International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 10, 2020
ISSN: 1475-7192

FACTORS AFFECTING VIABILITY OF COFFEE PRODUCTION IN IFUGAO: A REGRESSION ANALYSIS

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ABSTRACT

A host of factors seem to affect coffee production in Ifugao. Aside from the traditional production factors, climate change may have begun to make inroads in the relatively slow performance of the sector considering it being an economic booster of the province of Ifugao. Decrease in production capacities has led to the reduction of coffee production and perturbed livelihood of the Ifugao coffee farmers.

Ifugao is one of the few provinces in the Philippines where the four varieties of coffee namely: robusta, excelsa, arabica and liberica thrive. Coffee production and processing in commodity development in the province of Ifugao has once again been given importance by the local government of the province; thus this study primarily aimed on analyzing the factors affecting the coffee production in Ifugao as production has somewhat decreased in the past decades. The study used ordinary least squares regression to analyze the effect of selected economic variables and climate change variables on volume of production. The study used time series data from 1990 to 2017.

It was found out that economic variables such as: Demand, Land Area and Farm Gate Price exerted significant effect on Volume of Production of coffee, and that climate change variables such as: Maximum Temperature and Precipitation exhibited significant effect on Volume of Production of coffee as well. The proximity effect exhibited by the findings raises the need for economies of scale in dealing with the factors affecting the viability of coffee production in Ifugao. Efforts to strengthen regional trade and integration may be an important strategy to enhance the industry.

Keywords: *demand, coffee, climate change, regression*

I. Introduction

Coffee is considered as one of the biggest exports in the world next to oil. One-third of the entire world's coffee is produced in Brazil. While Colombia, Vietnam, India, Indonesia, Guatemala, Ethiopia and Mexico are also major producers. World consumption in 2017was at162.57 million bags, and in 2018, it rose to 165.35 million bags. Coffee demand in Asia & Oceania is projected to grow by 3% to 37.84 million bags, and in North America by 1.7% to 30.97 million bags. Africa's demand for coffee is estimated to grow by 1.8% to

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11.94 million bags, and Central America & Mexico's demand by 1.4% to 5.47 million bags and Europe's by 1.2% to 54.54 million bags. However, consumption in South America is likely to remain stable at 27.14 million bags in 2019/20 (ICO, 2019).

The Philippines in the late 19th century became the fourth largest world producer of coffee but export abruptly declined a decade later when coffee rust devastated the coffee plantations. In the 1970's, the country once again emerged as a coffee exporter. Prior to 1990, the Philippines exported 15 % to 30% of the production. The collapse of the International Coffee Agreement (ICA), led to downfall in world coffee pricesand a decline in PH coffee exports. Export earnings, largely from Robusta coffee, dramatically dropped in 1995 from a peak of $118.7 million in 1986.

At present, the Philippines is a net importer of coffee, with a domestic consumption almost twice of the local production. The problem on the increasing import of coffee beans is compounded by the declining production of coffee in the country which is attributed to the declining trend in the area of coffee farms and the number of bearing trees in the past two decades. These patterns can be ascribed to land conversion, shifting of crops, mining, and damages of typhoon. In 2014, coffee production areas covered 117,450 ha planted to almost 80 million coffee bearing trees (DA-BAR, 2016).

Robusta, Arabica, Excelsa, and Liberica are the four important coffee species in the Philippines, with the first two species accounting for more than 90% of the total volume of production. In 2014, the Philippines produced 52,168t Robusta (69.14%), 18,028t Arabica (23.89%), and 5,258t combined Liberica and Excelsa (7%). Sultan Kudarat is the leading producer of Robusta and Arabica, while Sulu is the top producer of Liberica and Excelsa coffees. Other major producers of coffee includes the provinces of Batangas, Bukidnon, Cavite, Davao del Sur, Davao Oriental, Iloilo, Kalinga, Maguindanao, North Cotabato, South Cotabato, Quezon and. Production of Liberica and Excelsa has been decreasing through the years (Philippine Statistical Authority, 2016).

Based on the latest Census of Agriculture (2016), there are nearly 276,000 coffee farms in the country, with about 79.4 million trees. The median farm size is 1-2 ha. A large percentage of the coffee trees in the country are already mature. Most of the trees are already old, aged 20 years and above. According to official data, the most common variety grown in the country is Robusta, which accounted for over 70 percent of total production in 2011. Robusta is mainly used for instant coffee. Next was Arabica, which cornered 21 percent. Arabica is cultivated in high elevation used for brewing or blending. Catimor is one Arabica variety. The other varieties are Excelsa and LIberica. The latter is also known as "KapengBarako" (PSA, 2016).

In 2011, production of coffee in the Philippines was estimated at 88,943 MT, a 6.35 percent decline from previous year's level of 94,536 metric tons. Number of bearing trees also declined by 1.65% Area planted to coffee also declined by 1.43 percent which is 119,657 hectares from 121,399 hectares in 2010. Strong winds brought about by typhoons Mina, Pedring and Quiel aborted development of berries in Benguet and La Union. Frequent rains adversely affected production in SulatanKudarat. There were reports of crop shifting to Señorita banana in Compostela Valley and to rubber in Zamboanga City Robusta remained the major variety with 71.14 percent share in the 2011 production (PSA, 2016).

The Cordillera Administrative Region (CAR) is one of the few regions in the country where the four varieties are grown.It contributed 6.37% to the national output, with Kalinga contributing 68% to the regional output. The province’s major produce was Robusta with 3,784 MT, while Arabica output only reached 58MT. 88 percent of coffee production (Robusta variety) come from the provinces of Abra, Apayao and Kalinga. Benguet and Mountain Province produce around 10% (Arabica variety), and only 2% come from Ifugao (Excelsa).

In Ifugao, coffee growing is also a province wide economic activity although three areas are particularly regarded as thecoffee producing municipalities:Asipulo, Lagawe, and Kiangan.The province of Ifugao has a total coffee production of 1120 metric tons (mt) of which 1105.56 mt are of Robusta variety while 14.55 mt are of Arabica variety. There are 1421 households involved in coffee production covering a total land area of 2520 hectares.Approximately, 0.42 mt per hectare are planted with coffee trees. At present, there are 64,655 bearing trees and 22,714 that are not yet bearing (DTI Ifugao, 2017). Majority of the beans are being sold to NESTLE Philippines - the world”s biggest food group for their preference to buy everything regardless of the coffee class.

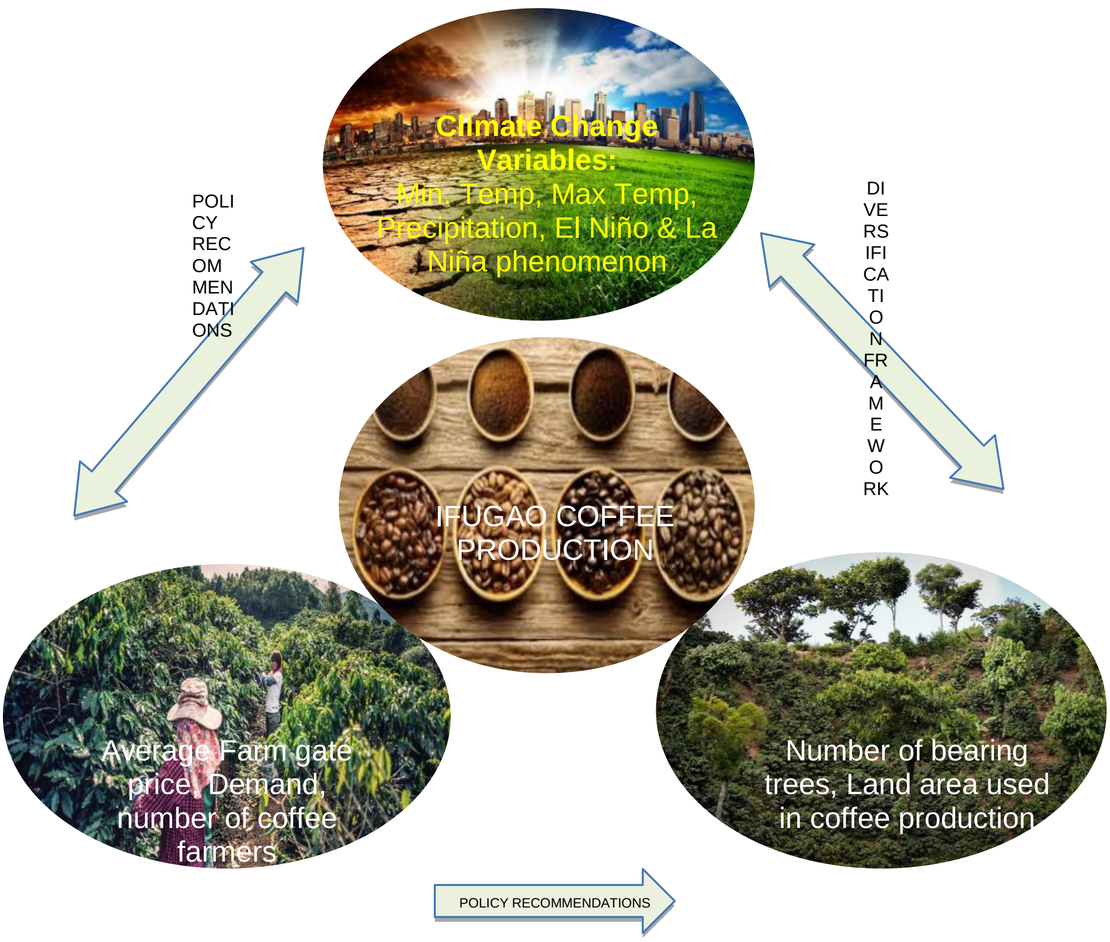
Interviews with local folks of Ifugao attested to the abundance of the coffee beans in the province and have been capitalized early on by most farmers. Dialogues with some personnel from PSA-Ifugao, DTI-Ifugao and the Provincial Agriculture and Environment & Natural Resources (PAENRO-Ifugao) also attested of the abundance of coffee beans in the province. In the early 1990s, NESCAFE Philippines has seen the province’s potentials as a coffee producer and has even conducted seminars on coffee production at the Ifugao State College of Agriculture and Forestry (now IFSU). Productions though in the 90’s declined and accordingly, land areas for coffee were converted for production of other organically-grown crops (PAENRO-Ifugao). In the mid 1990’s to early 2000 farmers were also encouraged by government (DENR) to plant Melina trees.

On previous surveys conducted by DTI-Ifugao, they were also able to identify issues and problems on thee coffee industry of the province. Among which are; limited supply of coffee beans and limited coffee nurseries, insufficient technical and entrepreneurial skills of growers, lack of access to the coffee industry market, and industry support and advocacy.

Given the importance of coffee production and processing in commodity development, and the refocusing on the Ifugao coffee to become one of the local commodities for comparative advantage as the One-Town-One-Product (OTOP)commodity, not to mention the province’s inherent strengths -viz: ideal climate for a year round production, capability to grow the commercial varieties of coffee beans, topography, land area, number of growers involved in the coffee industry and the province’s geographical proximity and accessibility of roads to nearby provinces and key cities of Luzon;would henceforth give the province an edge in the domestic market.Thus, the potential of the coffee industry of Ifugao, the numerous comparative economics studies on the topography and agricultural practices of Ifugao and its’ sister provinces like Benguet and Kalinga, and the common issues or problems determined earlier has interested the researcher to conduct a study on the aforementioned.

Aside from the traditional production factors, climate change may have begun to make inroads in the relatively slow performance of the sector considering it being an economic booster of the province of Ifugao. Therefore, to find out factors affecting the sustainability of the coffee industry of Ifugao- data on the volume of production of coffee in Ifugao from 1990 to 2018 will be regressed against data on selected economic variables such as: demand, number of coffee bearing trees, average farm gate price of coffee, number of coffee farmers and land area; and climatic variables such as maximum temperature, minimum temperature, precipitation and the occurrence of the El Niño & La Niña phenomenon.Results of the econometric model developed in this study would be used in the development of a diversification framework for improving coffee production in the province and the model could also be used as basis for policy recommendations of government and non-government organizations working towards the sustainability of the coffee industry of Ifugao. Paradigm of the study is shown below.

II. Conceptual Framework



Objectives

This study sought to assess the effect of selected economic variables and climate change variables on coffee production in Ifugao from 1990 to 2018. Specifically, the study aimed to:

1. Establish the trend ofselected economic variables such as: demand, number of coffee bearing trees, average farm gate price of coffee, number of coffee farmers and land area; and climatic variables such as maximum temperature, minimum temperature, precipitation and the occurrence of the El Niño & La Niña phenomenon in the past 28 years?
2. Determine and evaluate the impact of selected economic and climate change variables on

volume of production of Coffee in Ifugao from 1990-2018;

3. Develop a diversification framework as a mitigation measure for improving coffee production in the Province of Ifugao.

III. Review of Related Literature

Millions of smallholder farmers in the humid tropics depend on tree crops such as cocoa, coffee, oil palm and rubber for their livelihoods (Schroth et al., 2014). In 2011, the annual retail value of coffee was approximately US$ 90 billion, making it the world's most valued tropical export crop (Jaramillo et al., 2011). An estimated 25 million farmers are growing coffee on over 11 million ha in more than 60 countries (Waller et al., 2007), predominantly by smallholders who account for approximately 70% of worldwide coffee production (Bacon, 2005). Economic performance indicators such as yield, costs and profitability are important determinants for decision making of small-scale coffee farmers (Bravo-Monroy et al., 2016). The intensification trend, however, appears to come at the expense of long-term maintenance of ecosystem services relevant for agricultural production (Foley et al., 2011), as intensified farming systems are known to cause environmental problems, such as loss of biodiversity and increased soil erosion (Perfecto and Vandermeer, 2015).

Fluctuating (global) market prices and increased incidence of pest and disease are putting pressure on smallholder coffee farmers, and climate change is expected to exacerbate their vulnerability (Morton, 2007). In the face of current and future challenges, it is important to identify farming practices that meet both economic and environmental goals while being resilient to current and future changes. Tropical agroforestry systems have been proposed as farming systems, which can reconcile economic and environmental goals (in Schroth et al., 2004; in Steffan-Dewenter et al., 2007). Ample research has shown that agroforestry systems can sustain high biodiversity levels (De Beenhouwer et al., 2013).

It is known that farmers with their experience can operate with some degree of variability in the local climatic conditions, and they are able to develop strategies from their own knowledge to cope with climate variability (Agrawal et al., 2008; Tucker et al., 2010). Still, contemporary climate change is occurring too fast and stochastically (Chlemuler, 2011) and this may generate changes in the climate conditions that may exceed the limits of the farmers' coping strategies (Smit et al., 2000).

Further, a study by Loreto et al. (2017) in Veracruz, Mexico have shown that limited capacity to adapt to climatic and economic stressors, and this capacity will probably decrease in the future if governmental policies and international market conditions prevail (Gay et al., 2006). People's vulnerability to the falling prices depends upon their access to assets land, credit, employment, and social networks (Bacon, 2005), but also in their location and the climate variability affecting their lands. Coffee producers are involved in other productive activities besides coffee production, such as agriculture and livestock; these activities generate income sources for the inhabitants in the region.

Coffee plantations rely on moderate temperature, high humidity, and rainfall. However, coffee has high water demand and drought spells affect quality and reduce yield (DaMatta and Ramalho, 2006; Cheserek and Gichimu, 2012).

Climatic extreme events, such as droughts, floods, frosts and heat waves have and will affect the coffee production (Conde et al., 2006). Since 1997, extreme weather has caused volatile prices regarding the coffee production in Mexico (Gay et al., 2006; Tucker et al., 2010) and low prices have affected the rural economies and threatened the biodiversity associated with the traditional coffee production (Cepal, 2002; IADB, 2002). The changing structure of the global coffee commodity chain has caused a decrease in prices paid to local producers (Bacon, 2005), especially because coffee is mainly produced by large corporations whose owners do not necessary form part of the poorest segments of society, and by small-scale farmers (Valkila et al., 2010).

The unstable prices and the extreme weather events raised the question among coffee producers of how the future impacts of climate changes will affect the economic variability (Tucker et al., 2010; Estrada et al., 2011). For instance, from 1999-2003 during a drought period, the international coffee prices fell to historical levels (Tucker et al., 2010). Changes in the market conditions and prices affect local coffee producers, particularly concerning to their capacity to engage in traditional climate risk management practices and livelihoods (Tucker et al., 2010). The economic crisis and natural disasters will potentially increase the livelihood vulnerability (Combes and Guil-laumont, 2002; Moser, 1998).

IV. Methodology

Research Method

To answer the main problem of this research, the descriptive-causal research was used as the research design of this study. The descriptive aspect dwells on the historical performance of the volume of production of the coffee industry of Ifugao and on the conditioning variables that have been identified and cited in the previous pages of this paper.

Data Gathering Procedure

Data on volume production, demand, land area, number of coffee bearing trees, number of coffee farmers and average farm gate price from 1990 to 2018 were secured from the Philippine Statistics Authority in CAR; while climatic variables such as maximum temperature, minimum temperature, precipitation and the occurrence of the El Niño & La Niña phenomenon were obtained from PAG-ASA from 1990 to 2018 as well.

Empirical Model

The Cobb-Douglas production function, which is widely used to represent the technological relationship between the amounts of two or more inputs, particularly physical capital and the amount of output that can be produced by those inputs, was used in this study. It was utilized to understand the relationship of selected economic and climatic variables, and coffee production using time series data from 1990 to 2018. The use of P-value, F-tests and R-squared results were included in the analysis of the study and other diagnostic tests to show that the model is not spurious and can be used for policy recommendation. The estimating equation is in logarithmic form and as follows:

$$lnY(\text{Volume of coffee production}) = ß_0 + ß_1 lnD\ (\text{demand}) + ß_2 lnLA\ (\text{land area})$$

$$+ ß_3 lnTr\ (\text{\# of coffee bearing trees}) + ß_4 lnCF\ (\text{\# of coffee farmers})$$

$$+ \beta_5 lnP \text{ (ave farm gate price)} + \beta_6 MnT \text{ (min. temp)} + \beta_7 MxT \text{ (max temp)}$$

$$+ \beta_8 Pr \text{ (precipitation)} + \beta_9 EN \text{(el niño)} + \beta_{10} LN \text{ (la niña)} + \varepsilon \text{ (error)}$$

V. Results and Discussion

This section presents the results, analysis, and interpretation of data necessary in attaining the objectives of the paper.

1. Movement of trends of selected economic and climatic variablesthat affects coffee production in Ifugaofrom 1990 to 2018.

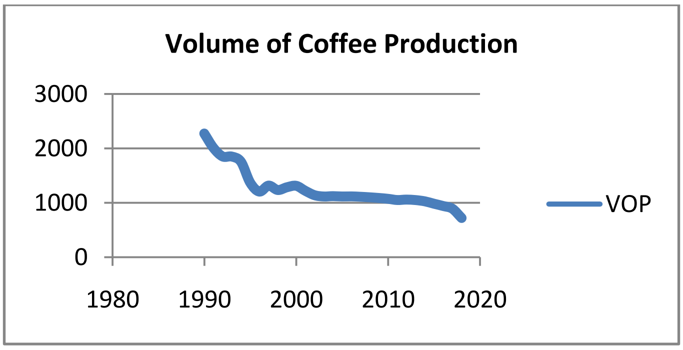


FIGURE 1

Figure 1 shows the overall trend of volume of production of coffee in Ifugao for the period of 1990 to 2018. In 1990, figure shows the highest volume of production of coffee in Ifugao of 2277.47 metric tons, but there was a decline from 1991 to 1996 as most of the farmers shifted to planting organic crops. Although a shift of volume in 1997 until 2000 happened, production of coffee in Ifugao from 2001 to present was still declining despite of government programs like putting up a coffee board to boost the industry (DTI-Ifugao, 2017).

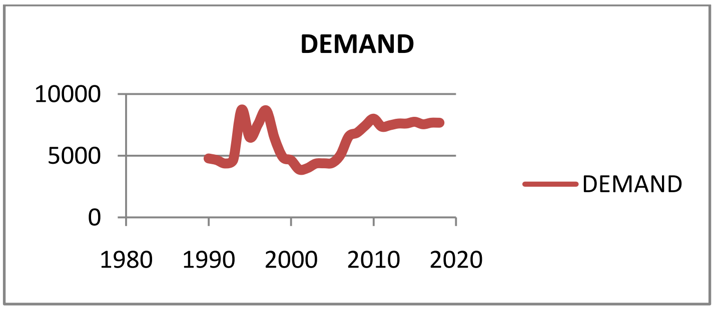


FIGURE 2

Figure 2 shows the domestic demand for coffee in Ifugao from 1990 to 2018 in kilograms. 1995 and 2009 shows a high demand for coffee in the province. During this period – the provincial government has also considered the coffee being a commercial crop of the country. Although demand for coffee in the province is generally seen as fluctuating.

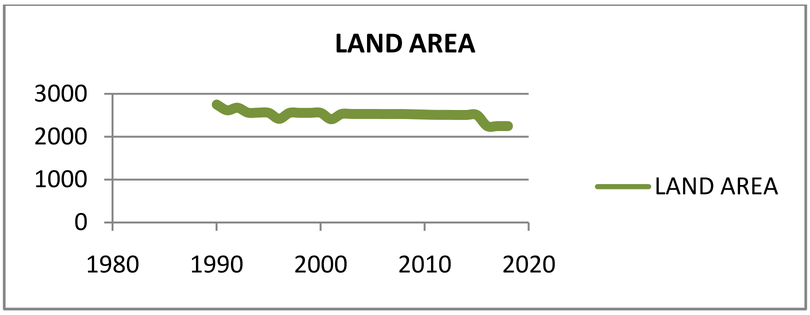


FIGURE 3

Figure 3 shows the trend of land area used in the production of coffee in Ifugao from 1990 to 2018. In 1996 and 2001, land area ratio went down from 2560 hectares to 2420 hectares, and in 2001 – ratio went down from 2560 hectares to 2411 hectares. According to the Department of Trade and Industry (DTI) in Ifugao, land areas for coffee were converted for production of other organically grown crops because of the higher income they can get from selling this crops rather than coffee. In the mid-1990s to early 2000s – farmers were also encouraged by the government (DENR) to plant Melina trees.

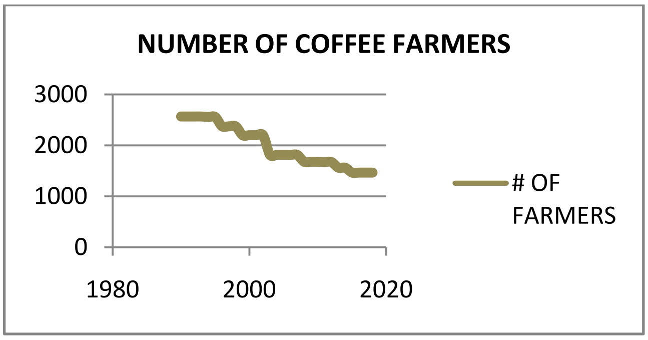


FIGURE 4

Figure 5 shows the trend of the number of coffee farmersin Ifugao from 1990 to 2018. A downward trend could be gleaned from the figure. According to the Department of Trade and Industry (DTI) in Ifugao, the conversion of land areas for coffee to other organically grown crops contributed to the decline of coffee farmers.

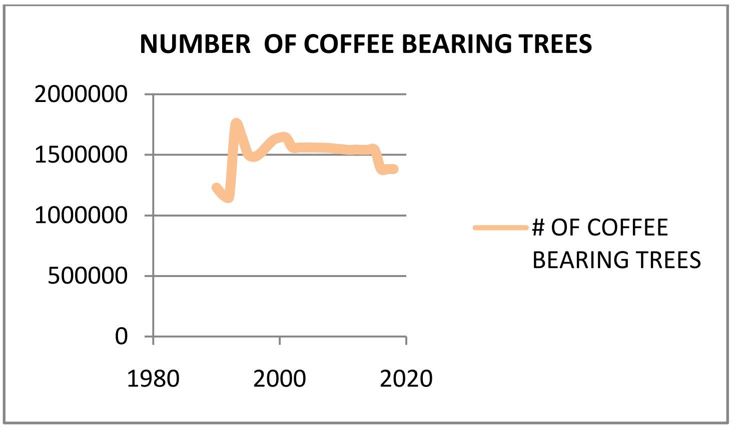


FIGURE 5

Figure 5 presents the trend of number of coffee bearing trees in Ifugao from 1990 to 2018. As shown in the graph, the early 90s show erratic changes on the number of coffee bearing trees in Ifugao. The 29.8% increase of coffee bearing trees from 1990 to 1993 could account for the fact that coffee trees bear fruits 2-4 years after planting.

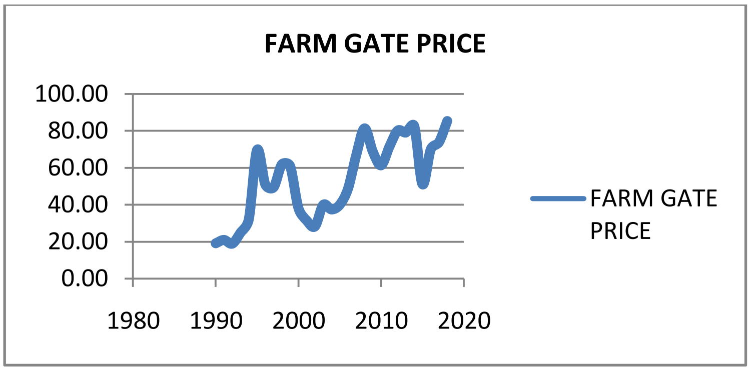


FIGURE 6

Figure 6 reveals the trend of the average farm gate price per kilo of coffee in Ifugao from 1990 to 2018. Irregular patterns on the farm gate price of coffee can be gleaned from the graph. According to DTI-Ifugao, there is no fixed market for the coffee, which could explain for the changes of price.

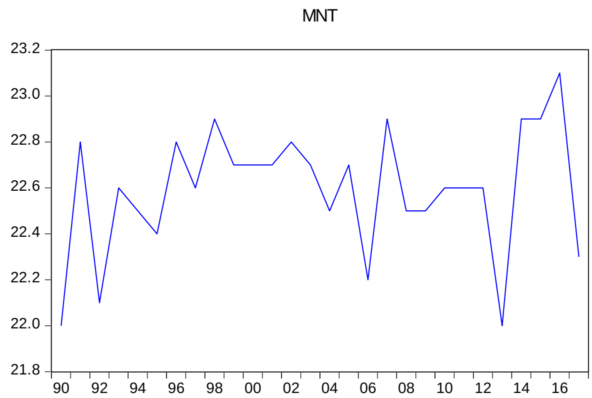


FIGURE 7

Figure 7 shows erratic movement for minimum temperature in Ifugao. Lowest minimum temperature experienced in the province were in 1990 and 2014 with 22.0 celcius.

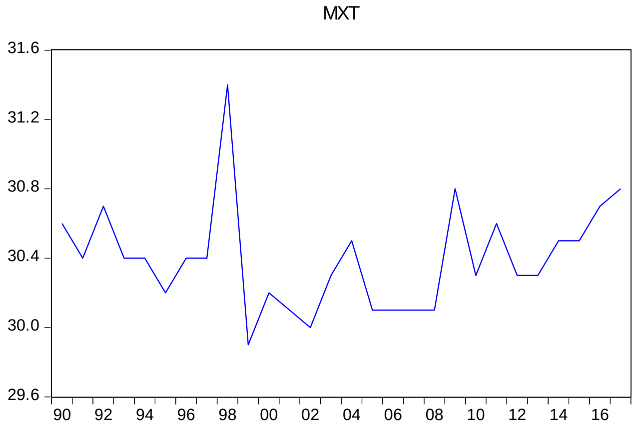


FIGURE 8

In the same manner, Figure 8 exhibited erratic trend for maximum temperature experienced in the province. 1999 had the highest temperature in the past decades with 31.4 Celsius.

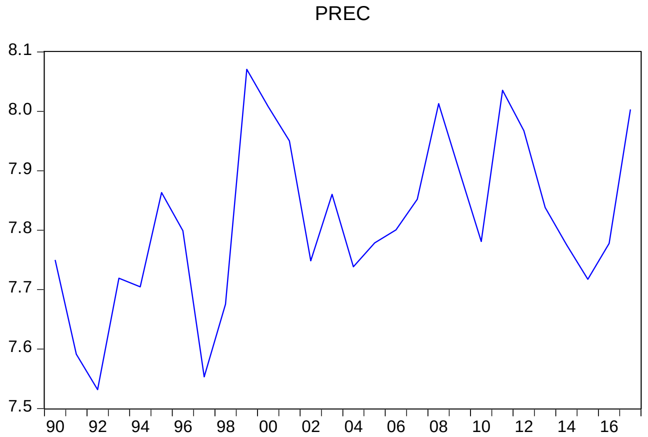


FIGURE 9

Figure 9 also shows irregular patterns of precipitation or rainfall in Ifugao in the past 27 years, with the highest volume of rainfall in1999.

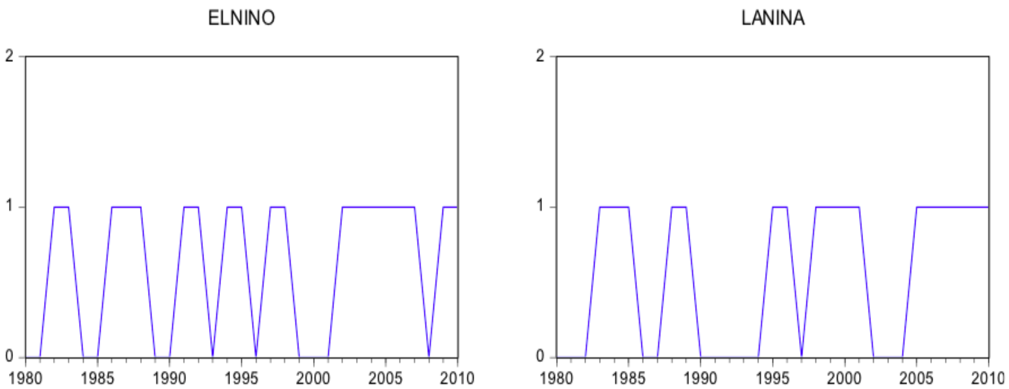


FIGURE 10

The diagram illustrates the occurrence of El Niño and La Niña phenomena in the Ifugao from 1990 to

2017. The El Niño phenomenon occurred more frequently at seven (7) times during the period, or an average of one occurrence every four (4) years compared to five (5) for the La Nina phenomenon or an average of one occurrence every six (6) years. Both, however, are deemed as advents of climate change.

2. Effect of selected economic and climatic variablesto the volume of production of coffee in Ifugao from 1990 to 2018.

To achieve the objectives of this paper, the researcher used the multiple regression analysis in which the econometric model was used to determine which among the selected economic and climatic factors in the coffee industry in Ifugao significantly affect volume of production.

To understand how climate change affects agricultural production in Ifugao, this study employed regression analysis using time series data from 1990 to 2018 on volume of agricultural production (VOP) and selected economic climate change variables. An econometric model was developed to validate the hypothesized relationship between the aforementioned variables. The model's final results are presented as follows:

$$VOP = 13.300 + 0.0694D + 0.0058LA - 0.0066Tr + 0.0022FGP + 0.0687CF$$

(4.61) (2.54) (2.05) (-.56) (3.73) (.49)

$$+ 0.0328(MNT) - 0.1295(MXT) + .4191(PREC) + 0.0501(LN) - 0.0912(EN)$$

(.54) (-3.5) (2.22) (1.41) (-1.88)

$R2 = .97$ $F\text{-stat} = 55.27$ $DW = 2.13$ $n = 28$

Five variables reflected statistically significant effects on the volume of coffee production in Ifugao based on their t-ratios: **demand, land area, farm gate price, maximum temperature and precipitation**. The rest of the predictor variables exert no statistically significant effects on the volume of production in Ifugao although their respective signs are consistent with theoretical expectations similar to the significant factors. Although taken collectively, as displayed by the F-statistics of the model, all the predictor variables exert significant effect on volume of coffee production in Ifugao.

The predictive power of the model is very good with an R^2 of 97%. Literally, this means that only 3% of variation in the dependent variable could be accounted for by factors excluded in the model.

Other things equal, a 1% increase in demand will increase volume of production of coffee by .069%; coffee production will likewise increase by .0058% when land area devoted to coffee production will increase by 1%; and that for every 1% change in average farm gate price, a .0022% will change volume of coffee production as well. For climatic variables, a 1% rise in maximum temperature will decrease volume of production by .1295%. On the other hand, a 1% increase in precipitation in Ifugao will increase the volume of coffee production by .4191%. The other predictor variables are to be interpreted in similar fashion albeit they are not statistically significant.

Table 1. Diagnostic Tests

DIAGNOSTIC TESTS		Test Statistics	Rule
Durbin-Watson Test	Autocorrelation	2.1192	must be > 1.92
LM Test	Autocorrelation	.5897	must be > .05
Jarque-Bera	Normality of error terms	.2016	must be > .05
ARCH	Heteroskedasticity	.0824	must be > .05
Chow Breakpoint Test	Structural Stability Test	.1654	must be > .05
Ramsey Reset Test	Specification Error Test	.3674	must be > .05

Based on the different diagnostic tests on the econometric model, the relationship between volume of coffee production and its conditioning variables is characterized by stability, as shown by the probability of the Chow Breakpoint Test of 0.1654, which is higher than the 0.05% level of significance. Using both Durbin-Watson Test and the Breusch-Godfrey Serial Correlation Test, model shows the absence of autocorrelation. The Jarque-Bera test indicates that error terms are normally distributed at 0.2016. Variables are homoskedastic using ARCH heteroskedasticity test. Ramsey Reset Test statistics of 0.3674 is also higher at the 0.05% level of significance, which means that specification error does not exist in the model.

The maximum Eigenvalue and trace test indicated 1 cointegrating equation, which shows that regression result is not spurious and exhibits a long-term equilibrium between volume of coffee production in Ifugao and the selected economic and climatic variables.

3. Diversification Framework as a mitigation measure for improving coffee production in the Province of Ifugao.

Climate change is expected to have strong implications for smallholder coffee farmers and implementing adaptation measures would lessen their vulnerabilities. Various adaptation options and measures have been identified in literature, but it is not always clear to what extent these can minimize the impacts of climate change (Harvey et al., 2014; Läderach et al., 2017; Rahn et al., 2014). Some adaptation options may only require incremental modifications in current farming practices; others may need radical changes in production system structures (Rickards and Howden, 2012). The existing coffee systems are part of larger, so-called, sociotechnical (agricultural) systems, defined as relatively stable configurations of institutions, rules, practices and knowledge networks (Smith et al., 2005). Techniques and practices are highly intertwined within value chains, organizational structures, regulations and policy (Markard et al., 2012), and continuously evolve to produce commodities more efficiently (Smith et al., 2005). Climate change will similarly put pressure on the coffee value chain and may lead to larger fluctuations in coffee supply and therefore higher volatility of coffee prices received by smallholders.

Measures therefore need to be developed and implemented to make smallholder systems more resilient to climate change (Lipper et al., 2014).

Initially, this framework needs to have climatechange adaptation options, their scale of application, and the necessary implementation steps. The framework shows thatimplementation complexity strongly increases with the degree of climate change. With modest climatic changes,incremental adaptations might suffice, but more substantial climatic change will require radical social-institutionalchanges for adaptation uptake and interventions. For the majority of smallholders the implementation ofany measure is largely constrained by a lack of access to knowledge networks and training material, organizationalsupport, and (mainly financial) resources. A landscape approach that encompasses collective action andcoordinated cross-sector planning can overcome some of these barriers. Systems adaptation can facilitate amove in this direction. Yet, the implementation of transformative adaptations requires visioning, realignment ofpolicies and incentives, and new market formations. This entails a repositioning and revision of certificationschemes to allow for more effective adaptation uptake for the benefit of smallholders and the environment.

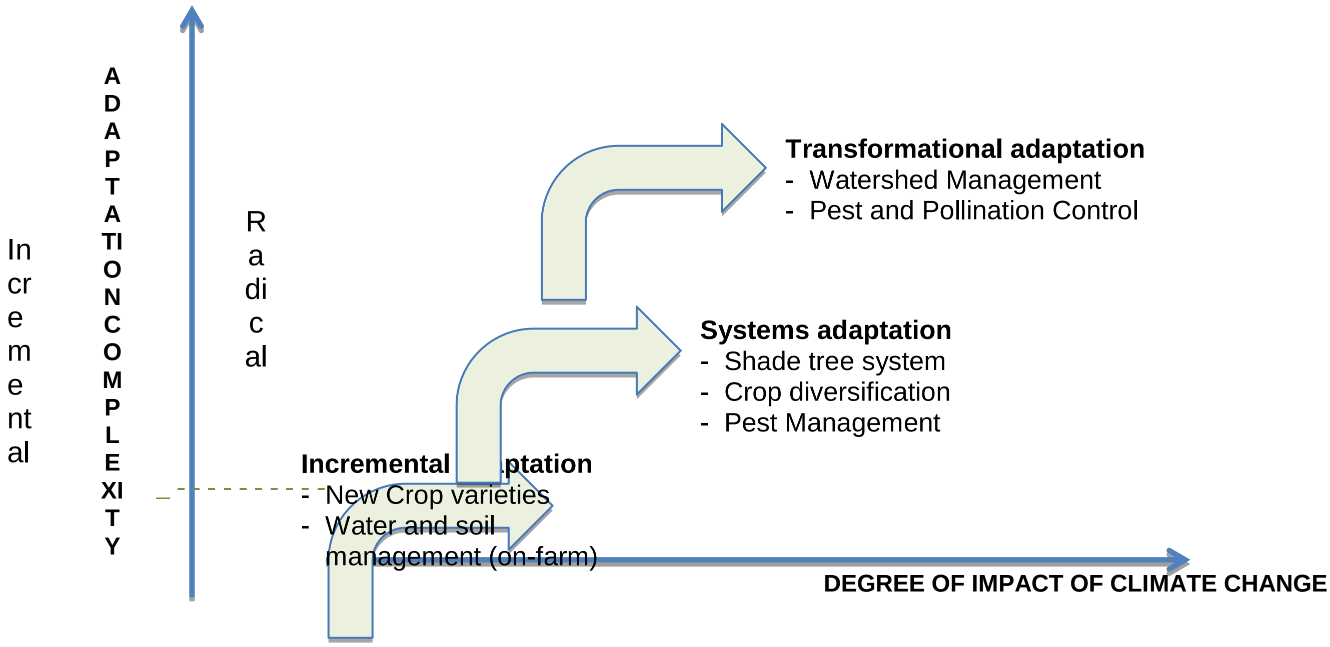


FIGURE 11. Diversification Framework[Adapted from Rickards and Howden (2012)]

VI. Conclusion

1. Over all trend for selected economic and climatic variables contributed to the decline of production of coffee in Ifugao.

2. Based on the regression analysis – demand for coffee, and area devoted to coffee production and average farm gate price of coffee exerts significant effect on the volume of production of coffee in Ifugao. Climate change has adverse effects on volume of production of coffee in Ifugao as well. Both selected economic and climatic variables affect the viability of coffee production in Ifugao; thus mitigating measures should be done to increase coffee production in Ifugao.

3. The viability of coffee production in the province of Ifugao could be intensified by creating adaptation strategies. Although tangible climate change adaptation measures are incipient, many organizational issues are currently hampering the implementation at farm and landscape scale. Using the functions from innovation management, many obstacles have to be overcome for effective implementation. Independent farmers need access to knowledge networks, finance and appropriate training.

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