ADOPTION AND IMPACT OF IMPROVED CASSAVA (*Manihot esculenta Grantz)* PRODUCTION TECHNOLOGY ON FARMERS WELFARE IN MEZAM DIVISION OF THE NORTH WEST REGION OF CAMEROON

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ABSTRACT: The aim of the evaluation was to assess the success of adoption and impact of ICPT at the farm level, and by implication the success of ACEFA's program in facilitating the transfer of those technologies. The evaluation design combines elements of theory-based and case-based approaches. These stem from a *realist perspective* that recognises the complexity of interventions in the social world and the difficulty of isolating the impact of a single intervention, seeking instead to explore what works, for whom, in what circumstances and why. Toward this end, the evaluation methodology tested an ex-post theory of change developed with ACEFA via a survey of cassava growers conducted between January and July 2018. A four-stage, clustered, randomized procedure was used to select a representative sample of 180 cassava farmers. These farmers were administered semi-structured questionnaires about their cassava production, consumption, marketing practices, preferences for different cassava cultivar characteristics, and their knowledge of, and access to improved seed and fertilizer. Data were analysed using SPSS and the quasi-experimental method. The survey revealed that (63.90 %) of the farmers planted improved cassava variety with most cultivated variety being 96/1414 (66.1%). 62.2% practices the planting configuration techniques. Socio-economic analysis results showed that majority of the farmers were females (65.56%) and over 46 years of age with over 4 members per household. Majority of the respondents were married (75 %) having primary level of education (66.1%). Most of the respondents were not novice in cassava production. Majority of respondents (67.8%) own the land they use for production. However, the rate of fertilizer usage on cassava was relatively low as (30.60%) reported. Adoption rates were higher among females than male farmers. 77.39% of the respondents revealed that they adopted because the variety is high yielding and profitable. 55.38% of those who did not adopt revealed that dis-adoption is influenced by the availability and accessibility of local cuttings compared to improved cuttings.

KEYWORDS: Rate of adoption, Impact, Production Technology, cassava producers, logit model.

1 INTRODUCTION

In order to ensure political stability, economic growth and eradicate poverty, one of the four pillars of Cameroon's Vision 2035 is to address food crisis and make Cameroon the breadbasket of the Central African Region (Manu, 2014). Increasing agricultural productivity is critical to meeting expected rising demand and, as such, it is instructive to examine recent performance in cases of modern agricultural technologies (Challa, 2013). Agriculture generates the highest number of employments (more than 60percent of both skilled and unskilled), ensures national food security, and shares a percent contribution of 15.33 percent to Cameroon's Gross Domestic Product (GDP), foreign earnings and, above all, provides raw materials to the industrial sector (24.49percent), which is still in its infant stage (Mouafor *et al.,* 2016). Cassava and its derivatives are in first place, with a value of 43percent of market share for roots and tubers: 26percent for processed products and 17percent of fresh roots (PNDRT, 2003). Cassava also provides higher income to growers well over rice and maize, its two major competitors in Cameroon (Mvodo and Liang, 2012a). For agricultural households, roots and tubers, most often are cultivated in combination with other crops. Cassava has carbohydrate content approximately forty-times higher than rice and twenty-times higher than maize (Nyerhovwo, 2004). Cassava lends itself to polyculture, it withstands drought and infertile soils (Ceballos *et al.*, 2006). Cassava (*ManihotesculentaGrantz*) is the main food crop of Cameroonians, having less agronomic

requirements, and is cultivated in numerous regions of the country (Ngome *et al.*, 2013; Temegne *et al*., 2016). Cassava is, together with maize, common beans, cocoyam, yam, plantain and rice, among the most important staple food crops of the North-West Region (NWR) of Cameroon. Cassava serves this function as it can be consumed raw upon maturity, processed into —garri, —water fufu, cassava flour mainly produced for home consumption after its introduction to the NWR around 1920 (Ohadike 1981; Warnier 1984). Its processed products are very popular with the growing urban population because they are easier to prepare and can be kept longer than the other staple crops. For instance, garri is made from cassava storage roots, grated, fermented, and fried with or without palm oil (Zundel *et al.,* 2010). In the N.W.R, as everywhere in Cameroon, cassava producers maintained that cassava performs five main roles including: famine reserve crop, rural food staple, cash crop for urban consumption, industrial raw materials and foreign exchange earner (Nweke *et al.,* (2002). In the humid savannas of Cameroon (to which the NWR belongs) most of the farmers growing cassava for home consumption also plant it as a commercial crop. In view of the changing role of cassava and the changing environment, new cassava varieties are required (Zundel *et al.,* 2010).

Besides, funding for research in general and agricultural research in particular in Cameroon and many developing countries becomes increasingly scarce. For this reason, research administrators have come under heightened pressure to ensure that available resources are used efficiently. The need to illustrate accountability has generated increased interest in research impacts assessment methods and motivated a large number of empirical studies designed to determine whether agricultural research programs are having their intended effects. A number of these studies have used some type of benefit-cost analysis to calculate return to research investments. Such approach typically involves measuring the diffusion of innovations generated by a research program and calculating the economic and financial margins resulting from their appropriation. Despite the fact that the findings of a number of recent research impacts studies back the view that investments in agricultural research continue to generate attractive rates of return, some scholars instead argue that economic framework type of analysis is borne with limitations. The latter contend that economic rate-of-returns calculation is, in some ways, relatively suited for evaluating agricultural research type of activities whose primary outputs (technological innovations) are essentially a means of achieving broader welfare goals that cannot always easily be measured. The realisation that traditional economic approaches are not always well-suited for dealing with changes in the quality of human lives has fueled interest in alternative research impacts assessment methods that are less dependent on tangible calculus of monetary costs and benefits.

One such alternative approach to understanding the impacts of agricultural research involves adoption case studies. Well conceived, intelligently planned, and carefully executed studies of a case can generate valuable insights into understanding how rural households adopt agricultural innovations and are affected by them (Stern et al, 2012; Sechrest et al. 1998). Such insights are useful in devising ways to maximize the appropriation of agricultural innovations, hopefully with favorable effects on sustainable food production, poverty reduction, and environmental protection. Case studies are not necessarily inexpensive to conduct, but they are easier to execute than controlled experimentation involving large groups of test subjects and are sufficiently flexible to accommodate a wide range of research or evaluation questions.

This research sample summarizes the findings of a recent case study that focused on the adoption rate and impact of improved cassava varieties on farmer's welfare through ACEFA programme. ACEFA is a programme jointly managed by the French government and the Cameroon government (through MINADER and MINEPIA) to support family farm enterprises (FAFs) in Cameroon as to what concerns supportive counseling and financing in the form of investments. The ACEFA programme has as vision to improve the competitiveness of the family Agro pastoral farms by improving on the incomes of the family agro pastoral farm enterprise (FAFs) and to professionalize producer organizations. The overall objective of the case study was to assess the success of adoption and impact of ICPT at the farm level, and by implication the success of ACEFA's programme in facilitating the transfer of those technologies in order to improve the welfare of ICPT producers (and consumers). Specific sub-objectives of the case study were as follows:

- document adoption at the farm level of ICPT and shed light on the factors affecting adoption;
- assess qualitatively and, where possible, quantitatively the impacts of ICPT on the welfare of cassava-producing households; and
- draw lessons from the ACEFA programme and ICPT and, accordingly, make recommendations that may be useful in the design and implementation of future projects of a similar nature.

1.1   THE CASSAVA ECONOMY OF CAMEROON

In Cameroon, cassava ranks first amongst root and tubers crops in terms of total production and consumption with yearly production estimated at 5 Mt (Agristat, 2010) with the Centre, East and South regions being the most productive areas (PNDRT, 2005). It is the main starchy staple with 80percent of rural and urban households consuming cassava and cassava derived products on a daily basis (Essono*et al*., 2008). Currently, however, there is a growing awareness of the potential of cassava as a source of food and of income but the majority of cultivated varieties are susceptible to pests and diseases causing significant

yield losses (Hahn *et al.,* 1989; Njukwe *et al.,* 2012a). Cassava and its products for example "baton", paste, flour, "fufu", "garri", and starch are being sold both in Cameroon and elsewhere in Central Africa for the rapidly growing urban populations (Njukwe *et al.,* 2012b). This increase in demand for cassava has led to increased prices in Cameroon and an increase in production beyond the previous traditional subsistence systems (Dury and Medou, 2004). Its ability to grow and produce reliable yields in areas where cereals and other crops do not perform well has also contributed to its popularity. Cassava is consumed in many forms particularly, fresh, boiled or processed but also for its leaves which serve as vegetables and is largely grown by smallholder farmers, with the main production system being intercropping (Agwu and Anyaeche, 2007). Smallholder farmers in Cameroon grow various cassava cultivars and there are marked producer and consumer preferences as to the type of variety grown and these determine the uptake of new varieties (Zundel*et al.,* 2010). Cassava also has gained industrial importance to produce ethanol, glucose and amino-acid, high-quality cassava flour is use in bread production both for domestic consumption and export purposes (Sanni*et al.,* 2007). Cassava products are components of basic food intake for seven (7) to eight (8) million people in Cameroon living in the eight (8) southern regions and cover around eight (8) percent of daily nutritional needs, just below plantain (9.8 percent) in the group of starchy food crops (SNI, 2009).

1.2   PRODUCTION TRENDS

According to official statistics, the area annually harvested to cassava in 2016 averagely is about 374,655ha. As areas devoted to its cultivation was estimated at 204,548 hectares with an annual production of 2.3 million tons (PNDRT, 2005). Most of the cassava grown in Cameroon is cultivated in association with other crops, particularly in the Western Highland zones and humid forest zone with bimodal rainfall; this implies that the planting densities are generally low. Average cassava cuttings planted per hectare is 10,000 cuttings. Total annual cassava production is currently estimated at 5,501,749 tons. Both of the two key determinants of production (area harvested and yield) increase yearly.

1.3   CONSUMPTION TRENDS

Among all the major energy-providing crops (cassava, yam, cocoyam,colocasia, sweet potato, plantain, Irish potato) that are grown in Cameroon, it ranks first in per capita consumption. According to FAOSTAT (2008), the per capita consumption of cassava in 2005 in Cameroon was 90.13 kg/year, where cassava provided an average of 270.87 kcal/capita/day, which is higher than was estimated in 2002, at 75kg/person (MINADER, 2003b). Of the two million tons produced that year, it was estimated that 1.1 million tons were consumed in total: 360 tons in urban and 770 tons in rural areas. Cassava offers an affordable source of calories and contributes to household food security; while it is a key dietary staple, cassava has remained a subsistence crop because of its rapid spoilage after harvest, caused by an inadequate/irregular supply to feed the few processing facilities and inefficient processing methods for the market (Njukwe*et al.,* 2012b). Cassava is consumed in many forms, it is consume raw, in the form of water "fufu", "garri", "kum-kum" (cassava flour). The leaves are prepared and eaten as vegetables. Cassava is eaten either fresh (boiled, raw) or processed. The quantity of each cassava product consumed varies by region, level of urbanization, and ethnic diversity of the dwellers and their diverse food habits.

2   METHODOLOGY

2.1   STUDY AREA

Mezam Division is located in the North West Region of Cameroon with its capital called Bamenda. It is located 366 km north-west of Yaoundé. The area covers an approximate area of 200km2 and is situated between latitude 5º58'42.6''N, and longitude 10º08'52.0''E. It is bounded to the North, East, and West by Menchum, Boyo and Momo Divisions and to the South by the Western Region. Mezam Division in the North West Region of Cameroon is divided into seven sub Divisions namely the Bali, Bafut, Bamenda I, Bamenda II, Bamenda III, Santa, and Tubah as seen in the above map of Mezam Division.The soils of Mezam are Oxisols. But there are still some dark and fertile soils around river banks for example River Mezam and other streams. Some valleys have dark alluvial depositions carried from hills and other areas. Mezam has a sub-equatorial climate which is a climate that is greatly modified by altitudes. This type of climate is shown by nine months of Rainy Season with an annual rainfall of about 2400mm. Rainfall pattern in the Mezam Division is at peak in the month of July to August. Mezam Division is characterized by a cool-like climate influenced mainly by mountainous terrain. The average temperature is 230C with the minimum and maximum ranging from 150C-320C. Also, the temperature is greatly modified by the altitude such that the high mountain areas experience cold climatic condition. There are two main seasons; wet seasons which corresponds to the forceful penetration of the monsoon winds from the Atlantic Ocean and a Dry Season which sets around the month of November to February, reducing most agricultural activities in most parts of Mezam except gardening in the Santa work area. There is also the Rainy Season, which starts from March and continue till October, giving the signal for almost all agricultural

activities in the area. The Dry Season is characterized by the Hamattan with dry air. Practically because of climate change, this area (Mezam) experiences some rains in January and no rains by mid-March. During the Dry Season, temperatures exceed 230C in the day and drop to 180C in the night and early mornings. During the peak period of rainy season, the rainfall is often estimated to 2900mm on an average, accompanied by lightning and thunder storms leading to landslide (common in the Bafut work area) especially in the months of August and September.

2.2 METHODOLOGICAL APPROACH AND SAMPLING

The impact evaluation design combines elements of theory-based and case-based approaches. These stem from a *realist perspective*; i.e. a recognition that outcomes are affected positively and negatively by the real world context in which they occur (Stern et al, 2012). In this perspective, realist evaluation recognises the complexity of interventions in the social world and the difficulty of isolating the impact of a single intervention, seeking instead to explore what works, for whom, in what circumstances and why. In line with realist, theory-based approaches, the evaluation design employed in this study case seeks to test a theory of change for ACEFA intervention via ICPT

Furthermore, a multistage sampling technique was used for this study with four stages. In the Division, Sub-divisions were selected through simple random sampling technique. Five of the sub-divisions in the Mezam Division were selected.

Stage two involved selection of villages in the Sub-Division selected in stage one giving a total of 12 villages, the third stage involved the selection of common initiative group of farmers into cassava production from each of the 12 villages selected in stage two giving a total of 85 cassava producer groups interviewed for the study (Table 1).

Table 1.

Sub-Division	Villages	Cassava producing groups
Bafut	Mundum	
	Njinteh	
	Mforya	46
	Achenie	
	Mbebeli	
Bali	Wosing	15
Santa	Awing	
	Baligham	9
Bamenda II	Ntahbeng	8
	Alahbukam	
Tubah	Bambui	7
	Bambili	
		85

Source: Field survey, 2018

While the fourth and last stage involved an average selection of seven Family agro pastoral farms (FAFs) from each selected group given a total sample size of 180 FAFs interviewed (Table 2).

Table 2.

Sub-Division	Cassava producing groups	Average FAFs/group	Total number of FAFs	30 percent of FAFs sampled/group
Bafut	46	7	322	97
Bali	15	7	105	32
Santa	9	7	63	19
Bamenda II	8	7	56	17
Tubah	7	7	49	15
Total	**85**		**595**	**180**

Source: Field survey, 2018

For primary data collection, a semi-structured questionnaire was used. This questionnaire was elaborated around a list of precise points that were related to the theme or topic of the study. Firstly, the questionnaire had a section on socioeconomic characteristics of the farmers: Sex, age group, family size, household size and level of education. Secondly, the questionnaire

assessed the level of adoption by asking questions on cassava varieties cultivated and source of these varieties. Finally, farmers were asked information on the, credits/loans, off-farm income, farming experience and land tenure system. The collected data were analyzed with the help of statistical packages such as Statistical Package for Social Sciences (SPSS) and impact evaluation was done qualitatively by using the quasi experimental and participatory approach. The analyses process consisted of coding the questionnaires and variables so as to ease their insertion in the statistical package. Descriptive statistics such as frequencies, means, percents, etc, were used to bring out the socio-economic characteristics of the cassava producers and the extent of improved cassava variety adoption. The logit model was used to analyse the factors influencing the adoption of improved cassava varieties.

3   RESULTS AND DISCUSSION

3.1   SOCIO-ECONOMIC CHARACTERISTICS OF THE CASSAVA FARMERS

The socio-economic characteristics of the farmers retained for this study included gender, age, marital status, family size, farming experience and educational level.

It was observed that 65.60percent of the respondents were females and 34.40percent were males. This implies that females dominated in cassava production. This was probably because women are the main food provider in rural Cameroon since as according to Prakash, (2006) it is estimated that in Cameroon, rural women supply about 90 percent of the food needed for subsistence by the population making them more involved in agriculture than the males.

Majority 56.1percent of the respondents were middle age adults ranging between 46 and 55 years old, while 32.8percent of the respondents were 56 years of age and above, also 9.4percent of the respondents were between 36 and 45 years of age and only a few 1.7percent were between 20 and 35 years of age. This implies that most of the farmers engaged in cassava farming were adults (46 -55 years old).

Criteria used to classify the status of the respondents were single, married, divorced and widow. Marital status is an institutional factor that has great influence on family matters. The results obtained showed that majority (75.0percent) of the respondents who were engaged in cassava production were married, followed by respondents who are widows 10.6 percent, divorced 9.4 percent and single who were 5.0 percent These results suggested that married respondents dominated in cassava production probably due to the fact that they had households' responsibilities hence, income obtained from cassava is important for alleviating household income and improving household food security.

Household category with household size of [0-5] was the highest with a percent of 51.7 percent followed by size of [6-10] with a percent of 46.1percent and only 2.2 percent was over 11. Large family size is an indicator for availability of labor provided that the majority of the family members are within the age range of active labor force.

With respect to farming experience, 42.2 percent of the respondents indicated that they have been into cassava production between 11 and 20 years, 37.7percent of the respondents indicated to have been into cassava production for over 21years and only 20percent of the respondents had been into production for less than or equal to 10 years. This shows that the respondents in this study are not novice in farming activities especially in cassava production. This indicated that study sample was composed of experienced farmers including those who were reluctant to change towards the use of improved cassava production technology.

In terms of educational background, majority (66.1percent) of the respondents had primary education, followed by No formal education (21.1percent), Secondary education (12.2percent) and only 0.6percent of the respondents attended university level.

Table 3. Socio-economic characteristics of survey respondents

Characteristics	Frequency	Percents
GENDER		
Female	118	65.60 percent
Male	62	34.40 percent
Total	**180**	**100.00 percent**
AGE		
[20-35]	3	1.70 percent
[36-45]	17	9.40 percent
[46-55]	101	56.10 percent
[56 and ab0ve]	58	32.80 percent
Total	**180**	**100.00 percent**
MARITAL STATUS		
Single	9	5.00 percent
Married	135	75.00 percent
Divorce	17	9.40 percent
Widow	19	10.60 percent
Total	**180**	**100.00 percent**
HOUSEHOLD SIZE		
[0-5]	93	51.70 percent
[6-10]	83	46.10 percent
[11 and above]	4	2.20 percent
Total	**180**	**100.00 percent**
FARMING EXPERIENCE		
less than or equal to 10	36	20.00 percent
[11-20]	76	42.20 percent
21 and above	68	37.70 percent
Total	**180**	**100 percent**
EDUCATIONAL LEVEL		
No formal education	38	21.10 percent
Primary	119	66.10 percent
Secondary	22	12.20 percent
University	1	0.60 percent
Total	**180**	**100 percent**
LAND TENURE		
Inheritance	34	18.90 percent
Renting	24	13.30 percent
Owner	122	67.80 percent
Total	**180**	**100 percent**

3.2 RATE OF ADOPTION OF IMPROVED CASSAVA CUTTINGS

In Mezam division, the most cultivated varieties are EScaPP$_{30}$, 96/1414, TMs92/0057, EScaPP32, TMs92/0326, 8034, 8017, TMs0239 due to the fact that growth of these cassava are determined by the agro-ecological zones. Some of the adopters of improved cassava varieties used only one type while others made a combination of two varieties. Out of all these mentioned varieties, 96/1414 is the highest yielding variety with long tubers and it is very good for processing ("Garri", "water-fufu", "cassava flour") more reasons why so many farmers cultivated it.

Results showed that 76 adopters (66.1percent) used only 96/1414, 10 adopters (8.7percent) used only the EScaPP$_{30}$ (Bitter purple). Also 4 adopters (3.5percent) used only TMs92/0057 variety and 4 adopters (3.5percent) used only EScaPP$_{32}$ variety. Furthermore 21 adopters (18.3percent) jointly used 96/1414+EScaPP$_{30}$.

Table 4. Rate of adoption of cassava production technology

	Improved cassava varieties	Use of fertilizer	Slanting planting
YES	**63.90percent**	**30.60percent**	**100.00 percent**
NO	36.10percent	69.40percent	0.00 percent

Over half of the sampled farmers planted improved cassava varieties 63.90percent. 100percent percent of these farmers practiced the slanting planting configuration. The rate of use of chemical fertilizer was much lower (30.60percent). This is because most of these farmers preferred organic manure over fertilizer. Most common combination involved adoption of improved cassava cuttings and slanting planting, without fertilizer application.

Table 5. Farmer's reasons for the cassava varieties grown

Category	Frequency	Percents
Adoption (ICV)		
High yielding and profitable	89	77.39 percent
Resistant to pest and diseases	21	18.36 percent
Early maturity	5	4.35 percent
Total	**115**	**100 percent**
Non-Adoption (Local varieties)		
Availability of cuttings	36	55.38 percent
Lack of capital	29	44.62 percent
Total	**65**	**100 percent**
Total	180	

The findings as shown revealed that, majority (77.39percent) of the farmers who adopted said high yield and profitability is the reason that made them grew the variety. Whereas 18.36percent and 4.35percent said the resistance to pest and diseases and the early maturity of the variety are the reasons why they grew the varieties.

For non-adopters of improved cassava varieties, majority (55.38percent) of the interviewed said it is because of the availability of local cuttings compared to improved cuttings that made them grew the local variety. And 44.62percent of the respondents said it is lack of capital that drives them from cultivating the improved variety. Varieties characteristics play a vital role in influencing farmer's adoption behavior. If the characteristics satisfy the need and interest of the farmers they will adopt (Tadesse, 2008).

3.3 FACTORS AFFECTING IMPROVE CASSAVA PRODUCTION TECHNOLOGY ADOPTION

Different socio-economic characteristics of the respondents on which adoption of improved cassava dependent cassava varieties were analysed, Socio-economic characteristics of interest analyzed included gender, age, marital status, family size, farming experience and educational level. To achieve this, a regression analysis was performed. In this analysis, the model output shows that the probability of obtaining a chi-square value is 23.248, P-value of 0.016 therefore indicates an existing significant relationship between the independent variables and the dependent variable (adoption of improved cassava varieties). The Nagelkerke R Square (R^2) value obtained was 0.231. This indicates that 23.1percent of the explanatory variables can accurately predict the dependent variable and thus be able to explain farmer's adoption of improved cassava varieties. The logit model results are presented in table 6.

Table 6. Logistic results of factors influencing Adoption of improved cassava varieties

Variable	B	Exp(B)
Age (0=less than 40, 1=more than 40)	.856**	2.355
Access to credit(0=No, 1=Yes)	1.513***	4.540
Farm size (Hectares)	.030	1.030
Years of farming (0=less than 20 years, 1=More than 20 years)	-.524	.592
Educational level (0=No formal education, 1=Formal education)	.111	1.117
Sex (0= Female, 1=Male)	-.520	.595
Household size (in numbers)	.588	1.801
main income source (0=Non agriculture, 1= Agriculture)	.089	1.093
Marital status (0=Single, 1=Married)	.096	1.101
Land tenure system	-.009	.991
Level of importance of cassava (0= consumption, 1=Commercialization)	-1.126	.324
Constant	1.238	3.448

*Note; **=significant at 5percent and ***=Significant at 1percent. Percent correct=87.8percent, and number of observations =180*

The adoption of Improved cassava production technology was dependent on two of the factors at 5 (**) and 1percent (***) levels of significance. Farm size, farming experience, educational level, household size, main income sourc, land tenure system and level of importance of cassava had no significant relationship with adoption. They were therefore not considered as factors influencing the adoption of improved cassava varieties in Mezam Division of the North West Region of Cameroon. At the 5percent level of significance, adoption was found to have a significant relationship with age. At the 1percent level of significance, adoption was found to be dependent on access to credit. Therefore age and access to credit were the main factors influencing adoption.

3.4 IMPACT OF IMPROVE CASSAVA PRODUCTION TECHNOLOGY ON THE FARMERS

Here, the impact of cassava production technology on farmers was assessed using five indicators of welfare. That is the productivity, Social impact, income, health status and skills.

3.4.1 PRODUCTIVITY

Agricultural productivity is a valid indicator of impacts because of the tremendous importance of agriculture in Cameroon. Considering the high percent (63.90percent) of farmers who cultivated improved cassava varieties in Mezam division, any technology that succeeds in increasing the productivity will bring about real income gains. From table 13 below, we can see that the cassava yields are averagely higher after the adoption of the improved cassava varieties as compared to the situation before adoption (9084.1031±5345.68275 and 5345.68275±3489.77632) respectively. It is however worth mentioning that some farmers who have adopted the improved cassava varieties can harvest up to 14167.80kg of cassava per hectare.

Table 7. Estimated yields of cassava per kilogram from 1ha of Land

Variables	Minimum	Maximum	Mean	Std. Deviation
Yields before adoption/weight in kg of bags.	11.69	13076.40	5345.68275	3489.77632
Yields after adoption/weight in kg of bags	11.34	14167.80	9084.1031	5345.68275

However, the annual cassava production per hectare is less than the national average which was estimated 13.3tons/hectare (Njukwe *et al.,* 2014). This finding is in line with the latter which postulated that, the NWR of Cameroon is among the least producing cassava antennas in the country.

3.4.2 FARMER INCOMES

Income is widely used as a welfare measure because it is strongly correlated with the capacity to acquire many things that are associated with an improved standard of living, such as food, clothing, shelter, health care, and education. Income gains are a valid indicator of project impacts because the productivity gains attributable to the adoption of improved cassava technologies logically should be reflected in income gains. In this study, 87.8percent mentioned a general increase in farm and household income after adopting the improved cassava production technology, either directly through increased sales of cassava, or indirectly. How can income gains be measured? In the absence of baseline data on farmers' cassava marketing

activities prior to the initiation of this study, we could think of no reliable way to measure income gains directly. Indirect methods based on farmers' recollections must be ruled out as too unreliable; when questioned about the distant past, few farmers are able to recall detailed information about amounts of cassava they sold and the prices they received. Lacking any approach to measure income gains directly, we simply asked farmers whether during the previous five years they had noticed any changes in (1) the quantity of cassava they produced each year, (2) the quantity of cassava they sold each year, and (3) their total annual income from cassava sales. The distributions of responses are shown in Figures 10. In response to all three questions, more than half of the respondents indicated that they had noticed increases. Interestingly, the proportion of farmers reporting an increase in the quantity of cassava sold was lower than the proportion of farmers reporting an increase in income from cassava sales. This discrepancy can be explained by the fact that cassava prices especially when it has been processed strengthened considerably during the past five years, so that total income from cassava sales could indeed have increased even if the physical quantity of cassava sold remained the same or even decreased. Taken together, the responses to these three questions provide additional evidence (again, admittedly circumstantial) that the improved cassava varieties with its associated technological package has had a positive effect on the incomes of many rural households throughout the study area in Mezam Division.

If rural incomes have increased because of the improved cassava production technology, how has the income gain benefited rural households? Through Focus group discussions, farmers who reported increased income from cassava sales were asked to describe how the additional income was spent. By far the most common reported use was:

- To pay children's school fees.
- Purchasing building materials to expand or renovate the farmer's house,
- Investing in family-owned retail trading business,
- Purchasing additional agricultural land,
- Pay medical bills
- Buy new clothes.

The additional income earned through cassava cultivation (much of which presumably can be attributed to the adoption of improved cassava technologies) for the most part seems to have been invested productively, rather than spent on short term consumption.
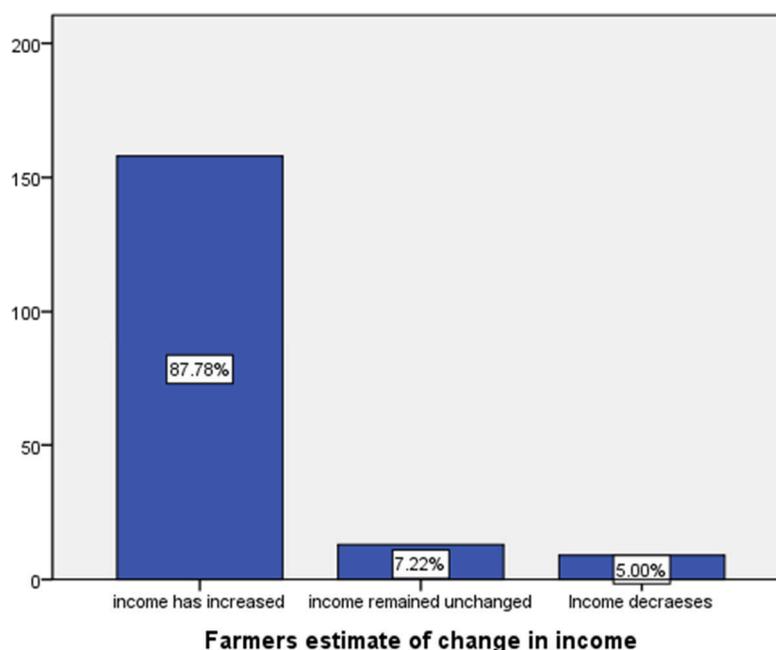

Fig. 1.   Farmers estimate of change in sales and income

3.4.3   SOCIAL CAPITAL

Here, we examined whether the group membership to which the farmers belonged had increased over time. This is presented in figure 2 as shown below.
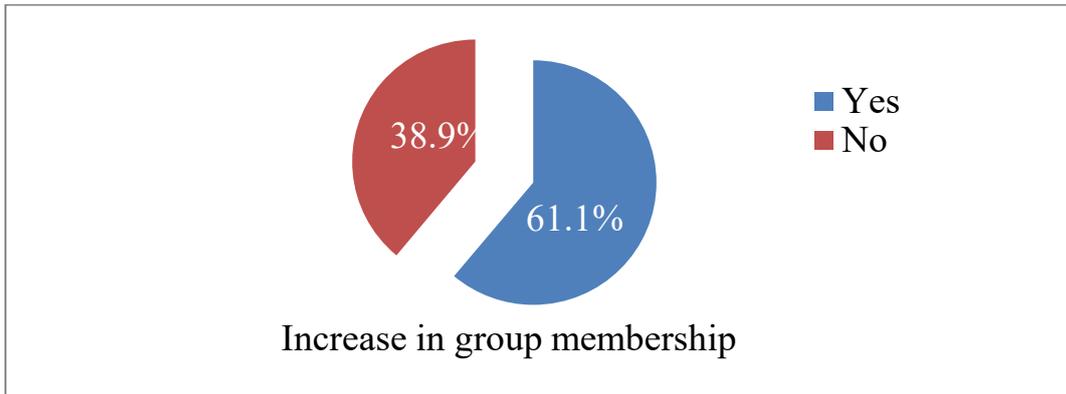

Fig. 2.   Increase in membership per group

Results revealed that all the farmers belonged to a group as shown on figure 2 above, 61.1percent of the farmers acknowledge an increase in membership of their respective groups as a result more farmers adopt the improved cassava varieties. Analyses of outcomes from focus group discussions suggest that beneficiaries increased their social networks as a result of the ACEFA programme. Networks were important for the acquisition of new information and experience-sharing on the improved cassava verities.

3.4.4   HEALTH STATUS

Here, the health status was captured using the consumption pattern, the number of meals eaten per day and the frequency with which meat or fish was eaten by the household.
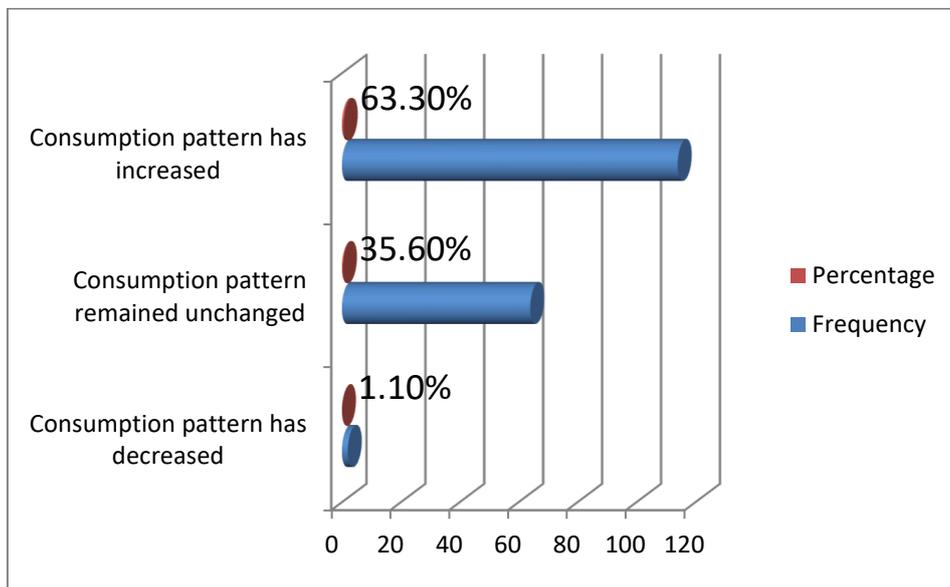
Fig. 3.   consumption pattern

Looking at food consumption and nutrition dynamics, figure 3 above, shows that 63.30percent had a general increase in the consumption pattern, the consumption pattern of 35.60percent of respondents did not changed and just 1.10percent noticed a decrease in consumption. Results from focus group discussion revealed that, the average number of meals per day had changed since the adoption of ICPT. Also, the level of luxury food consumption that is consumption of meat/fish on a weekly basis had increased from one to two or three times per week.

3.4.5   SKILLS

The table below presents the different skills gained by the cassava producers.

Table 8.   Skills acquired by the farmers

Characteristics	Frequency	Percents (percent)
Post-harvest management	37	20.6
Improve cropping system	18	10
Farm maintenance	46	25.6
Use of improved planting materials	79	43.9
Record keeping	125	69.4

From the above table, economically, slightly above 90percent of the farmers explained they have witness a change in their farming skills in different ways. The skills include knowledge on how to do proper record keeping (69.4 percent), the use of improve planting materials (43.9 percent), farm maintenance (25.6 percent), post-harvest management (20.6percent) and improved cropping system (10 percent). The percents indicate the percent of farmers who acquired specific skills. This knowledge is justified by the trainings they receive from the ACEFA project in Mezam division.

3.4.6   CHALLENGES ASSOCIATED WITH THE ADOPTION OF CASSAVA PRODUCTION TECHNOLOGY

Presented in the figure 4 below are the challenges faced by farmers which limits their abilities to reap the maximum benefits of the adopted improved cassava varieties.
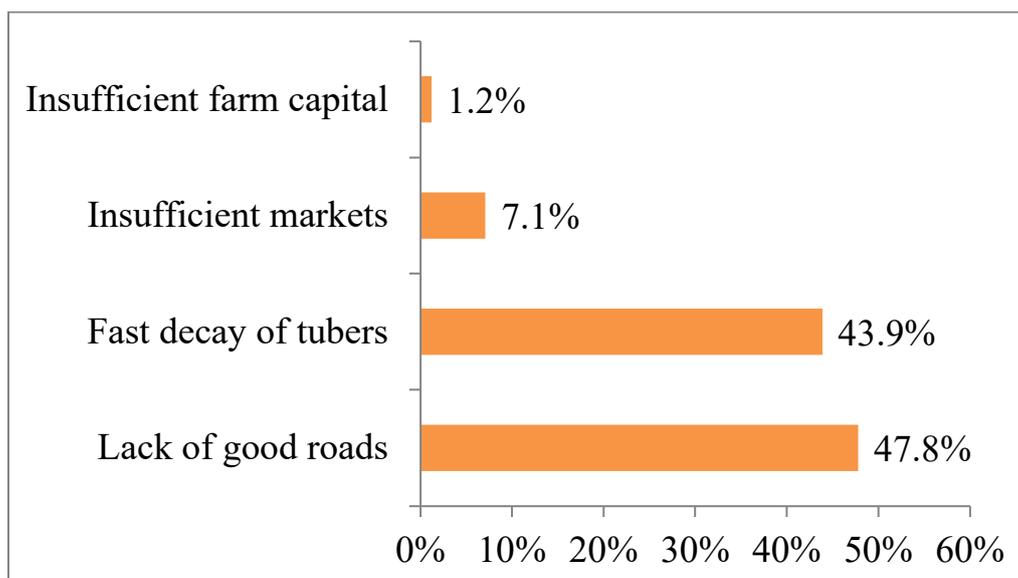

Fig. 4.   Challenges associated with cassava production technology

From figure 4 above, we can infer that the most troubling issue of the farmers is the lack of good roads to transport their farm produce with limited or no damages incurred (close to 48percent). This was closely followed by fast decay of the tubers of the improved varieties (close to 44percent). Information from focus group discussions revealed that farmers harvest just few ridges of their cassava from farms weekly so as to meet up with market demand since as most are being sold in their local markets. Other challenges such as insufficient markets (just over 7percent) and insufficient agricultural capital (1.2 percent) were mentioned by the farmers.

4   LESSONS FOR RESEARCH IMPACT EVALUATION

The adoption rate of the improved cassava varieties by the farmers was reasonably high (63.90 percent). The reasons why the farmers adopted were because of high yield and profitability (77.39 percent), resistance to pest and diseases (18.36 percent) and early maturity of cuttings. Notwithstanding this level of success, non adopters claimed that the local cuttings were more available (55.38 percent) than the IC cuttings and that lack of capital (44.62 percent) was still acute. Moreover, the age of the farmer, access to credit, the farm size, household size, main source of household income, marital status of the farmer, and level of education of the farmer positively affects their decisions to adopt the improved cassava varieties. However, access to agricultural credits (B = 1.513, p = 0.009) and the age of the farmer (B= 0.856, p = 0.027) were of significant importance. Similarly, while the age of the farmer, sex of the farmer, educational level, access to credits, and farm size were positively correlated with the use of chemical fertilizers, it turned out that access to agricultural credits (B = 1.054, p = 0.038) and farm size (B = 0.440, p = 0.040) were also of significant importance. In the same vein, the adoption of the improved cassava varieties improved the welfare of the farming households in their social capital (membership in groups), human capital (improved skills) and financial capital (increase in yields and farm income). The implications of the findings are straight forward. That is, adoption of improved cassava varieties is high in the study area. Those households who adopted the improved cassava varieties were able to improve on their yields, sales, farm income and consumption patterns. Also due to social impact and access to counseling, the cassava producing farmers have been able to improve on their associative life while gaining new skills. Overall, 47.8 percent of the respondents complained of poor road infrastructure to transport their farm produce and 43.9 percent also complained of fast decay of their tubers on-farm. These were the major challenges faced by the farmers.

WHAT HAVE BEEN THE IMPACTS OF THE ICPT?

In the absence of reliable baseline data, it was not possible to calculate quantitative measures of project impact. Based on farmers' qualitative judgments, however, it is clear that adoption of ICPT has been associated with significant farm-level productivity gains (cassava yields after adoption: 9084.10 kg) and noticeable increases in the income earned (87.78 percent) from sales of cassava (76.67 percent). 63.30 percent of the respondents experience an increase in their consumption. Furthermore, harnessing on social capital and access to counseling the farmers have been able to improve on their associative life while gaining new skills. Also, impacts on the nutritional status of rural households appear to have been pronounced. Results from focus group discussion revealed that the average number of meals per day had changed since the adoption of ICPT, and the frequency of "luxury food" consumption (meat and/or fish) had increased from one to two or three times per week.

In addition to documenting the uptake and diffusion of ICPT, this case study provides valuable insights about the many factors that can affect the adoption of agricultural innovations in general. The survey results show that adoption of improved cassava production technology is directly influenced by three sets of factors: (i) *characteristics of the technology* (e.g. complexity, profitability, riskiness, compatibility with other technologies); (ii) *characteristics of the farming systems* (e.g. agro-climatic conditions, prevailing cropping systems, access to credit, age and farm size, and availability of physical inputs); and (iii) *characteristics of the farmer* (e.g. ethnicity and culture, wealth, education, gender). Most challenges faced in production were poor road infrastructure (47.8 percent) and fast decay of tubers (43.9 percent), which call for getting down decentralized rural infrastructures along with quality and efficiency of related services. For instance, storage facilities will require roads *and* transport services to get crops to collection points as well as reliable energy services to keep perishables in proper condition.

This put into perspective the kinds of decentralized rural infrastructure investments that can have the most direct positive impact towards improving the welfare of rural households. For instance the availability of feeder roads, storage facilities and reliable energy services can lower the transactions costs of market exchange for farming households, both by improving physical connections and also by reducing information asymmetries. Better physical market connections increase the availability of inputs (improved seeds, fertilizers) and agricultural extension services – in addition to improving market access – all of which are likely to increase agricultural productivity and, consequently, welfare.

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