Journal of Economics and Development Studies
December 2016, Vol. 4, No. 4, pp. 71-80
ISSN: 2334-2382 (Print), 2334-2390 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jeds.v4n4a7
URL: https://doi.org/10.15640/jeds.v4n4a7

Technology Transfer through Participatory Approach: The Case of NERICA Introduction in Cameroon

D. K. Malaa[1], A. B. Jaff[2], A. R. Agboh-Noameshie[3], E. L. M. Ngonkeu[4], N. K. T. Bebom[5], & N. Woin[6]

Abstract

To ensure food security in Cameroon there is a need to increase food production through the introduction of new technologies. In the year 2008, New Rice for Africa – (NERICA) varieties that are said to be adapted to various agro-ecological zones in the country were introduced using the participatory Varietal Selection (PVS) approach. With this approach, farmers were exposed to many new varieties and their own varieties at tillering, flowering and maturity to select the best. This paper uses data collected from 240 rice farmers (51% female), during the PVS trials in three agro-ecological zones, between 2009 and 2011. The trials were aimed at assessing the best-adapted varieties preferred by farmers based on their biophysical and organoleptic characteristics, with a view of producing and disseminating the seeds of the selected varieties across the country to boost rice production. After two years of field trial that ended up with an organoleptic test, the results showed that farmers preferred characteristics for the selection of varieties were based on, plant height, yield, grain shape and color, aroma, stickiness and taste. With these as their priority, four lowland (NERICA-L-36; NERICA-L-42; NERICA-L-56; NERICA-L-60) and four upland varieties (NERICA 3; NERICA 8; NERICA 9; NERICA 13) were selected. The study recommends that trials be conducted on fertilizer rate, planting density, planting date, etc. to get the best bet cultural practices so as to put at the disposal of the farmers a complete economical and productive package.

Key words: Participatory Varietal Selection, New Rice for Africa, technology transfer, biophysical, organoleptic

I. Introduction

1.1 Background study

For three billion people, half of the world's population, rice is the staple food. Two billion also depend on growing and processing rice for their livelihood, most of them smallholders in poor countries. Rice is a basic commodity consumed across the continent of Africa. In Cameroon per capita rice use increased from 2.3 (1961) to 22.2 in 2005 (FA0STAT, 2006). The rice ecologies of Cameroon are the upland, lowland and irrigated rice. The upland and lowland rice are grown indigenously by small scale farmers who rely mainly on family labor (Malaa and Nzodjo 2011).

[1] Institute of Agricultural Research for Development, Yaoundé, Cameroon; Email: dorothymalaa@yahoo.yahoo.co.uk
[2] Department of Agricultural Extension and Rural Sociology, University of Dschang; Email:jaffalda@yahoo.com
[3] Africa Rice Center, Cotonou, Benin; Email:A.Agboh-Noameshie@cgiar.org
[4] Institute of Agricultural Research for Development , Yaoundé, Cameroon; Email:ngonkeu@yahoo.fr
[5] Institute of Agricultural Research for Development, Yaoundé, Cameroon; Email: bebomtite@yahoo.fr
[6] Institute of Agricultural Research for Development, Yaoundé, Cameroon; Email:woin57@hotmail.com

Irrigated rice is grown in intensive systems with the use of machinery was introduced by the Chinese entrepreneurs who began exploiting the irrigation opportunity of Cameroon as far back as 1930 (Vaillant, 1950). Traces of these can be seen in the Badounga village in the West Region, Menchum Valley in the Northwest Region etc. According to Malaa and Nzodjo 2011 rice is cultivated on a surface area of 100,000 ha across the country by 108,500 farmers who produced a total of 244,000 tons of paddy (146,000tons of white rice) in 2009. This production constitutes just 30% of home demand and the 70% imported cost the state an amount of 1194, 4 million francs CFA. The rice crises in the world predicted by economist before the year 2007 was manifested through food riots in 2008 that brought many countries to a total disorder due to increase in the price of rice in the world market. In response to the prediction in 2007 the government of Cameroon joined the Coalition for the Development of Rice in Africa (CARD) in 2008, whose main object was to lobby for funds to develop the rice sector in Africa. CARD assisted the country to put in place the National Rice Development Strategy. The strategy stipulates that the country be self-sufficient in rice by 2018.

To avoid the reoccurrence of the rice crises the government while re-launching the rice sector decided to stabilize the price of rice in the country. Considering the importance of rice alongside the implication of continuous importation on the foreign exchange earnings of the country, concerns have risen on the need for the country to attain self-sufficiency in the production of rice.

In Cameroon rice is produced in three different ecologies (lowland and upland, both of which are rain fed and irrigated), across the country. The ability to diversify or change production systems depends on the type of intervention, the instruments as well as the livelihood of individuals (Romer and Macro, 2005). However, major motivating factors for policies in this direction include; the quest for food self-sufficiency, national food security, availability of cheap food, reduction of importation, empowerment of producers through fair input and output prices and alleviation of poverty in the rural area.

The rice varieties grown across Cameroon before 2008 were introduced using a top-down approach. With this approach farmers were obliged to accept what was given to them since they had no other alternative. These varieties over the years have lost their genetic capability leading to a drastic drop in yield of < 1 ton per hectare for upland rice and <2tons/Ha for lowland/irrigated rice (Malaa and Nzodjo, 2011). To re launch the rice sector there is need to introduce new varieties like New Rice for Africa that are high yielding and tolerant to diseases. On like the top down approach used in the 1980s, the participatory approach was used this time to introduce the NERICA varieties. This approach of technology transfer called participatory varietal selection (PVS) permitted the farmers to select their preferred varieties among the introduced and their existing varieties at tillering and maturity. This study therefore sought to find out the extent to which farmers could select their preferred varieties based on their biophysical and organoleptic characteristics.

1.2 Objective

The study had as the primary objective to offer farmers an opportunity to select their preferred varieties based on their biophysical and organoleptic characteristics.

2 Literature review

Reviewing other studies related to the PVS approach, Yadaw *et al* (2006) saw the approach as one which is used to provide choices of varieties to the farmers for increasing production in their diverse Socio-economic and agro-ecological condition. It is also a selection process for testing released or promising genotypes in farmer's fields. PVS includes research and extension methods to deploy genetic materials at on-farm experiment. Therefore, the varieties developed through PVS can meet demand of different stakeholders. Kolech, S.A., et al (2015) discovered that a substantial number of farmers in northwest Ethiopia grow potato in the dry season ("Belmehr", March to August) when rainfall is not dependable for the growth of the crop, resulting in lower yield. Ethiopian Agricultural Research Institutes have tried to change the situation by releasing new late blight tolerant varieties that potentially could allow for production of the crop in the rainy season ("Meher", May to October).

The study was conducted at sites representing two major agro-ecological zones in northwest Ethiopia and during both production seasons using 12 varieties (9 local and 3 new) with a 'participatory variety selection' approach.

During the Belmehr season, erratic rainfall resulted in low yield and lower average tuber weight. By contrast, in the Meher season, late blight, desiccating wind and severe precipitation, includes hail, limited production. These factors were important in both agro-ecological zones, with varying degrees of importance. Twenty-three traits were found to influence the varieties that farmers selected, with the degree of importance of each trait differing between agro-ecological zones and gender groups. Some local varieties yielded as well as new varieties in both seasons. Overall, we found participatory variety selection to be an effective approach for identifying factors important for the adoption of potato varieties, including factors that may not be addressed in conventional potato breeding programs.

Furthermore, Nkongolo K.K *et al* (2008) had as specific objective of their study to select diverse and productive sorghum lines adapted to local conditions and accepted by farmers and consumers at large using farmers' knowledge and breeders' scientific approach. Participatory rural appraisals (PRAs) were conducted on the major characteristics of sorghum landraces. This was done in village meetings by focused group discussions (FGDs), matrix ranking, and individual interviews. Participatory variety selection was applied to select diversified sorghum lines that possess farmer-preferred plant and grain traits. During the first season, male and female farmers were invited to research stations to select 20 accessions from a pool of 101 landraces. These 20 accessions were evaluated by farmers on community plots managed by them at several sites in different agro-ecological areas for two years. Selection was based primarily on agronomic traits such as time to maturity, height, drought tolerance, insect resistance, and grain yield. Protein content and genetic differences assessed by the breeders were also used as selection tools. Overall, the results of the present study showed that farmers' characterization of several accessions combined with statistical, nutritional, and genetic analyses performed by the breeders has allowed selection of sorghum landraces that have out-performed breeder-developed lines on more than one criterion.

According to Pandit D.B. *et al* (2002), participatory selection was conducted at the Wheat Research Centre, Bangladesh Agricultural Research Institute (BARI), Dinajpur to facilitate farmers in selecting and disseminating their preferable variety and replace widely cultivated disease susceptible Kanchan to increase wheat yield and production. Farmers' need for wheat variety was identified through participatory rural appraisal in 2002 and impacts were assessed by house hold level survey in 2005. Researches were conducted as mother and baby trials. Scaling-up seed dissemination was carried out through seed supply. BAW1008, Shatabdi, and BAW 1006 produced higher yield in both mother and baby trials and got higher scores for farmers' overall preference. The farmers emphasized on yield together with bold and white grains, more grains/spike, strong stem and other characters during scoring. They identified BAW 966, BAW 1006, BAW 1008, and Shatabdi for good Chapati quality. They expected to cultivate BAW1008, Shatabdi, and BAW 1006 in the following years. Farmer to farmer seed dissemination was highly satisfactory and seeds of Shatabdi reached 47% wheat farmers of the villages in 2004-05. Varietal diversity was increased remarkably and seven varieties were grown in the study villages. Participatory variety selection approach in wheat was found very useful to increase wheat production in the working villages.

Widespread use of participatory Varietal Selection is a method that permits to reach farmers with diverse crop varieties within a short time. It is against this background that the PVS approach was used to find out the rice varieties preferred by rice farmers in three agro-ecological zones in Cameroon in terms of their biophysical and organoleptic characteristics.

3 Methodology

3.1 Study Area

Based on the socio-economic, agro-ecologic, accessibility features and the rice production knowledge, three key sites were selected for the implementation of the project. The Sahel zone grows irrigated, upland and lowland rice, the western highlands irrigated and lowland rice while only the upland rice is grown in the bimodal rain forest zone. With respect to producer only rice farmers were included in the sampling frame while the sampling technique also ensures that areas where widespread rice productions are established were selected. Farmers grow irrigated rice on developed and undeveloped plots. The three pilot sites where this study was carried out are found in three different agro-ecological zones in Cameroon. These sites are:

3.1.1 Garoua or the North: Located in the North region in the Sahel zone with rainfall of 400 to 1200mm per year, it has diverse soil types that vary from ferralitic to vertisol type. Both upland and lowland rice varieties are grown in this site.

3.1.2 Mbam Basin : Extending from the center to the west region it falls within the bimodal rain forest zone with rain fall of 1200 to 1500 mm per year. The soils are ferralitic and acidic with low fertility. This site is well known for growing upland (plateau) rain fed rice.

3.1.3 Ndop plain: Found in the North West region, it is located in the western highlands, with rainfall of 1200 to 1500 mm per year. The soils are rich and appropriate for agriculture. This is the seat for one of the rice production units in the country (UNVDA).

3.2 Sampling Technique and sample size

The study adopted a two-stage sampling technique for the selection of rice growing villages in the three principal rice growing agro ecological. Respondents were randomly selected from the rice growing population in the different rice growing villages.

Sample size: 240 farmers randomly selected from these sites participated in the participatory varietal selection.

Data collection tools: Between 2009 and 2011, a multidisciplinary team (Research technicians, extension workers, farmers) used structured questionnaires to collect data at the different growth stages of rice baby to mother trials. Observation and measuring methods were also used to collect biophysical and organoleptic data on the 60 upland and 40 lowland new varieties the NERICA inclusive and local varieties.

3.3 Methods

3.3.1 Agronomic Test

For the lowland rice ecology, the cleared piece of land was manually tilled at 30cm deep by the side of a ready nursery bed. The field was inundated with water and made into mud. Transplanting was done at 20cm X 20cm with 2-3 plants per spot.

Photo 1: Farmers in active participation in selection at tillering

As regards to the upland rice ecology, the cleared piece of land was tilled 20cm deep was pegged and planted. At a feeding zone of 20cm X 20cm, 3-4 grains of rice seed were planted per hill. Weeded plots were fertilized with NPK (20 10 10) at a dose 300 kg /ha at planting; 50kg/ha of urea at tillering and 50kg/ha of urea at flowering.

Photo 2: Farmers in active participation in selection at maturity

Harvesting was done manually with the assistance of siècle when the field had attainted about 80% maturity. Threshing and winnowing was done manually. The paddy was dried on tarpaulin.

3.3.2 Palatability Test

As concerns the palatability test, two kilogram each of the selected varieties were hulled. As shown on fig 3, the rice was given to the female PVS farmers to boil with a given quantity of water equal to double the volume of rice. Boiled rice was served in flasks.

Photo 3: Women boiling the various varieties of rice for palatability test

Photo 4 portrays people from all works of life (researchers, extension workers, restaurants owners, farmers, administrators, etc) who were invited to test the different varieties of rice to make their best choices. Using a score of 1 to 5 to rank the most to the least preferred in terms of the stickiness, flavor and taste.

Photo 4: Women and men from all works of life scoring the different varieties of boiled rice

4 Results

4.1 Socio-demographic characteristics of the farmers

Using Simple descriptive analysis (percentage, tabulation, graph etc) the results showed that with a global percentage of 51 females to 49 males and mean age of 43,1±9,9 year and 41,8 ± 8,3 years respectively, the Ndop site is the only site that has more than 50% women. This is attributed to the fact that agriculture in this zone is dominated by women while in the Muslim community in the Northern part of the country agriculture is carried out mostly by men. More than 75% of the participants are married with less than 20% being both single and widow in all the sites. As regards to the educational level of the farmers, more than 75% have attended at least primary school and less than 10% have never been to school. Agriculture is the principal activity of these farmers. They own an average of 2.2±1.7 ha of land and grow rice on an average of 0.44±0.2ha of land. Alongside growing rice as a cash crop of which as much as an average of 74.9±8.7% of the rice produced is sold, 94% of them grow other cash crops. The mean household size by gender is 3.4±2.3 male to 3.3±23 female with an average labor force of 5.7±2.2.

4.2 Varietal Selection

An analysis of results showed that upland varieties selected varied per site and by gender within the same site. At tillering V24 was selected by both sexes in the Mbam Basin while in Ndop site V13 was selected only by males and NERICA 8 by females. With respect to the lowland selection at tillering, NERICA-L-38, NERICA-L-52, NERICA-L-15 and NERICA-L-36 were selected by both males and females in Ndop. In Garoua the varieties that were selected irrespective of gender are NERICA-L-59 and NERICA-L-60. Combined data showed that NERICA-L-36 was the best varieties selected at tillering in Ndop and NERICA-L-60 was the best variety for the PVS farmers in Garoua.

The farmer's choice of these varieties was backed up by a number of preferred characteristics as shown on table 1, alongside the importance of each characteristic.

Table 1: Preferred rice characteristics at tillering and their importance of as expressed by PVS farmers

N°	Preferred Characteristics	Importance of Characteristics
	Good germination capacity	High yield
	Many tillers	High yield
	Vigorous growth	Resistant to diseases and high yield
	Big leaves	Leaves cover the ground thus reduce weed invasion and also protect grains from birds attack
	Average height	Resistant to lodging(inundation or wind), Easy to harvest, with no weed and easy to thresh
	Homogenous growth	Mature at same time and thus ease harvesting

At maturity in the lowland ecology, NERICA-L-36 was selected at all the sites and by both sexes while varieties like NERICA-L-42 and NERICA-L-21 were just selected in Ndop and Garoua respectively. By pulling the data together NERICA 3 was selected across all the sites in the country while NERICA 9, NERICA 4 and NERICA 14 were only selected in the Mbam Basin, Ndop and Garoua (Nord) respectively. The characteristics that favored the selection of theses varieties and the importance of the characteristics as responded by the participants were as shown on table 2.

Table 2: Preferred rice characteristics at maturity and their importance as expressed by the PVS farmers

N°	Characteristics	Importance of the characteristics
1	High yield	Profitable
2	Homogenously mature	Harvest at same time
3	Short cycle	Can grow rice about twice a year
4	Large grain	Has heavy Weight thus high yield
5	Large/Long panicle	Easy to thresh
6	Grain color	Attractive for the market
7	Large leaves and awns	Protect the paddy from birds attack
8	Long grain	Attractive for the market
9	Paddy color	Attractive for the market
10	Few empty packets	High yield of good quality

To confirm the choices made on the field came the organolyptic phase where the varieties selected at maturity in the second year were cooked and tested for their stickiness and flavor. At this final stage some varieties selected at tillering and maturity like NERICA 14 and others were rejected after palatability testing for not having the desired cooking quality, flavor or taste.

NERICA 3 was selected by >25% and >40% of farmers at tillering and maturity respectively and was finally selected by >45% after organoleptic/palatability test across the three agro-ecological zones, making it a leading upland variety in the country. The second most preferred variety was NERICA 8, selected by >40% of farmers after palatability testing. Other preferred varieties included NERICA 9, preferred by >55% of farmers at one site (Tonga), and NERICA 13, preferred by >30% of farmers at two sites.

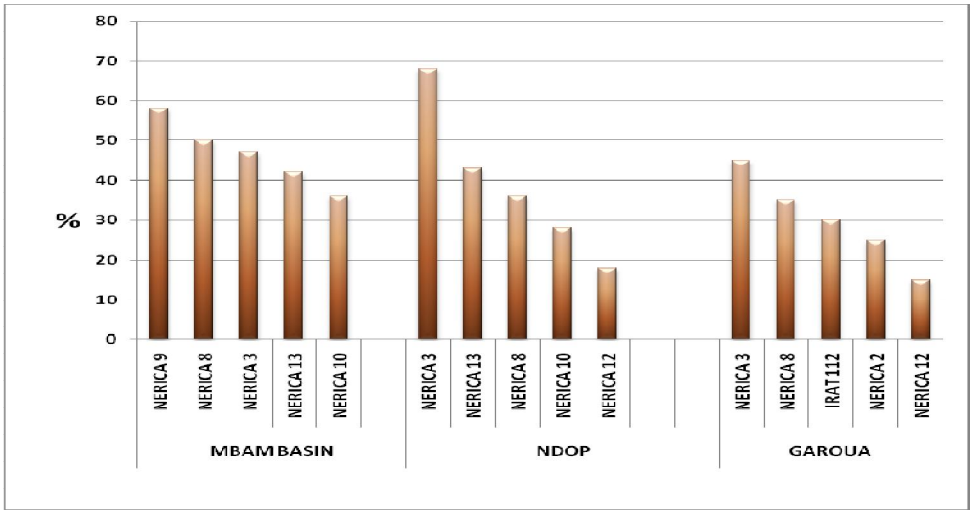

Figure 1: Upland varieties globally selected per project site at maturity

Unlike the upland varieties, the lowland/irrigated varieties selected were specific to each site. While 45% and 35% of farmers respectively selected NERICA-L 56 and NERICA-L 42 in Ndop (western highlands, 40% and 35% respectively selected NERICA-L 36 and NERICA-L 60 in the Sahel zone.

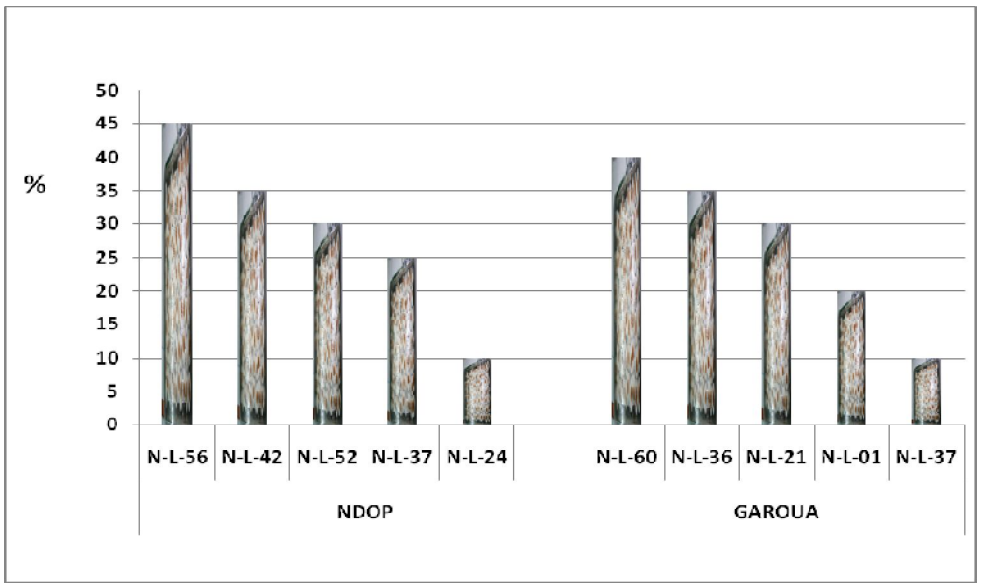

Fig 2: Lowland varieties globally selected per project site at maturity

Even though there were a great number of the varieties selected at the tailoring stage by the PVS participants were dropped along the way, some of the varieties were able to meet the expectations of the participants.

Figure 3 shows the rice map of the most cultivated rice varieties as of date, that was selected by the farmers as per their biophysical and organoleptic characteristics in various agro-ecological zones.

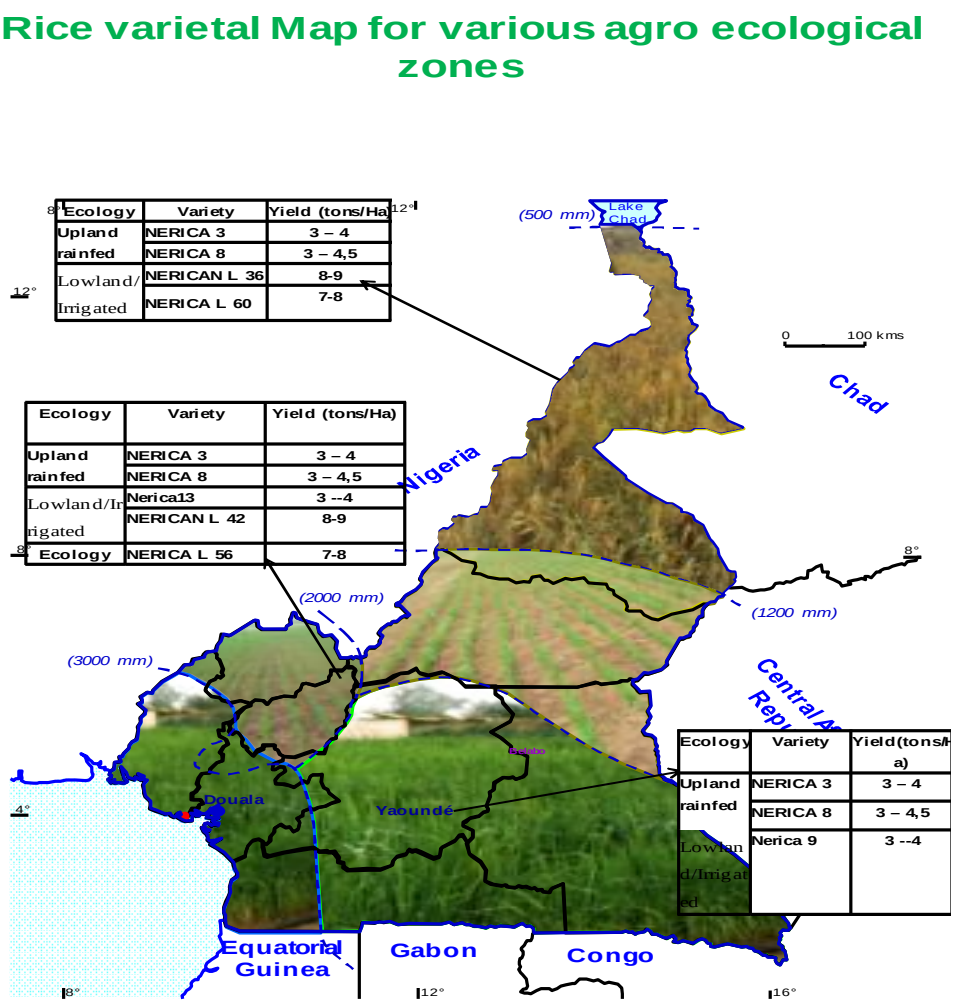

Figure 3: Rice Varietal Map.

5 Conclusions and Recommendations

The approach of participatory varietal selection permits the farmers to select the varieties they preferred best. With varying reasons for making their choice, some varieties selected at tillering were given up at maturity for others which were not selected at tillering. At the palatability test some varieties selected at maturity were rejected for not having the cooking quality, flavor or taste they expected. While the criteria for choosing the varieties ranged from profitability (associated with high yields) to market quality (associated with grain shape and color), by the third year the farmers were growing the selected varieties by themselves.

Nonetheless, it is imperative to carry out additional assessment with the adapted varieties (e.g. fertilizer rate, planting density, planting date) to determine "best bet" cultural practices in order to recommend a complete economic and profitable package to farmers. The project has so far carried out selection of varieties adapted to three agro ecological zones. There is an urgent need to carry out PVS in other agro ecological zones as well. Furthermore a good seed system needs to be put in place and should be back-stopped by the maintenance of genetic materials at the research level.

Acknowledgement

We wishes to thank all the PVS farmers in the Mbam basin (Tonga), Ndop and Garoua (North) project site who accepted to participate whole heartedly to this very important process of the project. We also thank all the extension staff in the project site for their constant collaboration.

Many thanks to the Common Fund for Commodity and the Africa Rice Centre for the financial, genetic material support, capacity building and technical assistance without which, this important aspect of the work wouldn't have been realized. Special thanks goes to the French Debt Relief Fund (C2D) for financing the dissemination of quality seed of the selected varieties through the project on Increasing the Productivity of Rice in Cameroon.

References

ACDIC., (2006). *"Food sovereignty in Cameroon: a study based on the rice sector"*. Yaoundé, Cameroon.

FAO. , (2006). *"Brief on import surges, countries, no. 4, Cameroon: poultry, rice and vegetable oils. Commodities and trade division*". , Rome, Italy

FAOSTAT, (2006). Database.

Kolech, S.A., Halseth, D., Perry, K., (2015). *"Identification of Farmer Priorities in Potato Production through Participatory Variety Selection"* American Journal of Potato Research Volume 92, Issue 6, pp 648–661

Malaa, D.K. & Nzodjo P., (2011). "*Strengthening the Availability and Access to Rice Statistics for Sub-Saharan Africa: a Contribution to the Emergency Rice initiative"* Yaounde-Cameroon

Neba, A., (1999). *"Modern Geography for the Republic of Cameroon"*, 3rd ed. Bamenda: Neba Publishers

Nkongolo, K. K., Chinthu, L., Malusi, M., and Vokhiwa, Z., (2008). "*Participatory variety selection and characterization of Sorghum (Sorghum bicolor (L.)Moench) elite accessions from Malawian gene pool using farmer and breeder knowledge"* African Journal of Agricultural Research Vol. 3 (4), pp. 273-283, available online at http://www.academicjournals.org/AJAR

Pandit, D. B., Islam, M.M., Harun-UR-Rashid, M., and Sufian, M.A., (2007). "*Participatory variety selection in wheat and its impact on scaling-up seed dissemination and Varietal diversity"* Bangladesh J. Agril. Res. 32(3): 473-486

Romer, C.L. and Macro, K., (2005). *"Tomorrow's hunger: a framework for analysing vulnerability to food insecurity"* ESA Working Paper No. 05-07 www.fao.org/es/esa.

Vaillant, A., (1950). Rice in Cameroon. Agronomie Tropicale 5: 606-621.

Yadaw, R. B., Khatiwada, S. P., Chaudhary, B., Adhikari, N.P., Baniya, B., Mudwari A., and Tripathi B.P., (2006). International Rice Research Institute (IRRI).