International Journal of Agriculture Innovations and Research
Volume 10, Issue 3, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy):
Received: 17/10/2021 | Accepted on: 15/11/2021 | Published: 30/11/2021

Dissemination and Adoption of Improved Varieties of Leguminous Seed Promoted by the Agricultural Research Institute for Development (IRAD) among Producers in Penka-Michel Subdivision, West Region of Cameroon

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Abstract **– The design of systemic innovations in the agricultural sector today makes it possible to reconcile the challenges of productivity and sustainability. But these innovations, which sometimes combine several variables, are often complex in the opinion of farmers. This article analyzes the process of diffusion of the improved varieties of leguminous seeds promoted by IRAD and the adoption by producers within the district of Penka-Michel in West Cameroon. Data were collected using the questionnaires on a sample of 80 producers and interview guide was address to 5 agricultural input sellers and 2 researchers. Producers were selected on the basis of the quota sampling method; agricultural input sellers and researchers were selected randomly according to their experience on the topic. Information collected from the questionnaire was collected and processed using Excel spreadsheets and SPSS 16.0 software, those from interview guide was transcribed. Results show that the production of leguminous grains in Penka-Michel is mainly done by women (66.2%) relatively mature (51 to 60 years) but with a low level of education and whose main activities are agriculture (78.8%). Although the improved varieties are less appreciated than the traditional ones, they come exclusively from IRAD, which first carries out a series of experimentation and tests before distribution. The dissemination process is carried out either through direct extension to producers with the support of Extension Agents, or through partners, which in this case are NGOs and Farmer Organizations. "Mouth to mouth" and self-dissemination by the farmers themselves seem to be the most important channel (73%) of disseminating information about innovations on improved seeds. Despite the popularization actions carried out, the adoption rate of new varieties remains relatively low. Of the 42.08% who had previously adopted these varieties, there were 38.47% who rejected them after adoption mostly due to lack of information and financial resources. Only 3.61% who finally adopted these varieties. While it is true that several variables such as household size, contact with research and seniority in production make it possible to analyze the adoption rate, it can be clear that it remains subject to several biophysical, socio-economic, technological and institutional constraints. It is therefore essential to redefine strategies that can be more effective in the long term.**

Keywords **– Adoption, Dissemination, Improved Leguminous Seed, Penka-Michel, West Region, Cameroun.**

I. INTRODUCTION

The last decades in sub-Saharan Africa in general and Cameroon in particular, have been marked by a radical change in the socio-economic environment and the conditions of agricultural production. Therefore, although increasing agricultural production is a central concern, the quality of production factors remains a challenge for most smallholder farmers (Nkamleu, 2004). The increases in population, the fluctuations in the prices of agricultural and food products, the increase in the basic needs of family farms and especially, the increase in the number of hunger-sensitive people have pushed the Cameroonian State and its development partners to strengthen the capacities of farmers, with a view to increasing agricultural production (Balkissou, 2000; Temple

et al., 2011).

Based on this observation, despite the fact that the agricultural sector contributes 22.9% to the GDP of the national economy, poverty remains concentrated in rural areas with agricultural production as main activity. Faced with the need to revitalize this sector, the State is relying on research, technologies and innovations, potential sources of agricultural growth that can contribute to poverty reduction. Innovation establishes a cause-and-effect relationship between agricultural research, the development of techniques and their dissemination and, at the end of the chain, their adoption by farmers, which induces repercussions and impacts of an economic and social nature (Hall et al, 2001).

The decline of the coffee hegemony in Cameroon in the 1980s and its consequences encouraged the emergence of new crops, once considered subsistence crops. Amongst these are the leguminous grains which have since gained importance and now play a key role in intercommunity and interregional trade. But the absence of available information on the performance of innovative cropping systems leads farmers to evaluate these systems based on their experience and knowledge. They make their choices based on their perception of innovation and their own constraints. An innovation perceived as riskier by farmers therefore has a lower probability of being adopted. In addition, depending on their production contexts, farmers develop preferences for certain characteristics of the innovation (Roussy et al., 2015).

The situation of legume production improved from 2003 with the implementation of various development projects for this crop (C2D legumes project, 2013). Nevertheless, the level of growth remains much lower compared to general forecasts, which increases the demand for food products, especially proteins. The protein consumption is 16 g/inhabitant/day, whose value is far below the minimum recommended threshold of 30 g/inhabitant/day (FAO, 2008). To redress the low productivity of the leguminous grain sector, the Ministry of Scientific Research and Innovation (MINRESI) has set up since 2013, the C2D legumes project in order to improve the production and consumption of food legumes in the Regions of Cameroon. Therefore, researchers at the Institute of Agronomic Research for Development (IRAD) produce improved varieties of legumes for producers. The varieties developed concern the following species: common bean (Phaseolus vulgaris L); soy (Glycine max); groundnuts/peanuts (Arachis hypogea); cowpea (Vigna unguiculata) and voandzou (Voandziea subterranea). Despite the efforts of agricultural research to make improved seeds of legumes available to farmers, the rate of seed adoption remains low in addition to inefficient application. The non-promotion of new varieties by producers is the concern that justifies this study, which questions the dissemination mechanisms and the challenges of peasant adoption of innovations promoted by IRAD.

II. RESEARCH METHODOLOGY

This study, which is based on a sample of 87 people (80 legume producers, 5 input sellers and 2 IRAD researchers) was conducted in Penka-Michel sub-division, located in Menoua Division in the West Region of Cameroon. This district is located between latitude 05°21'52" and 05° 31'41" North, longitude 10°7'39" and 10°20'00" East and about 1430 m altitude. Penka-Michel is geographically delimited: to the north by Bamougoum; to the south by Bamendjou; to the west by Kong-Nzem and Fokoue; and the east by Batcham sub-divisions (PCD, 2015).

International Journal of Agriculture Innovations and Research
Volume 10, Issue 3, ISSN (Online) 2319-1473

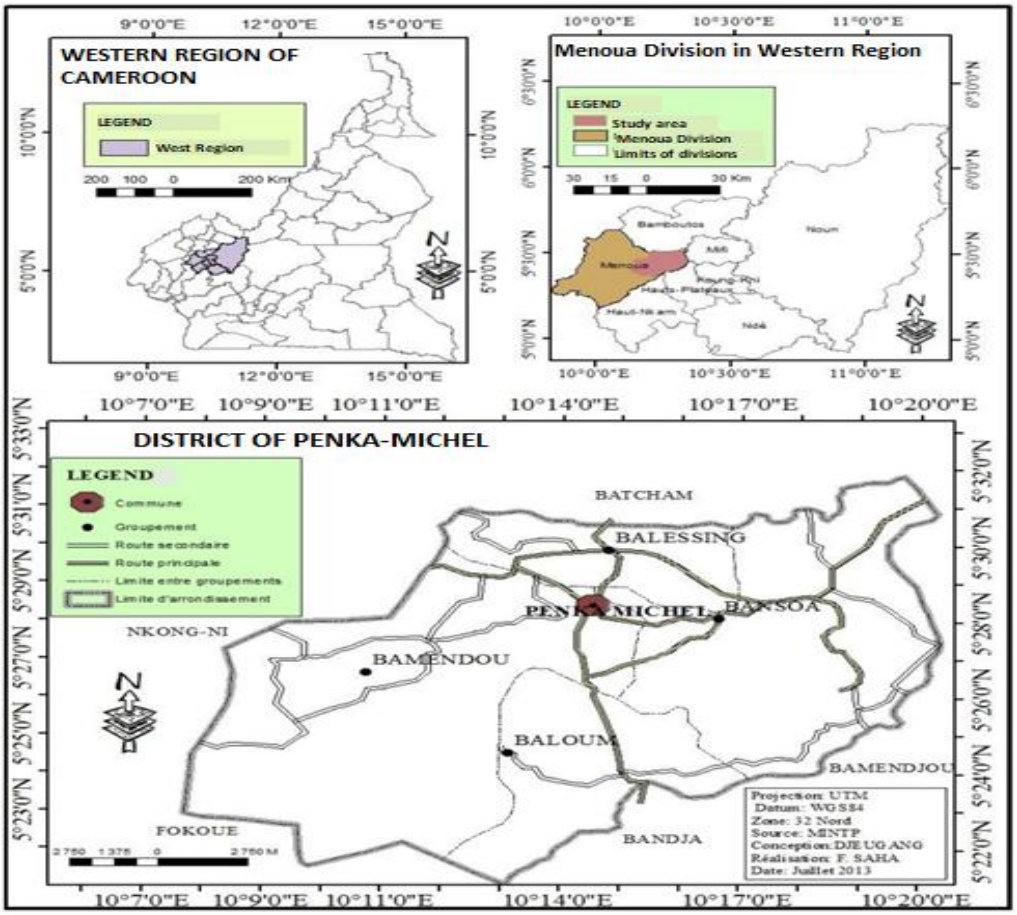

Fig. 1. Location map of the Penka-Michel district.

Source: PCD of Penka-Michel 2015.

The choice of this area for the study mainly responds to a need to extend research actions in areas of food crop production and to increase the production and consumption of pulses for sustainable food security and increased income for producers. The choice of crops takes into account the varieties developed and promoted in this area, namely common bean (*Phaseolus vulgaris L.*), peanuts (*Arachis Hypogaea L*) and soybean (*Glycine max (L.) Merr.*). Their particularity lies in the production cycle, its color, the size of the seeds and their resistance to attack.

The sampling method used is the quota method. Indeed, the selected producers were those working with Head of Agricultural Post (CPA) or Extension Agents (AVZ) and producing at least 2 of the selected crops. Thus, 10 farmers were retained in each of the functional agricultural posts in the district. Thus, of the 13 posts in the district, we investigated the following 08 posts: Baloum-Ndounke, Baloum, Banie, Makia, Balefock, Bassossia, Badjeghang and Balessing.

The analysis of the qualitative data was carried out by thematic grouping after transcriptions and decoding. The quantitative data were analyzed and coded using the SPSS (Statistical Package for the Social Science) software. The method consisted in calculating on the one hand the descriptive statistics (averages, percentages) of farmers who displayed a certain behavior with respect to the new varieties and on the other hand, the estimation of a Logit model made it possible to identify variables that affect the adoption of improved varieties of leguminous grains/pulses in production systems.

III. RESULTS AND DISCUSSION

3.1. *Socio-Economic and Demographic Characteristics of Pulse Producers*

Understanding the challenges of the adoption of innovations in a farming environment very often requires a prior analysis of the socioeconomic and demographic context. In the context of this study, it is about the socio-demographic characteristics of the producers of legumes with seeds of the district of Penka-Michel.

3.1.1. *Demographic Profile of Producers*

Analysis shows that 66.2% of pulse producers are women with ages ranging from 21 to 70 years. The majority (or 54%) are between the ages of 51 and 60 years, which indicates an aging population and likely to be less receptive to the adoption of an innovation. The overall low level of education is not to be left out with 60% of producers at the primary level, 35% at the secondary level and 2.5% who have not been to school. This level of education is unfortunately not an asset for the popularization and adoption of modern production techniques. Folefack (2003) asserts that more educated peasants easily pick up the lessons and recommendations of extension workers, they read and understand newspapers better, follow radio and television broadcasts, and are more likely to adapt to changes in the system. Production, marketing and food.

3.1.2. *Producers' Activities*

Most of the economic activities of these producers are concentrated on agricultural activities but also secondary non-agricultural activities but directly or indirectly linked to it. Table 1 below shows the distribution of the secondary activities of the people interviewed.

Table 1. Distribution of producers according to their secondary activities.

Activities	Frequency	Percentage
Agriculture	17	21,2
Trade	23	28,8
Rearing	25	31,2
Civil servant	3	3,8
Arts and craft	5	6,2

In addition to agricultural activity and especially that of the production of pulses which occupies a large majority (78.8%) of all the producers of Penka-Michel, the study reveals that for those for whom it is not the main occupation, it represents a significant secondary activity alongside activities such as small trade, breeding and handicrafts. This result is consistent with the general observation of the dominance of agricultural activity in the rural environment of West Cameroon, but also in the sub-region. In Chad, Mopate and Maho (2005) also spoke of an occupation of 89% and justifies this by the fact that the main foodstuff comes from the farms.

3.1.3. *Land Acquisition Methods*

Farmers have an average of 2 to 4 fields for farming activities and the surfaces vary between 0.5 and 6 ha; the average being about 1.96 ha per household. Table 2 below shows the different modes of land acquisition.

Table 1. Modes of access to land.

Mode of Land Acquisition	Frequency	Percentage
Share-cropping	1	1.2
Inheritance	60	75
Gift	7	8.8
Rent	2	2.5
Bought	9	11.2

The main system for acquiring land is inheritance (75%). The main landowners are men. Because, the lands are granted to them by inheritance and some buy to increase their production surface area. This result agrees with that obtained by Nzoffou et al. (2019) for whom the main form of access to land in the Bamileke region remains inheritance.

3.2. *Selection Process of Seed Legume Varieties*

The study shows that the selection of varieties takes place at 2 levels. First at the research level for experiments and tests and secondly at the producer level. The varieties currently cultivated in the Western Highland Region of Cameroon are the result of joint research between IRAD and private institutions that have obtained genetic material directly from the International Center for Tropical Agriculture (CIAT) and PARBRA (Pan-African Bean Research Alliance). Currently, nearly 30 varieties are cultivated under small-scale farming, the majority of which are local varieties (IRAD, 2013). At the research level, the selection criteria for varieties are diverse and they are based on: their adaptability to different agro-ecologic areas, their richness in protein, iron and zinc, their yield and their resistance to diseases. These are only the most suitable varieties, the tests of which have been conclusive, which will be distributed to the farmers according to a well-defined extension system. According to these criteria, the varieties most used in the Western region and especially in the district of Penka-Michel are: MEX 142, NUV109-2, NUA99, ECAPAN 021 and NUV6.

Farmers often choose the crops to grow based on family food preferences, cultural factors, food security imperatives and market opportunities. Other important factors that influence the types of pulses grown include knowledge of production and post-production practices, as well as access to seeds (Mhango, Snapp and Kanyama-Phiri, 2013). For the producers of Penka-Michel, the reasons which guide and influence the choice of varieties to be sown or the adoption of new varieties are diverse. Figure 2 below illustrates these reasons.

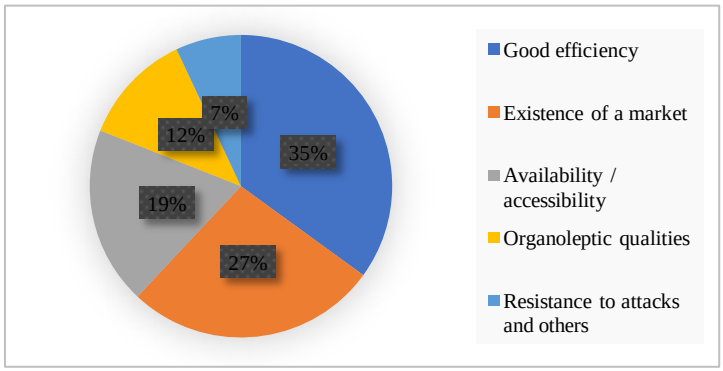

Fig. 1. Criteria for choosing varieties of leguminous grains by farmers.

Yield is the dominant criterion, followed by the existence of outlets which apply exclusively to newly introduced varieties. Availability / accessibility ranks third because the varieties grown by people are those they find on the local market. Most of the varieties promoted by research are non-existent in the markets. The organoleptic quality comes in 4th position, it is the main reason why "black beans" continue to be cultivated by the majority despite the low yield. In addition to the above reasons, the choice of bean varieties is influenced by resistance to attack, cost of inputs, adaptability to the soil and season (creeping bean is usually sown in the 2nd season).

3.3. *Dissemination Process of Improved Varieties of Seed Legumes*

3.3.1. *Seed Supply Sites in Penka-Michel*

To ensure better traceability and measurement of the effects of the use of varieties, research has standard distribution sites, mainly the IRAD stations in Dschang and Foumbot. At the local level, the agricultural posts and some NGO and CIG partners ensure the relay of distribution into remote areas. The distribution system is mainly through direct sales from August through September. But overall, demand remains greater than supply and training initiatives for seed producers to take over from the above mentioned are observed alternatives. These trainings consist of training workshops and regular follow-ups in the fields during the cultivation period. These seed sourcing strategies appear to be ineffective with producers who continue to use traditional sourcing methods. Figure 3 below shows the different sources of supply for producers.

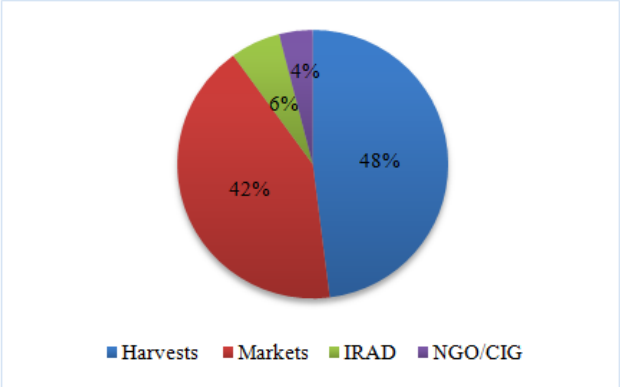

Fig. 3. Different sources of seed supply for pulses.

Even if seeds from the local market or from mass selection (old harvests) are of questionable quality, they remain the main sources of supply. The low rate attributed to research (IRAD) and relay points (NGOs / CIGs) are linked to the deficiencies in the channels for disseminating information, promoting and raising awareness. In addition, insufficient monitoring of seed producers does not allow them to have quality production in sufficient quantity to meet the needs of producers.

3.3.2. *Distribution Chain of Improved Varieties of the Seeds of Leguminous Grains*

The transmission of information in the peasant environment remains a major challenge especially for the countryside of West Cameroon, its impact on the popularization of research results are considerable, and justifies the reasons why research institutes like IRAD are trying to remedy this by diversifying the channels for disseminating innovation. Information is relayed to the populations by the peasant leaders, local associations and traditional authorities. At the same time, since they are the target of the agricultural extension mechanism,

farmers also ensure self-diffusion of these technologies (Afemasse, 1994; Enyong et al., 1999). The importance of this channel demonstrates the weight that producers have in the dissemination process.

Word of mouth and self-dissemination by farmers appears to be the most important channel for disseminating information about innovations with around 73% of producers informed by other peasant farmers. Extension through research and actions carried out by non-governmental organizations (NGOs), charities (CODAS Caritas) and local elites remain ineffective alternatives despite their interest in promoting the production of pulses. But these influence the supply of improved varieties. In addition, the lack of monitoring of seed producers does not allow them to have quality production in sufficient quantity to meet the demand of producers. Extension could be more effective if it is client-centered, that is, if it supports farmer-led experimentation and favors participatory approaches (Johnson *et al*., 2003).

3.4. *Adoption of Innovations in Seed Legume Varieties*

3.4.1. *Adoption Factors of Seed Legume Varieties by Producers*

When producers have the choice between several varieties, whether traditional or improved, they use a set of criteria to choose. The reason that mainly guides and influences the choice of varieties to sow or the adoption of new varieties is resistance to attack. Indeed, 18.8% of producers think that improved varieties are more resistant to attack (pests, molds, weevils, etc.) and 35.0% assume that they are less so than local varieties. Thus, the variety most stored is the local variety (62.3%) against (37.7%) for the improved variety. The arguments supporting these choices are: Improved varieties require additional costs for conservation. In fact, the varieties promoted by IRAD require the use of fertilizer. The nitrogen-phosphorus-potassium (NPK) formulas recommended by the station for legumes are: 12-11-18; 12-6-20; 11-11-22; 14-24-14. To control pests to legume crops such as snails, they suggest treatment with insecticide. In rural areas, people opt for the use of "Poudrox" to reduce the invasion of weevils; Despite the fact that these varieties are high yielding, they are prone to rapid attack by weevils. Therefore, they must be quickly disposed of. Preferably before the second agricultural campaign, at the risk of seeing the purchase price drop mercilessly or of running out of possible market outlets. The renewal of plant material is mandatory if producers want to ensure a certain level of production.

3.4.2. *Identification and Analysis of the Determinants of Adoption of Legumes*

This study is based on the hypothesis that the probability of adopting an improved variety of legumes would be a function of the socio-economic, technical and geographical characteristics of the producer and his environment. Like Anderson *et al.* (2005), the determinant variables of the model are those which most affect the probability of adoption of varieties. The logistic regression model presented in Table 3 below makes it possible to analyze the determinants of the adoption of pulses by the producers of Penka-Michel.

Table 3. Results of the logistic regression model of the determinants of legume adoption (N = 80).

Explanatory variables	B	Exp (B)	1/ Exp(B)
Sex (0 = Women et 1 = Men)	-1,514***	,220	4,545
Size of household (0 = Average, 1= High)	,272	1,312	//

Explanatory variables	B	Exp (B)	1/ Exp(B)
Length in production (0 = inexperienced, 1 = experienced)	,251	1,286	//
Producer organisation membership (0 = Yes, 1 = No)	-,495	,609	1,642
Contact with research (0 = Yes, 1 = No)	1,053***	2,867	//
Constante	,964		
Number of observations N = 80; -2Log likelihood ratio = 86.488; Nagelkerke R^2 = 0.186; Cox & Snell R Square = 0.131 Percentage of correct prediction = 75 %; Omnibus test of the model coefficients χ^2 = 11.251; sig, 001 *** significant at 1%; ** significant at 5%; * significant at 10%			

Depending on the size of the household, we see that this variable has a positive coefficient and is significant at 10%. Statistically, this shows that the smaller the household size, the higher the chances of adopting the varieties. Thus, medium-sized households have a 1.312 times higher probability of adopting a modern variety than large-sized households. This could be explained by the fact that the more people there are in a household, the more difficult it will be to meet the needs of the members. Adopting an innovation involves additional costs that are difficult for large households to bear. This result is consistent with those of Tsegay 2009), for whom the increase in family size tends to exert more pressure on consumption rather than on the contribution to production.

Contact with research appears to significantly affect the level of adoption of pulses given the significance level of 1% of this variable. Households benefiting from supervision, especially from extension agents for the case of this study, have a 2.867 times higher probability of adopting new varieties than those who are not supervised. This could be explained by the fact that the proximity of producers to extension agents and therefore to research increases the flow of training, information, awareness and access to new innovations, which increases the chances of adoption. This result is consistent with those observed by Mabah *et al.*, (2013; De Janvry *et al.*, (2015) stipulating that contact with extension facilitates access to information and promotes the adoption of innovations.

Experience from length of time in pulse production also has a significant positive influence on adoption. Producers with more than 15 years in the production of legumes have a predisposition to adopt innovations unlike those with less than 15 years. The odds ratio of this variable is equal to 1.286. Therefore, producers over 15 years in production have a 1.286 times higher probability of adopting than those with less than 15 years experience. Indeed, the high experience producer who are in this case relatively old farmer are those who adopt new varieties the most. Contrary to general convictions which claim that the "old" are less receptive to the adoption of an innovation, those of Penka-Michel with assets at their disposal such as the possession of large areas of land and diversified incomes which allow them to afford certain freedoms such as "taking the risk of experimenting with something new to see what it will turn out". This result is similar to studies which have observed positive relationships between seniority and adoption, showing that older, heads of households could

also have a better economic situation which offers them an opportunity to experiment with new crops (Demeke *et al.* 2011).

3.4.3. *The Effects of Adopting New Varieties*

In this study, the effects of adoption were particularly analyzed on the common bean varieties. The overall finding is that of an increasing yield, especially among producers who adopted the improved FEB-192 variety during the 2016 crop year. It is true that producers are gradually adopting the varieties, as it is true that some varieties are abandoned after attempted adoption. Table 4 below illustrates the rejection rates of some varieties after adoption.

Table 4. Main varieties of abandoned leguminous grains (common beans).

Adopted Varieties	Frequency	Percentage (%)	Varieties Abandoned after Adoption	Frequency	Percentage (%)
GLP 190-S	67	83,75	GLP 190-S	12	17,91
FEB-192	59	73,75	FEB-192	5	8,47
GLP 190-C	35	43,75	GLP 190-C	10	28,57
MEX-142	27	33,75	MEX 142	7	25,92
BG.G	12	15	BG.G	12	100
Ty 339'6-12	2	2,5	Ty 339'6-12	1	50

The table shows that the most adopted variety is GLP 190-S (Varieties of local bean of purple color spotted with white) identified by the populations as non-creeping "Mac-Mac". The one that is the least adopted is Ty 339'6-12 (Varieties of local bean, small grain, zebra color, "Mac-Mac"). The trend of rejection after adoption is rather reversible. Indeed, the results show that the variety BG. G (New varieties of common bean, white in color) was totally rejected by all the producers who had previously adopted it. The Ty 339'6-12 which was not already adopted is also partially rejected.

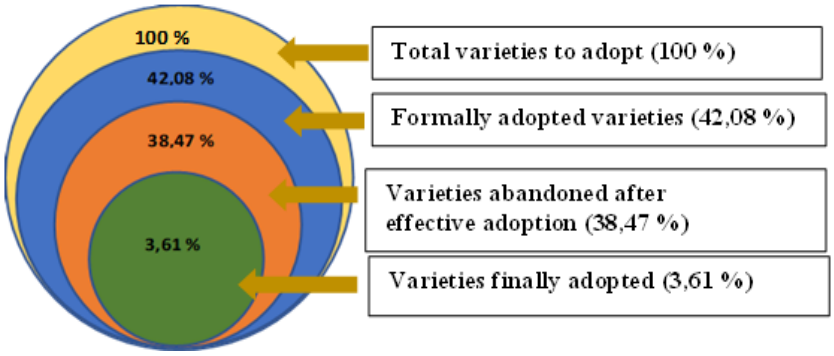

Fig. 4. Adoption rate of new varieties of common beans.

Overall, the prior adoption rate for the common bean varieties is 42.08%, but with a rejection rate after adoption of 38.47%, we end up with a final adoption rate of 3.61%, which remains very low despite the efforts made. The reasons given by producers explaining the abandonment or non-use of seeds are diverse: a lack of information is mentioned by 18% of producers who are unaware of the existence of improved varieties; the doubtful quality of seeds (14%) but also their unavailability (12%) are discussed; the lack of financial means as

well as the lack of skilled labor (10%) are also significant reasons. Many other reasons are mentioned such as inefficiency in productivity, storage constraints, insufficient mastery of production techniques, the high purchase price of seeds, the lack of outlets and the permanent non-renewal of seeds etc. For Ekepu & Tirivanhu, (2016), adopting multiple legume-based cropping systems and the number of innovators can be useful in establishing the extent of adoption. Several factors influence the adoption of technologies and can be classified into biophysical, socio-economic, technological and institutional factors. These constraints make producers reluctant to try the technologies offered to them or force them to abandon them after a certain period of use.

IV. CONCLUSION

This study on the analysis of the dissemination process of new varieties of leguminous grains promoted by IRAD and the challenges of their adoption by Penka-Michel producers was based on a relatively elderly population of producers. They are characterized by a low level of education but with relatively large plots of land (1.96 hectares on average) likely to favor the experimentation of varieties. The analysis shows that varietal selection takes place at two levels, first at the level of research institutes through experiments and tests on seeds obtained from the CIAT and PARBRA, but producers too are making choices. These choices are influenced by the social and cultural context in which they live such as the family's food preferences and adoption pattern driven by copying behaviors. Despite the low seed supply from research institutes, which the new varieties of leguminous grains distributed in the rural areas around Penka-Michel therefore comes exclusively from IRAD which proceeds either through direct extension with a team partner deployed for the occasion (AVZ), or indirectly with the support of local partners or relay points which in this case are NGOs, farmers' organizations or the traditional authority, most farmers prefer to draw on either their previous harvest or obtain supplies from local markets for traditional seeds. The analysis of the adoption of the new varieties promoted shows a low adoption rate of less than 4% despite the popularization efforts made, and strongly influenced by socioeconomic, technical and even physical factors such as lack of information on the effectiveness of improved varieties and technical production itinerary, lack of financial resources, traditional and dietary habits, soil adaptability. The issue raised by this study invites us to think about the redesigning of an operative and functional innovation and research system. According to Ekepu & Tirivanhu, (2016), in the long term, it will clearly be necessary to create formal seed systems, which will allow small farmers to access good quality seeds. Actions to support formal and informal seed systems need to be coordinated, and be part of a participatory plant breeding initiatives in order to develop crops that will be welcomed by farmers. Increasing funding for extension agencies and facilitating the employment of extension workers will lead to penetration of extension services in rural communities.

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