants in Sahelian zone, Ati-Chad. International Journal of Animal Science, Husbandry and Livestock Production 6(4): 312-321.

Baco MN, Ahanchédé A, Bello S, Dansi A, Vodouhè R, Biao G et Lescure JP (2008) Évaluation des pratiques de gestion de la diversité du niébé (Vigna unguiculata): une tentative méthodologique expérimentée au Bénin. Cahiers Agricultures 17(2): 183-188. DOI: 10.1684/agr.2008.0169

Baco MN, Biao G, Pinton F et Lescure JP (2007) Les savoires paysans traditionnels conservent-ils encore l’agrobiodiversité au Bénin? Biotechnologie Agronomie Société et Environnement 11(3): 201-210.

Baudoin JP and Maréchal R (1985) Genetic diversity in Vigna. In: Cowpea research, production and utilization, S. Singh, KO. Rachie. New-York, USA, Wiley, 3-5.

Bliss FA, Barker LN, Franckowiak JD and Hall TC (1973) Genetic and environmental variation of seed yield, yield components and seed protein quantity and quality of cowpea. Crop Science 13: 656-660. DOI: 10.2135/cropsci1973.0011183X001300060021x

Bressani R (1985) Nutritive value of cowpea. In: Cowpea research, production and utilization, SR. Singh, KO Rachie. New-York, USA, Wiley, 353-359.

Caillon S, Degeorges V, Lanouguère-Brunepau P, Lebot V and Quero-García J (2005) Les taros du Vanuatu: que conserver et comment? Natures Sciences Sociétés 13:306-310. DOI: 10.1051/issn:2005047.

CNAR (Centre National d’Appui à la Recherche) (2015) Esquisse de la couverture végétale du Tchad en relation avec les sols au sud du 16ème parallèle.1p.

CNRD (Centre National de Recherche pour le Développement) (2018) Carte bioclimatique du Tchad. 1p.

Dansi A, Zoundjihkepon J, Mignouna H and Quin M (1997) Collecte d’ignames cultivées du complexe Dioscorea cayenensis-rotundata au Bénin. Plant Genetic Resources 112: 81-85.

DPSA (Direction de la Production et des Statistiques Agricoles) (2021) Rapport de l’enquête agricole 2020/2021 Ministère du Développement Agricole. Rapport 2020-2021. 18p.

Eliax M, Penet L, Vindry P, McKey D, Panaud O and Robert T (2001) Unmanaged sexual reproduction and the dynamics of genetic diversity of a vegetative propagated crop plant, cassava (Manihot esculenta), in a traditional farming system. Molecular Ecology 10: 1895-1907. DOI: 10.1046/j.0962-1083.2001.01331.x

FAOSTAT (2019) Base de données statistiques agricoles. Organisation des Nations Unies pour l’Agriculture et l’Alimentation (FAO). Rome, Italie.
Gaoua BO, Bidjaoueye M, Nanema RK, Naoura G and Zongo JD (2011) Agromorphological characterization of some rice species in the main rice cropping area of Chad. International Journal of Biological and Chemical Sciences 5(2): 445-460. DOI: 10.4314/ijbcs.v5i2.72077

Gapili N, Bemadjita A, Nadjam D, Mbéguium N and Bolni MN (2020) Ethnobotany and Genetic Diversity of South Chadian Cowpea Landraces as a Novel Source of Early Grain Production. International Journal of Agricultural Science 5: 85-100.

Gapili N and Djinodji R (2016) Farmer’s management practices to maintain the genetic diversity of sorghum (Sorghum bicolor L. Moench) in south of Chad. Journal of Experimental Biology and Agricultural Sciences 4. DOI: 10.18006/2016.4(Issue6).625.630

Gbaguidi AA, Dansi A, Loko LY, Dansi M and Sanni A (2013) Diversity and agronomic performances of the cowpea (Vigna unguiculata (L.) Walp.) landraces in Southern Benin. International Research Journal of Agricultural Science and Soil Science 3(4): 121-133.

Gomes AMF, Draper D, Nhantumbo N, Massinga et Valleur A (2021) Diversity of Cowpea [Vigna unguiculata (L.) Walp] Landraces in Mozambique: New Opportunities for Crop Improvement and Future Breeding Programs. Agronomy 11 (991): 12p. DOI: 10.3390/agronomy11050991

Harouna Issa A, Bakasso Y, Alzouma Mayaky Z, Doumama A et Boucar IM 2014 Diagnostic participatif de la diversité de morphotypes et des connaissances locales en matière de culture du Voandzou (Vigna Subterranea L.) au Niger. International Journal of Innovation and Applied Studies 9(4): 1915-1925. DOI: 10.4314/ijbcs.v9i4.21

Konn KC, Roy-Macauley H, Gueye MC, Otto MC, Rami JF et Pasquet RS (2007) Diversité génétique des variétés traditionnelles de niébé [Vigna unguiculata (L.) Walp.] au Sénégal : étude préliminaire. Plant Genetics Resources 152: 33-44.

Manusset S (2006) Proposition pour une clé d’identification des variétés de manioc chez différents groupes culturels en Guyane française. Antropo 11: 61-73.

Mekhib F (2007) Infra-specific folk taxonomy in sorghum (Sorghum bicolor (L.) Moench) in Ethiopia: folk nomenclature, classification, and criteria. Journal of Ethnobiology and Ethnmedecine 3. DOI: 10.1186/1746-4269-3-38

Missihnoun AA, Agbangla C, Adoukonou-Sagbadja H, Ahanhanzo C et Vodouhe R (2012) Gestion traditionnelle et statut des ressources génétiques du sorgho (Sorghum bicolor L. Moench) au Nord-Ouest du Bénin. International Journal of Biological and Chemical Sciences 6:1003-1018. DOI: 10.4314/ijbcs.v6i6.8

Mohammed SB, Dizdizienyo DK, Umar ML, Ishiyaku MF, Tongoona PB and Gracen V (2021) Appraisal of cowpea cropping systems and farmers’ perceptions of production constraints and preferences in the dry savannah areas of Nigeria. CABI Agriculture and Bioscience 2:25. DOI: 10.1186/s43170-021-00046-7

Murdock LL, Margam VM, Baoua BI, Balfe S, and Shade RE (2012) Death by desiccation effects of hermetic storage on cowpea bruchids. Journal of Stored Products Research, 49: 166-170. DOI: 10.1016/j.jspr.2012.01.002

Nadjiam D (2021) Local Taxonomy and Diversity of Chadian Sorghum [Sorghum bicolor (L.) Moench] Accessions. Agricultural Sciences 12: 513-529. DOI: 10.4236/as.2021.125033

Nadjiam D, Diallo M, Mbéguium JMM et Guissé A (2016) Pratiques paysannes de gestion des cultivars de manioc (Manihot esculenta Crantz) au Sud du Tchad. International Journal of Biological and Chemical Sciences 10: 1098-1113. DOI: 10.4314/ijbcs.v10i3.16

Nadjiam D, Doyam AN and LeDiambo B (2015) Etude de la variabilité agromorphologique de quarante-cinq cultivars locaux de niébé (Vigna unguiculata (L.) Walp.) de la zone soudanoïde du Tchad. Afrique Science 11: 138- 151.

Nadjiam D and Touroumngaye G (2014) Evaluation des performances agronomiques des variétés de niébé [Vigna unguiculata (L.) Walp] en zone sahélienne du Tchad. Revue Scientifique du Tchad, Série B, Editions CNAR 15(5): 58-63.

Naoura G, Djinodji R, Doyam NA and Djoudang K (2016) Ethnobotanic study and characterization of the farming system of dry season sorghum's accessions in South of Chad. Journal of Applied Environmental and Biological Sciences 6: 109-114.

Ouedraogo JT, Sawadogo M, Tignegre JB, Drabo I et Balma D (2010) Caractérisation agromorphologique et moléculaire des cultivars locaux de niébé (Vigna unguiculata) du Burkina Faso. Cameroon Journal of Experimental Biology 06(1):31-40. DOI: 10.4314/cajeb.v6i1.56878

Owade JO, Abong GO, Okoth MW and Mwang’ombe AW (2020) Trends and constraints in the production and utilization of cowpea leaves in the arid and semi-arid lands of Kenya. De Gruyter, Open Agriculture 5: 325–334. DOI: 10.1515/opag-2020-0038

Padulosi S and Ng NQ (1997) Origin, taxonomy and morphology of Vigna unguiculata (L.) Walp. In: Advances in Cowpea research, BB. Singh, DR. Mohan Raj, KE. Dashiel, LEN. Jackai. IITA and JIRCAS. IITA, Ibadan, Nigéria, 1-12.

Pasquet R, Echikh N, Gepts P and Baudoin JP (1997) La domestication du niébé, Vigna unguiculata (L.) Walp. in : Actes du colloque de De noop, Solagral, 261-284.

Quin FM (1997) Introduction. In: Advances in Cowpea research, BB. Singh, DR. Mohan Raj, KE. Dashiel, LEN.Jackai. IITA and JIRCAS. IITA, Ibadan, Nigéria, 9-15.

Saka JO, Agbeleye OA, Ayoola OT, Lawal BO, Adetumbi JA and Oloyede-Kamayo QO (2018) Assessment of varietal diversity and production systems of cowpea (Vigna unguiculata (L.) Walp.) in Southwest Nigeria. Journal of Agriculture and Rural Development in the Tropics and Subtropics 119 (2): 43–52.
Singh SR and Rachie KO (1985) Cowpea Research, Production and Utilization. IITA and Bean/Cowpea Collaboration Research Support Program. New-York, USA, Wiley. 460p.

Touré Y, Koné M, Silué S et Kouadio YJ (2013) Prospection, collecte et caractérisation agromorphologique des morphotypes de voandzou [Vigna subterranea (L.) VERDC. (FABACEAE)] de la zone savanicole en Côte d’Ivoire. European Scientific Journal 9: 1857-7881.

Wembou EP, Odah K, Dansi A, Kabiezim E, Tozo K and Akpagana K (2017) Diversité variétale et conservation des ignames cultivées (Dioscorea cayenensis, Dioscorea rotundata et Dioscorea alata) dans la région de la Kara (Togo). Revue Marocaine des Sciences Agronomiques et Vétérinaires 5 (4): 391-399.

Willemen L, Scheldeman X, Cabellos VS, Salazar SR and Guarino L (2007) Spatial Patterns of Diversity and Genetic Erosion of Traditional Cassava (Manihot esculenta Crantz) in the Peruvian Amazon: An Evaluation of SocioEconomic and Environmental Indicators. Genetic Resources and Crop Evolution 54: 1599-1612. DOI: 10.1007/s10722-006-9172-7

Zablotowicz RM, Focht DD and Cannell GH (1981) Nodulation and N fixation of field-grown California cowpeas as influenced by well-irrigated and drought conditions. Agronomy Journal 73: 9-12. DOI: 10.2134/agronj1981.00021962007300010003x