PRODUCTION FUNCTION ANALYSIS FOR THE SEMI-SUBSISTENCE IRISH POTATO PRODUCTION SYSTEMS AND THE FARMERS' ECONOMIC WELL-BEING IN SANTA, CAMEROON

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Abstract

The objectives targeted in this study are: to identify the drivers of the semi-subsistence Irish potato production; to evaluate the effect of the semi-subsistence Irish potato production on the farmer's economic well-being and to identify the constraints associated with the semi-subsistence Irish potato production in Santa, Cameroon. The study made use of a Cobb Douglas production function to analyze the results. Primary data was collected via simple random sampling. The results showed that startup capital, quantity of seeds planted, quantity of fertilizer applied, level of education, labour input per season and pesticide usage all had a positive and significant effect on the quantity of Irish potato produced. It was also observed that the semi-subsistence Irish potato production had a positive effect on the farmer's economic well-being. Further, insufficient capital, climate variability, fluctuation in market price, poor farm to market roads, lack of improved seed varieties, high cost of input, pest and disease are the major constraints to the Irish potato production. The study suggests that the Irish potato production should be encouraged in Santa by focusing more on its specific determinants.

Keywords: Economic Well-Being, Production Function, Irish Potatoes, Semi- Subsistence, Santa

INTRODUCTION

The Irish potato is a consumed crop worldwide with many attributed health benefits (Reddy et. al., 2018). It is grown in more than 125 countries and consumed almost daily by more than a billion people. Hundreds of millions of people in the developing countries depend on Irish potatoes for their survival. The Irish potato cultivation is expanding strongly in the developing world, where the potato's ease of cultivation and nutritive content has made it a valuable food security and a cash crop for millions of farmers (Basha et. al., 2017). Developing countries are now the world's biggest producers and importers of Irish potatoes and their products (FAO, 2020). Once harvested, Irish potatoes can be used for a variety of purposes: as a fresh vegetable for cooking at home, as a raw material for processing into food products, food ingredients, starch and alcohol, as feed for animals, and as seed tubers for growing the next season's crop (Freedman and Keast, 2011).

The Irish potato is a versatile, carbohydrate rich food prepared and served in a variety of ways. Freshly harvested, it contains about 80 percent water and 20 percent dry matter. About 60 to 80 percent of the dry matter is starch. On a dry weight basis, the protein content of the Irish potato is similar to that of cereals and is very high in comparison to other roots and tubers. In addition, the Irish potato is low in fat and rich in several micro nutrients.

Generally, the only region of the world where per capita food production has declined steadily in recent decades is Sub-Saharan Africa (SSA), where Cameroon is located. Here, the agricultural output has grown by an average of less than 1.5% annually, with a slower increase

in food production than the population growth. Thus, promoting productivity and output growth in the agricultural sector, particularly in the smallholder subsector, is the main strategy for achieving effective economic development, (Bashir et. al., 2014). The continuously increasing agricultural productivity is often expected to be accompanied by increases in agricultural demand associated with the rising per capita income and population growth. However, agriculture still remains the backbone of Cameroon's economy, employing about 43.4% of the total population, and providing 42% of its Gross Domestic Product (GDP) and 30% of its export value revenue (FAO, 2020).

In Cameroon, Irish potatoes were introduced during the German colonial period (1884–1914), but the widespread cultivation began later on in the 1940s, following the introduction of new varieties by the British and Dutch governments (Horton, 1987). This crop was well received by farmers in the highlands of Western Cameroon, where it proved to be well adapted to the high plateaus. In the late 1940s, the degeneration of the Irish potato seed (probably due to viral infections) and a late blight infestation reversed the crop's initially strong inroads, especially in the extreme southern regions. The Irish potato production is an important agricultural activity, and it is estimated that about 50,000 to 65,000 hectares of land are used for its production in Cameroon (FAO, 2020). In Cameroon, planting generally takes place at the beginning of the rainy season, usually in March, followed by a harvest in June, presumably before the occurrence of flooding. A second planting season generally takes place in November, depending on the water stored in the soil. Over 200,000 farmers grow Irish potatoes in Cameroon, mostly smallholders and predominately women (Fontem et. al., 2004).

However, during the drier periods, such as November and January, few farmers plant Irish potatoes along the riverbanks and valleys. They are cultivated on intensive, small-scale localities in six of the 10 regions of the country.

The West and the North West Regions are the predominating areas, with 80% of the national production. 17% is exported to sub-regional countries like Gabon, Central African Republic, Congo, and Equatorial Guinea (Fontem et. al., 2004). These two regions are located on the western highlands of the country, which are characterized by cool temperatures, and a high rainfall of at least 800 mm per annum at altitudes ranging between 900 and 3000 meters above the sea level. The Irish potato production is, therefore, still constrained by poor farming practices, pests, inefficient use of available technologies, poor soil fertility, the high cost of inputs such as fertilizers, seed and fungicides, lack of access to credit, and a lot more despite the government subsidization. This is because not all farmers growing Irish potato receive these subsidies, thereby causing a deficit in the Irish potato production.

Economists have suggested that there are many factors influencing farmer's efficiency. For instance, Van (2007) broadly summarized these into agent and structural factors. Agent factors are associated with the characteristics of the farm manager such as educational level, age and social capital. Structural factors are either on-farm (e.g., farm location, farm type, farm size, fertility and drainage) or off-farm such as policy, infrastructure, upstream and downstream relations (Ogada et. al., 2014). Different researchers have examined how the above factors influence technical efficiency. Abebe (2014) pointed out that several empirical studies on productivity and efficiency attributed demographic, socio-economic, institutional and environmental factors to efficiency differentials among farmers. In the same vein, analyzing the factors that influence the technical efficiency of the open Irish potato production, researchers (Kavoi et. al.,2016) found the educational level of the household, past experience in the Irish potato farming and the family size to have a positive impact on the technical efficiency. Expectedly, gender and farm size exhibited a

negative relationship. Similarly, a study in Swaziland established that age, educational level, experience and access to credit all had a significant positive relationship to the technical efficiency of the Irish potato growers (Malinga et. al., 2015).

If Cameroon maintains its position as the "bread basket" of the central African sub-region, one of the areas to be credited is the Santa sub-division as one of the major agricultural production basins, particularly for market gardening. This is because the food produced in Santa Sub-Division is not only consumed in the North West Region and other parts of Cameroon, but far beyond to other countries (Alangeh, 2013). Santa sub-division contributes in no small measure to the food security in the central African sub region. The semi-subsistence farming is a very important farming type in Santa as it is a major livelihood activity for the people in terms of income, employment and sustenance. Improving the technical efficiency by analyzing the production function will lead to an increase in the yield of farmers which will in turn lead to an increase in food supply, food security, well-being and higher incomes. This may go a long way to reduce the dependence and importation as high yields may promote an increase in the creation of agro-industries which will process the potatoes.

The Irish potato is one of the world's most important root and tuber crop worldwide (Reddy et. al., 2018). Being a highly produced crop and a source of food and income, improvements in its production and yield can positively change the lives of millions of farm households. Unfortunately, in Cameroon, the Irish potato production is yet to reach its peak. In terms of awareness and knowledge dissemination, until now, we are not aware of any major study in the case of Cameroon that has attempted to discuss its production function and linkage to the economic well-being of farmers. So far the majority of studies in this domain are focused on new varieties and technologies. The sparing literature makes it problematic. The low-income farmers account for most of the staple food that feeds the country. A very significant proportion of the national food production done by these farmers is also sold to the neighboring countries (Kelly, 2006). The success of Cameroon's agriculture is thus not only important for the farmers and the nation, but has a significant impact on the right to food for the central Africa sub region. Because of the relatively high agricultural production, many deny the fact that food insecurity in Cameroon is problematic. This is because it is not often considered as one of the hunger hotspots in the region when compared to countries like Gabon, Chad, Niger, the Central African Republic, Sudan and others (Kelly, 2006).

In terms of nutrients, the Irish potato is rich in several micronutrients; vitamin C is extracted from its skin as a medium sized potato of 150g when eaten provides nearly half the daily adult requirement (100mg). The potato is a moderate source of iron and its high vitamin C content promotes iron absorption. The Irish potato is equally a good source of vitamins B_1, B_3 and B_6 and minerals such as potassium, phosphorus and magnesium, and contains folate, pantothenic acid and riboflavin. Potatoes also contain dietary antioxidants which prevent diseases related to ageing and dietary fiber (McGill et al., 2013). Despite all these nutrient advantages, the output of the semi-subsistence Irish potato farmers is still very low. As a step to resolving this situation, this study targets as objectives: (1) to identify the drivers of the semi-subsistence Irish potato production in Santa subdivision, (2) to evaluate the effect of the semi-subsistence Irish potato production on the farmers' economic well-being in Santa sub division and (3) to identify the constraints associated with the semi-subsistence Irish potato production in Santa sub division.

LITERATURE REVIEW

In Cameroon, the Irish potato is becoming an important cash and food crop (Kelly, 2006). Since its introduction, the production trends have been increasing positively (FAO, 2O20). The Irish potato was introduced in Cameroon during the 1910s by the German mission in Cameroon where local farmers began its cultivation in small scale gardens. The Irish potato is generally grown in areas between 1800 and 2700 meters above the sea level, the highest producers in Cameroon being the Southern Highland Zone (SHZ), (Maganga, 2012). According to FAO (2O20) 90% of the Irish potatoes is produced by small holder farmers in the SHZ where it is used as food and a source of income and considered as having the same potential as maize, rice and wheat in the region.

Maganga (2012) conducted a study on the technical efficiency and its determinants in the Irish potato production in Malawi. The study examined empirically the technical efficiency of the Irish potato producers in Dedza district using cross sectional data from 200 farmers. Translog stochastic production frontier model was used to predict the farm level technical efficiency by using the Maximum Likelihood Method. The study found that the individual farm level technical efficiency was about 83%. The result showed that non-farm employment, education, farm experiences are all positively related to the technical efficiency and significant at 1%. Age and household size were negatively related to the technical efficiency and significant at 5 and 10%, respectively. There was no significant relationship between the technical efficiency and the extension visits and credit access. In addition, improving efficiency will result in farmers gaining considerably in terms of profits. Inefficiencies could be attributed to non-farm employment, education level, farm experience, degree of specialization, age of household head, household size and frequency of weeding.

A research conducted on the socio-economic and institutional factors influencing the Irish potato production at smallholder farmers' level in the Gicumbi District in Rwanda found that the Irish potato yield in Rwanda is low (Manishimwe et. al., 2019). It is around 9 tons per hectare compared to the potential yield estimated at 40 tons per hectare. The causes for the low yield are not fully known. Primary and secondary data were used. Primary data were collected using a structured questionnaire administered to a sample of 120 smallholder farmers. Secondary data were extracted from existing publications and databases on potatoes. The Probit regression was used in data analysis. The results showed that gender, age, family size, farming experience, cows and small livestock ownership, total area cultivated and farm gate prices positively influenced the crop production. The cost of land and labour negatively influenced the Irish potato production. The institutional factors comprising of fertilizer credits, access to credits and extension services, training on farm records, fertilizer use and planting and weeding techniques positively influenced the Irish potato production. The distance to market and natural control of pest and diseases influenced negatively the Irish potato production. It was recommended that the factors with a positive impact on the production should be enhanced while those with a negative impact should be addressed so that they could positively influence the Irish potato production.

Agiro (2011) conducted a research on the analysis of the socio-economic factors influencing the Irish potato production at household level in the case of Shashemene, Shalla and Siraro Counties in West Arsi Zone, and Ethiopia. He found out that the input costs for fertilizer and seed as well as labour cost comprise a large share of the total variable costs involved in the Irish potato production. Family labour also plays a significant role in the production of Irish potatoes especially for Shashemene and Siraro counties. Results

showed that there were also some differences in the Irish potato production and yield across the counties. Having somehow similar land size allotted to potatoes, the production in Siraro and Shalla was almost double that of Shashemene. The average yield in these two counties was also higher than that of Shashemene. This might be due to the higher level of fertilizer use in these two counties as compared to Shashemene. Following the basic research question as to which socio-economic factors influence the Irish potato production and yield as well as the land allotted to potatoes, it was concluded from the regression results that the household characteristics (mainly the household education level) and the input use attributes strongly contribute to both Irish potato production and yield.

Mengui et al (2019) examined the technical efficiency of the smallholder Irish potato producers in Santa Subdivision. Data were collected through surveys among the Irish potato producers, and the analyses were conducted using the Data Envelopment Analysis (DEA) and the Tobit model. The majority of the households surveyed in the region were male headed, with less than a half of the sampled households surveyed being female headed; 62.5% and 37.5% were male and female headed, respectively. This was a reflection of the situation in the study area, where most households were headed by males, and fewer headed by females. There were various constraints faced by households in the area.

The relationship between the economic well-being and the overall well-being is not always direct, particularly when comparing well-being over time, between individuals or through market prices. Generally, in a given society at a given time, income is positively related to the reported subjective well-being, so that individuals with a higher income tend to report higher subjective well-being than those with a lower income. However, Graham and Pettinato (2002) present evidence that people's

aspirations change over time so that their idea of the minimum satisfactory level of income increases over time (in a growing economy); this implies that one is forever chasing a receding target. Income growth may thus generate little increase in this component of well-being (even though, at each point in the growth process, the better-off are happier than the less well-off). This is consistent with the earlier work by Easterlin (1974), who reported that the average national happiness does not appear to increase over long spans of time, in spite of the large increases in per capita income, i.e. the so called "Easterlin Paradox". Much of the above research is limited, however, in terms of fully understanding household economic well-being, as it relies on the GDP per capita as a proxy of the typical income of each individual. These limitations come about both because the GDP growth may differ from the growth in household income and also because the average income is generally a poor proxy of the typical (i.e. median) income.

METHODOLOGY

This study was limited to Santa subdivision, which is located in the North West region of Cameroon, in the Western Highlands of the country. It would have been better to cover the whole North West region in order to make it more general and to have strong understanding about the production function of the semi-subsistence Irish potato production and the economic well-being of the farmers. Due to time constraint and security purposes it covered just a small area which makes the study less general. Also, the study was focused mainly on the input output relationship and it didn't discuss how the farmers market their output. The study encountered a number of limitations. The main challenges were difficulties in accessing some villages in the study area. To remedy this problem, social media was used. In some cases the respondents were not able to provide correct records of their round Irish

potato production and earnings because they lacked record keeping. However, different techniques were used to overcome the problem. This included asking different questions for the same answer.

Santa is one of the 32 sub divisions of the North West Region which is located between latitudes 5° 42′ and 5° 53′ North of the Equator and longitudes 9° 58′ and 10° 18′ East of the Greenwich Meridian (FAO, 2020). It has a population of 64,391 inhabitants with a surface area of 532.9Km² area (national institute of statistics). It covers some nine villages, namely, Mbei, Njong, Akum, Mbu (Baforchu), Alatening, Baba II, Awing, Baligham, and Pinyin. Located in the Western Highlands of Cameroon, it is bordered to the North by Bamenda Sub Division, to the West by Bali and Batibo Sub-Divisions, to the South by Wabane, Babadjou and Mbouda and to the East by Galim. It lies some 20km from Bamenda and is dis-enclave by the national road number 10 which links Bamenda to Bafoussam and the rest of the country and sub-region. The major economic activity in the study area is agriculture - vegetable production, Irish potatoes, and maize production with other activities being livestock rearing. The selection of the study area considered the geographical location, culture and history of the Irish potato farmers, climatic conditions and their long involvement in Irish potato production.

The environment of Santa subdivision is biophysical, covered with an evergreen tropical ecosystem. A variety of biodiversity is found in Santa subdivision that includes animals, birth species and the Lake Awing. The biophysical environment of Santa subdivision has significantly been tampered with and exploited for: habitations and settlements, agricultural practices and housing and furniture materials causing deforestation. These intensive activities have caused and continue to create environmental hazards to soils, water sources, climate and biodiversity.

Santa subdivision has a temperate climate with two significant seasons - the rainy season which occurs between March and October and the dry season from November to February. Temperature in Santa subdivision ranges between 20C to 28C while the annual rainfall ranges between 3000mm to 5000mm. The area is made of high and low lands. The soils are rich in nutrients and promote the cultivation of various crops such as Irish potatoes, cabbages, beans, vegetables, pepper, okra cocoyam and even certain cash crops such as bananas. The soil and climate are very helpful to vegetation and agriculture. Vegetation is usually green throughout the year with fewer trees in the areas with a high concentration of houses.

Data Presentation

The study used both primary and secondary data collected from randomly sampled semi-subsistence Irish potato farmers in Santa subdivision. A two-stage sampling procedure was applied to select the respondents. In the first stage, five villages, namely Santa, Akum, Mbei, Pinyin and Baba II were selected based on the high concentration of the Irish potato production and for convenience. In the second stage, within the five selected villages individual farmers were randomly chosen. This method was suitable as it guarantees the representativeness of the population of interest and, it is also cost-saving. Semi-structured questionnaires were administered to a total of 200 semi-subsistence Irish potato farmers.

The primary data were collected by using a questionnaire survey, and face to face interviews. A preliminary face to face interview was conducted to gain insights into the farming practices related to the Irish potato cultivation and for a real-time clarification of questions. The interview was also useful for refining the survey questionnaires. Among the participants, comprised of Irish potato farmers, there were representatives of a diversity of young and old, males and females. Structured questionnaires

containing closed ended and open ended questions were used to elicit information from the farmers.

Each questionnaire was divided into five sections. Section A contained a question on the socio-demographic characteristics of the farmers such as age, gender, marital status, household size, and level of education. Section B was structured in order to obtain information on the farm characteristics and practice. Section C was structured to get data on the famers' economic well-being; Section D was structured to gather information about the institutional services provided to farmers and finally, Section E tried to capture the problems associated with the semi-subsistence Irish potato production in Santa subdivision. Considering the possible non-response in the face-to-face mode of data collection, three repeated interviews were conducted to either complete some questionnaires and to replace unwilling respondents so as to achieve the calculated sample size.

In order to validate the survey data, relevant secondary data were obtained from existing website publications such as journal articles, government annual reports cooperatives, and written theses. The study used cross-checking data from multiply sources and searched for regularities in the research data. To ensure the validity and reliability of the instrument, the questionnaires were pre-tested and submitted to an expert review and validation. The researchers obtained the consent of the farmers before the questionnaires were administered. Also, the information provided by the farmers was strictly confidential and used solely for academic purposes.

The population in the study consisted of farmers, and more specifically of semi-subsistence Irish potato farmers from Santa, Akum, Pinyin Mbei and Baba II in Santa subdivision, North West region of Cameroon. These localities were chosen because they contribute an essential agricultural share by being an Irish potato producing hub within the North West region and also due to a lesser risk of non-accessibility. In the absences of up-to-date list of Irish potatoes farmers in the study area, the study employed a convenient and simple random sampling technique to select the semi-subsistence Irish potato farmers for the study. The farmers were chosen based on their availability and willingness to participate in the study. The theoretical sample of the study was initially 398 but due to financial and time constraints and also due to a greater risk in accessing villages in the study area to administer questionnaires, the sample was narrowed down to 200.

Econometric Model

Focusing on the parameter estimation and tests, we consider the function specification, thus, a Cobb-Douglas function was chosen as the functional form of the production function. The reason for choosing this type of production function is that it is linear in its logarithmic form, and therefore easy to estimate by using ordinary least squares estimation technique (OLS). The function has the following form.

$$Y_i = f(\alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon_i) \quad (1)$$

This equation (1) can be reduced as:

$$Y_i = (f(\alpha)_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n + \varepsilon_i) \quad (2)$$

Where: Y_i is Irish potato output of the ith-farm; X_1 = Farm size, X_2 = Labour input per season, X_3 = Capital, X_4 = Quantity of seeds planted, X_5 = quantity of pesticide applied, X_6 = Quantity of fertilizer applied, X_7 = Production experience of the farmer, X_8 = Level of education of the farmer, X_9 = Age of farmer, X_{10} = Membership in a farmers cooperative, $\beta 1, \ldots, \beta n$ are parameters to be estimated, α_0 = Constant and ε_i = error term. Therefore, the generalized equation of the production function for the semi-subsistence Irish potato production function can be stated as:

$$Y_i = (f(\alpha)_0 + \beta_i X_i + \varepsilon_i) \quad (3)$$

We derived the economic well-being model from equation (3) as follows:

$$Ew_i = (f(\delta)_0 + Y_i + \varepsilon_i) \tag{4}$$

Where Ew_i = Farmers economic well-being, δ_0 = Constant, Y_i = Irish potato output and ε_i = Error term

RESULTS

Characteristics of the Sample Population

This section analyses the demographic characteristics of the respondents. The analysis outlines the gender of the respondents in Santa subdivision, their age range, marital status, household size, educational level, Irish potato production status and experience, farms size,

fertilizer application and income level of the respondents per season. Table 1 shows that 139 respondents were males (69.5%), while 61 respondents were females (30.5%). This implies that the majority of the Irish potato farmers in Santa subdivision were males, while most of the females were involved in marketing and other activities. According to the study, 17 respondents were between the ages 21 to 30 years (8.5%), 91 respondents were between the ages 31 to 40 years (45.5%); 58 respondents were between the ages 41 to 50 years (29%), 34 respondents were between the ages 51 to 60 years (17%). This indicates that most of the Irish potato farmers in Santa subdivision are young farmers in their 30s.

Table 1: Characteristics of the Sample Population

Variable	Frequency	Percent	Cumulative %
Distribution of respondents according to gender and age range			
Male	139	69.5	69.5
Female	61	30.5	100.0
Total	200	100.0	
Distribution of respondents according to age range (years)			
Between 21-30	17	8.5	8.5
Between 31-40	91	45.5	54.0
Between 41-50	58	29.0	83.0
>50	34	17.0	100.0
Total	200	100.0	
Distribution of respondents according marital status			
Single	16	8.0	8.0
Married	184	92.0	100.0
Total	200	100.0	
Distribution of respondents according to household size			
Between 1-4 persons	32	16.0	16.0
Between 5-8 persons	112	56.0	72.0
> 9 persons	56	28.0	100.0
Total	200	100.0	
Distribution of respondents according to level of education			
No Education	8	4.0	4.0
Primary Education	62	31.0	35.0
Secondary Education	119	59.5	94.5
Higher Education	11	5.5	100.0
Total	200	100.0	

Source: Author, from field survey 2021

Table 1 shows that 16 respondents were single farmers (8%), while 184 respondents were married (92%). Therefore, the Irish potato production in Santa subdivision is dominated by married couples. The Table also shows that 32 respondents had a small household (between one to four persons) (16%); 112 respondents had an average household (between five to eight persons) (56%); 56 respondents had a large household (more than nine persons) (28%). This shows that the majority of the Irish potato farmers in Santa subdivision had average size families.

Table 1 shows that 8 respondents had no education (4%), 62 respondents were primary school drop outs (31.0%), 119 were secondary school drop outs (59.5%), and 11 respondents attained higher education (5.5%). This indicates that the majority of the Irish potato farmers in Santa subdivision were literate. The Table shows that 160 respondents were permanent Irish potato producers in Santa subdivision (80%), while 40 respondents indicated that they were temporary Irish potato producers (20%). This means that most of the Irish potato producers in Santa subdivision were permanent producers.

Distribution of Respondents according to Farm Characteristics

Table 2 presents the distribution of farm size in the Irish potato production and the application of fertilizer. It shows that 65 respondents had farms of less than one hectare (32.5%); 110 respondents were Irish potato farmers with farms ranging between one to two hectares (55%); 18 respondents had farms ranging from two to three hectares (3.5%); 7 respondents had farms ranging from three to four hectares (3.5%). This reveals that the majority of farmers in Santa subdivision grew Irish potatoes on a small scale. The Table shows that 191 respondents applied fertilizers to their Irish potatoes (95.5%), while 9 respondents did not apply fertilizers to their Irish potatoes (4.5%). This reveals that the majority of the

semi-subsistence Irish potato producers in Santa subdivision had applied fertilizers.

Table 2 shows that 85 respondents had an experience ranging between one to ten years; 90 respondents had an experience between eleven to twenty years (45%); 10 respondents had an experience between 21 to 30 years (5%). Finally, 15 respondents have been involved into Irish potato production for >31 years (7.5%). This indicates that many of the Irish potato farmers in Santa subdivision have been producing Irish potatoes for more than ten years. The Table also shows that 45 respondents had income levels of less than 250.000FCFA (22.5%), 99 respondents had income levels ranging between 250.000 to 500.000FCFA (49.5%). About 37 respondents said their income level was between 500.000 to 750.000FCFA (18.5%), 16 respondents said their income level fell between 750.000 to 1.000.000FCFA (8.0%). Finally, 3 respondents had income levels of more than 1.000.000FCFA (1.5%). This shows that the majority of the semi subsistence Irish potato farmers in Santa subdivision had income levels between 250.000 to 500.000FCFA.

Drivers for Semi-subsistence Irish Potato Production in Santa Subdivision

The section focuses on the relationship between inputs and quantity of Irish potatoes produced by the semi-subsistence Irish potato farmers in Santa subdivision. The results from the regression analysis were presented in Table 3. The R-squared, known as the coefficient of determination, determines how much of the independent variable explains the dependent variable. Therefore, the variations in the output of Irish potatoes in Santa subdivision are being explained by 94.2% of the independent variables used in this study. The significant value of .000 indicates that the overall model is significant. This means that the variables used are a good fit for the model.

The beta coefficient for the farm size is -111 showing that, a one-unit increase in the farm

size will lead to a decrease in the quantity of Irish potatoes produced by .111. This variable, however, is not significant leading us to accept the null hypothesis and conclude that the farm size does not significantly affect the quantity of Irish potatoes produced by the semi-subsistence farmers in Santa subdivision. The coefficient for the labour input per season is 4.956. This shows that a 1% increase in the labour input will lead to a 4.956 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject

the null hypothesis and conclude that the bigger labour input is, the greater the quantity of Irish potatoes produced. The coefficient for the start-up capital is 0.077. This shows that a one-unit increase in the farm expenditure will lead to a 0.077 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the more money is used to take care of the farm, the greater the quantity of Irish potatoes produced.

Table 2: Distribution of respondents according to farm characteristics

Variable	Frequency	Percent	Cumulative %
Distribution of respondents according to Irish potato production status			
Permanent	160	80.0	80.0
Temporal	40	20.0	100.0
Total	200	100.0	
Distribution of respondents according farm size (Hectare)			
< 1	65	32.5	32.5
Between 1 – 2	110	55.0	87.5
Between 2 – 3	18	9.0	96.5
Between 3 – 4	7	3.5	100.0
Total	200	100.0	
Distribution of respondents according to fertilizer application			
Yes	191	95.5	95.5
No	9	4.5	100.0
Total	200	100.0	
Distribution of respondents according to production experience (years)			
Between 1 – 10	85	42.5	42.5
Between 11- 20	90	45.0	87.5
Between 21 – 30	10	5.0	92.5
>31	15	7.5	100.0
Total	200	100.0	
Distribution of respondents according to income level (CFA)			
<250000	45	22.5	22.5
Between 250000 - 500000	99	49.5	72.0
Between 500000 - 750000	37	18.5	90.5
750000 - 1million	16	8.0	98.5
>1million	3	1.5	100.0
Total	200	100.0	

Source: Author, from field survey 2022

Table 3: Production function for the semi-subsistence Irish potato production

Variable	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
Farm size	-.111	.938	-.002	.906
Labour input per season	4.956	1.654	.130	.003
Start-up capital	.077	.013	.226	.000
Quantity of seeds per season	1.923	.475	.159	.000
Quantity of pesticide used	.513	.157	.117	.001
Quantity of fertilizer applied	.053	.012	.155	.000
Production experience	2.585	.871	.087	.003
Level of education	4.903	1.021	.097	.000
Age range of respondent	-1.316	.798	-.035	.101
Member in a farmers' cooperative	-3.821	1.737	-.048	.029
Constant	-17.465	4.872	n/a	.000
R-Squared	0.942	n/a	n/a	n/a
F Statistics	308.652[10,0.000]	n/a	n/a	n/a
Total Observation	200			

Source: Author, from field survey 2021 N/B: n/a = not applicable

The coefficient for the quantity of seeds planted per season is 1.923. This means that a one-unit increase in the quantity of seeds planted per season will increase the quantity of Irish potatoes produced by 1.923. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the more seeds are planted per season, the bigger the quantity of Irish potatoes that is likely to be produced. The coefficient for the quantity of the pesticide used per season is 0.513. This means that a one-unit increase in the quantity of pesticide used per season will bring forth a 0.513 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the more pesticides are used per season, the graeter the quantity of Irish potatoes that is likely to be produced. The coefficient for the quantity of fertilizers applied per season is 0.053. This means that a one-unit increase in the quantity of fertilizers applied per season will lead to a 0.053 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the more fertilizer

is applied to the Irish potatoes planted, the greater quantity is likely to be produced.

The coefficient for the production experience is 2.585. This shows that a one-unit increase in the production experience of the Irish potatoes farmers in Santa will lead to a 2.585 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the longer the farmer has been producing Irish potatoes, the bigger quantity of Irish potatoes he is likely to produce. The coefficient for the level of education is 4.903. This shows that a one-unit increase in the level of education of the farmer will lead to a 4.903 increase in the quantity of Irish potatoes produced. This variable is significant at the 1% level of significance making us to reject the null hypothesis and conclude that the more the farmer is educated, the greater quantity of Irish potatoes he is likely to produce. The coefficient for the age range is -1.316. This shows that a one-unit increase in the age of the farmer will lead a 1.316 decline in the quantity of Irish potatoes produced. This variable is, however, not significant. The coefficient for membership in a farmers'

cooperative is -3.821. This shows that belonging to a farmers' cooperative will lead to 3.821 declines in the quantity of Irish potatoes produced. This variable is significant at the 5% level of significance.

The Semi-subsistence Irish Potato Production and the Farmers' Economic Well-being

This section evaluates the effect of the semi-subsistence Irish potato production in Santa subdivision on the farmer's economic well-being. The R-squared, known as the coefficient of determination, determines how much of the independent variable explains the dependent variable. Therefore, the effect of the semi-subsistence Irish potato production on the farmer's economic well-being in Santa subdivision is being explained by 87.2% of the independent variables used in this study. The significant value of .000 indicates that the overall model is significant. This means that the variables used are a good fit for the model.

Table 4: Semi-subsistence Irish potato production effect on the farmer's economic well-being

Variable	Unstandardized Coefficients		Standardized Coefficients	Sig.
	B	Std. Error	Beta	
Quantity produced	.027	.003	.960	.000
Farm size	-.154	.039	-.122	.000
Labour input per season	-.204	.071	-.190	.005
Start-up capital	.001	.001	.118	.034
Quantity of seeds per season	-.026	.021	-.076	.215
Quantity of pesticides used	-.011	.007	-.086	.121
Quantity of fertilizers applied	.001	.001	.114	.044
Production experience	-.013	.037	-.015	.730
Level of education	.127	.045	.089	.006
Age range of respondent	-.004	.034	-.004	.905
Member in a farmers' cooperative	-.150	.074	-.067	.043
Constant	1.247	.211	n/a	.000
R-Squared	0.872	n/a	n/a	n/a
F Statistics	116.195[11,0.000]	n/a	n/a	n/a
Total Observation	200			

Source: Author, from field survey 2021 N/B: n/a = not applicable

From Table 4 above, the coefficient for the quantity produced is .027. This means that a one-unit increase in the output, will lead to a .027 increase in the level of income of the Irish potatoes farmers in Santa subdivision. This result is significant at the 1% level of significance. The coefficient for the start-up capital is 0.01. This shows that a one-unit increase in the farm expenditure will lead to a 0.001 increase in the level of income. This variable is significant at the 1% level of significance. The coefficient for the quantity of fertilizers applied per season is 0.001; this means that a one-unit increase in the quantity of fertilizers applied per season will lead to a 0.001 increase in the level of income of the farmer. The coefficient for the level of education is 0.127. This shows that a one-unit increase in the level of education of the farmer will lead to a 0.127 level of income, as a result of increase in the quantity of Irish potatoes produced. As a result, we reject the null hypothesis and conclude that. Semi-subsistence Irish potato production is significantly associated with higher levels of economic well-being of farmers in Santa subdivision

Constraints Associated with the Semi-subsistence Irish potato production

From Table 5 below, the majority of the farmers indicated that the changes in the weather conditions, price fluctuations, the lack of good "farm to market" roads, pest and diseases, … are constraints associated with the semi-subsistence Irish potato production in Santa subdivision. As a result, we reject the null hypothesis and conclude that the changes in the weather conditions, price fluctuations, the lack of good "farm to market" roads, pest and diseases…, are all constraints associated with the semi-subsistence Irish potato production in Santa subdivision.

Table 5: Constraints associated with the semi-subsistence Irish potato production

Variable	Obs	Non-Constraint	%	Constraint	%
Insufficient capital	200	20	10.0	180	90
Changes in the weather conditions	200	49	24.5	151	75.5
Post-harvest losses	200	97	48.5	103	51.5
Fluctuations in market prices	200	10	5.0	190	95.0
Lack of good "farm to market" roads	200	31	15.5	169	84.5
Lack of improved seed varieties	200	18	9.0	182	91.0
High cost of input	200	24	12.0	176	88.0
Pests and diseases	200	3	1.5	197	98.5

Source: Author

SYNTHESIS OF THE RESULTS

This study aimed to analyze the production function for the semi-subsistence Irish potato production systems and the economic well-being of small holder farmers in Santa subdivision. Since the Irish potato is considered to be a staple/cash crop, instrumental for the food security in Cameroon, it is therefore necessary to analyze the input-output relationship. The discussion of findings will be done according to the specific objectives of the study. Objective one was to discuss the drivers of the semi-subsistence Irish potato production in Santa subdivision. Ten drivers were considered, the first of which was the farm size. The results indicated that as the farm size increases, the quantity of the Irish potatoes produced by the farmers in Santa subdivision decreases. This result goes against our a priori expectation, as much as we expected that a larger farm should produce higher output. This is, however, justifiable in the sense that large farms require more capital which is often than not hard to obtain. For the large farms to be able to produce high output, a lot of money is needed for investment, hence many farmers complained about the strict credit union regulations that made it difficult for them to get loans.

The second variable was the labor input. The results indicated that there is a positive relationship between the labour input and the quantity of the Irish potatoes produced. This means that the more workers spend time on the farms, the more output will be produced which is in line with our expectation. This result is logical in the sense that the more time is spent on the different stages of the production of Irish potatoes, the more accurate and perfect it will be done there by increasing yield. This result is in line with that obtained in another study on the technical efficiency of the smallholder Irish potato producers in Santa Subdivision done by Khan et. al. (2019). The results indicated that the start-up capital is another variable having a positive impact on the quantity produced. It means that the more money is spent on the farms, the more Irish potatoes are produced. This is obvious in the sense that the more expenditure is incurred in purchasing original farm equipment

such as sprayers, hoes, machetes, and also spent on other farms inputs such as fertilizers, chemicals and high yielding seeds (as many farmers in Santa subdivision have to travel to other regions just to get these inputs) will increase the quantity of Irish potatoes produced. Farmers with little capital will end up not being able to travel and purchase all the equipment and farm inputs thereby reducing their yield.

The study also shows that the quantity of seeds planted, the quantity of pesticides used, and the quantity of fertilizers applied all have a positive relationship to the quantity of Irish potatoes produced. This means that the more seeds are being planted and sprayed with sufficient pesticides, alongside applying enough fertilizers, will increase the quantity of Irish potatoes produced. This is justifiable as the Irish potato is most of the time, if not all times, being attacked by plant diseases - one of the problems cited by the farmers. As a result, spraying the crop efficiently with sufficient quantities of pesticides will help limit the rate of attacks thereby increasing yield. Also, applying more quantities of fertilizers will add up to the soil fertility of the farm land which will provide the Irish potatoes with sufficient plant nutrients needed for the growth, thus increasing the output. These results are similar to that obtained by Bezawit (2011) who conducted a research on the analysis of the socio-economic factors influencing the Irish potato production at a household level, the case of Shashemene, Shalla and Siraro Counties in West Arsi Zone, Ethiopia.

Another variable was the production experience of the farmers. The results indicated that there is a positive relationship between the farmer's production experience and the quantity of the Irish potatoes produced in Santa subdivision. This means the longer a farmer has been involved in the Irish potatoes production, the more output he will have. This is in line with our prior expectation. This result is logical in the sense that experience is associated with know-how. A farmer who cultivates year after year gathers a lot of experience as a result of his/her

failures. Mistakes made in the past production year will not be repeated in the future. The result will be the increased output. This result is in line with that obtained by Maganga (2012) who conducted a study on the technical efficiency and its determinants in the Irish potato production in Malawi.

Another variable was the educational level of the farmers. The results indicated that there is a positive relationship between the farmer's educational level and the quantity of Irish potatoes produced in Santa subdivision. This means the more a farmer is educated, the more output he will produce. This is in line with our prior expectations. This result is logical in the sense that education comes with some basic know-how such as timing, counting and measuring. A farmer who attaints a higher level of education will be more effective in implementing new farming techniques than those with lower levels of education or illiterates. This study is not consistent with that done by Awudu and Eberlin (2001). The study showed a negative relationship between the age range and the quantity of Irish potatoes produced. This means that as the age of the farmer increases, the quantity produced decreases. This is, however, logical and true in the sense that the older the farmer is, the slower he/she will tend to accept and adopt new practices, better technologies and inputs compared to the younger farmers. This result is somehow different from that obtained by Mengui et. al. (2019). Their study found that the age range had a positive impact on the output.

The last driver that was considered was the membership in a farmers' cooperative and it was observed that it has a negative but significant impact on the quantity of Irish potatoes produced. This is not in line with our expectations. However, the semi-subsistence Irish potato farmers who are members of the farmers' cooperative in Santa subdivision complained about cooperatives not giving out loans and credits to them to invest in their farms; as a result, the majority of the younger and vibrant farmers are no longer members of the

cooperatives. Finally, the cooperatives are dominated by older farmers who are no longer productive.

Objective two was to evaluate the effect of the semi-subsistence Irish potato production on the farmer's economic well-being in Santa subdivision. Out of the eleven variables used, four of them had a positive effect. The results indicated a positive relationship between the quantities of the Irish potatoes produced and the level of income. This is in line with our expectation as the higher output entails a higher level of income. Higher income allows people to satisfy their needs and pursue many other goals that they deem important to their lives. Moreover, increases in income have been associated with improvements in other dimensions of well-being, such as life expectancy, educational attainments. A semi-subsistence farmer with higher levels of income will be able to pay his/her bills, sent children to school and save money in the bank, thereby increasing his/her well-being. This is in line with the results obtained by Graham and Pettinato (2002).

The study also showed a positive relationship between the farm expenditure per season and the farmer's level of income. This means that as the farm expenditure per season increases, the level of income increases. It is justifiable in the sense that when a semi-subsistence farmer spends much more money on his/her farm to purchase durable tools and other farm inputs, the output produced is high, and as a result of this, the income level increases. An increase in the income level will enable the farmer to buy good farm equipment and good variety seeds thereby increasing yield, and as a result, the economic well-being is increased. The study showed a positive relationship between the quantity of pesticides applied and the level of income. This means that as the quantity of pesticides applied increases, the level of income also increases. This is so because the more frequent the Irish potato plants are being sprayed with chemicals, the rate of

plant disease attacks is reduced, thereby increasing the quantity of the Irish potato produced. Increasing the quantity of the Irish potato produced will lead to an increase in the income level of the farmer, thus enabling him/her to send his/her children to school; he/she will also pay the bills and take care of basic needs. It will also allow the farmer to save money in the bank, thereby increasing the farmer's economic well-being.

Finally, the study showed a significant positive relationship between the level of education of the farmer and the level of income. This means that as the level of education of the semi-subsistence farmer increases, the level of income also increases. This result is logical in the sense that education comes with some basic know-how such as timing, counting and measuring. A farmer who attaints a higher level of education will be more effective in implementing new farming techniques than those with lower levels of education or illiterates, and as a result of this the quantity of the Irish potatoes produced is increased, thereby increasing the level of income.

Objective three was to verify the constraints associated with the semi-subsistence Irish potato production in Santa subdivision. According to the study, most farmers indicated that the most important challenge they faced during the Irish potato production was pest and diseases (98.5%). This is possibly due to the Irish potatoes' susceptibility to disease and changes in the weather conditions cited as a constraint by the majority of farmers (75.5%). According to the study, most of the farmers (95%) were not able to sell their products at the expected market price due to price instability beyond their control unless the government intervenes. Another crucial problem encountered by the respondents was the lack of improved hybrid seed varieties (91.0%), as many farmers had to travel to other regions of the country to purchase them.

The problem of purchasing inputs due to high cost was also one of the major challenges

faced by the majority of the Irish potato farmers during the production. This is due to the fact that most of the farmers had little capital investments (90%). This has been a major problem for the farmers since the 1960s. Another problem some respondents faced was the post-harvest losses of the Irish potato (51.5%), this is due to the lack of good "farms to market" roads, and as a result, many farmers used remote ways to transport the Irish potatoes from their farms to the market after the harvest. The problem of the post-harvest losses is also owing to the poor storage facilities to keep the Irish potatoes after harvest.

CONCLUSION

The main research objective of this study was to determine the drivers of the semi-subsistence Irish potato production in Santa subdivision and to evaluate how this Irish potato production affects the economic well-being of the farmers in Santa subdivision. Specifically, the study had the objectives to discuss the drivers of the semi-subsistence Irish potato production in Santa subdivision, to evaluate the effect of the semi-subsistence Irish potato production on the farmers' economic well-being in Santa subdivision and finally to verify the constraints associated with the semi-subsistence Irish potato production in Santa subdivision. To achieve these objectives, the study employed both descriptive and inferential statistics to analyze the data collected from the questionnaires. Results were summarized by using percentages and were presented in tables. The inferential statistics employed ordinary least square (OLS) to analyze the drivers for the semi-subsistence Irish potato production, and the effect the Irish potato production had on the farmers' economic well-being in Santa subdivision.

The result showed that the majority of the semi-subsistence Irish potato farmers in Santa subdivision were married, mostly males in their early 30s with average households and

income levels ranging between 250.000-500.000FCFA. Also, most of the farmers were found to be permanent Irish potato farmers with production experience of above 10 years and had attained a secondary level of education and so could read and write. The majority of the farmers cultivated Irish potatoes on a small scale in farms ranging between 1-2 hectares and most of them applied fertilizers. To discuss the drivers for the semi-subsistence Irish potato production, ten drivers were considered. Eight of them were statically significant with the start-up capital, quantity of seeds planted, quantity of fertilizers applied and level of education being the most significant drivers. The results also showed the semi-subsistence Irish potato production had a statistically significant effect on the farmers' economic well-being. Finally, most of the farmers indicated that among the most challenging constraints they faced were insufficient capital, changes in weather conditions, fluctuations in market prices, lack of good "farm to market" roads, lack of improved seed varieties, high cost of input, pest and disease.

The result from the OLS showed that start-up capital, quantity of seeds planted, quantity of fertilizer applied, level of education, labour input per season, production experience, and quantity of pesticides used all had positive effects on the quantities of the Irish potatoes produced, while farm size, membership in a cooperative and age range had a negative effect. The statistical result also showed that the semi-subsistence Irish potato production had a positive effect on the farmers' economic well-being. The results from the descriptive statistics pointed out that the semi-subsistence Irish potato production in Santa subdivision is facing a lot of constraints among which is the insufficient capital, changes in the weather conditions, fluctuations in market prices, lack of good "farm to market" roads, lack of improved seed varieties, high cost of input, pest and disease.

In view of the above conclusion, this

study makes the following recommendations to increase and boost the semi-subsistence Irish potato production and farmers' economic well-being. There is a need to put emphasis on the youth's participation in the Irish potato production in Santa subdivision. Older Irish potato farmers find it difficult to adapt and adopt new technologies, and as a result, the quantity produced is low. The Ministry of Agriculture can come out with appealing ways to entice the youth to move into the Irish potato production by subsidizing the cost of farm inputs and also by giving out long-term farm development loans with lower interest rates to the semi-subsistence farmers. By so doing, the output is increased and the farmers' economic is affected positively.

It is also an interesting result of this research that farm expenditure, quantity of seeds planted, quantity of fertilizers applied, level of education are strong drivers of the semi-subsistence Irish potato production in Santa subdivision. As a result, an improvement in the input supplies, especially that of fertilizers, can have a significant contribution to improving the production both at farmers' level and national level. However, as it can be seen from the result of the study, membership in a farmers' cooperative is contributing negatively to the Irish potato production. This might imply that the current services provided to the farmers in Santa subdivision might not have brought any significant improvements. Consequently, this result calls for a serious monitoring and a review of the current farmers' cooperatives operating in Santa subdivision.

Finally, the study recommends that with regards to the semi-subsistence Irish potato production in Santa subdivision, the government should construct good "farm to market" roads to facilitate the transportation of Irish potatoes to the markets and also install price control mechanisms in order to remedy the high rate of price fluctuation in the market.

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