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Forecasting of Rice Self-Sufficiency in the Benin Republic Using ARIMA Model

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ABSTRACT

Rice is one of the staple foods in the Benin Republic. Annual rice consumption is increasing faster than annual rice production. That is why Benin is not yet self-sufficient in rice production. To meet the local demand, huge quantities of rice are imported. For country planning, forecasting is the main tool for predicting rice variables. This paper describes an empirical study that used a time series modeling approach (Box-Jenkins' ARIMA model) to forecast rice production, rice consumption, rice importation, rice exportation and finally rice self-sufficiency in Benin. Based on ARIMA model, the rice self-sufficiency rate in Benin is forecasted to be 47%, 56%, 58%, 59% and 68% respectively in 2019, 2020, 2021, 2022 and 2023. The forecasts would be helpful for the policy makers to foresee ahead of time the future requirements of rice production, adopt appropriate measures to develop rice sector for effective rice self-sufficiency and to reduce rice importation.

1. Introduction

In most African countries, the agricultural sector occupies an essential place in the national economy. In Africa, every 1% increase in agricultural productivity reduces poverty by 0.6%, and a 1% increase in production reduces the number of people living with less than one dollar a day by 6 million (Thirtle et al. 2003). Two out of five people in Africa still live in extreme poverty (Beegle et al. 2016) and increasing agricultural productivity is crucial for reducing poverty (Christiaensen et al. 2011). Agriculture is the primary production activity of rural livelihoods in sub-Saharan Africa, and on average 92% of rural households is engaged in farming (Davis et al. 2017). Rural

Households also derive about two-thirds of their income from on-farm agriculture, compared with one-third (on average) in other developing countries (Christiaensen, 2017).

As a result, the economic "take-off" of Sub-Saharan African countries in general and of Benin, in particular, is closely linked to agriculture (Aho and Kossou, 1997). The agricultural sector contributes 38% to Gross Domestic Product (GDP) in Benin (PNUD-IDH, 2011). Crop production is the primary production activity in the agricultural sector and on average contributes 23% to GDP (FAO, 2012a).

In the crop production sub-sector, cereal products hold the prominent place, and among cereals, corn, sorghum, and rice are the most important ones. Local rice production provides 1% contribution to GDP (MAEP, 2007). In order to satisfy domestic consumption and re-exportation, Benin imports huge quantities of rice. West Africa is experiencing rapid growth in rice consumption due to population growth, urbanization and increasing purchasing power (Fofana et al. 2014). At the same time, rice is the most critical nutritional source and a highly strategic food commodity for the West African region (Seck et al. 2013). Rice is the staple food of more than 750 million people in sub-Saharan Africa (USDA, 2016). Average annual rice consumption in sub-Saharan Africa (4%) is increasing faster than rice production (3.3%) (LARES, 2008). Longtime considered as a luxury food consumed during feast days; rice became part of eating habits of the populations of Benin. In Benin,

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while rice consumption is increasing, only 7% of the rice production potential (land and water resources) is used (JACQUES, 2008). In the country, rice ranks third regarding cereal production after maize and sorghum (ABEL, 2009) and is the second most crucial cereal regarding consumption after maize. Despite the progress realized in local rice production in sub-Saharan Africa after the food crisis of 2007-2008, rice demand has never been met; rice importation dependence is still around 50% and local rice production represents only 60% of domestic consumption (Saito et al. 2015, USDA, 2016). The rapid increase in domestic rice production is a significant challenge for Sub-Saharan Africa (Secket al. 2012).

Given these situations and given that Benin has enormous potential for rice cultivation of which less than 8% is currently exploited, it is imperative to think of increasing the local supply of rice in order to satisfy local demand, reducing rice importation and increasing rice exportation.

This study aims to forecast rice production, rice consumption, rice importation, rice exportation and finally rice self-sufficiency over the next five years in Benin.

2. Material and method

2.1.Methods of data collection

The data used in this study were obtained from the official websites of the Ministry of Agriculture of Benin (MAEP) and Food and Agricultural Organization (FAO). For the time series data, we considered different periods: area, paddy rice and rice importation cover the period 1961-2016; rice exportation covers the period 1961-2015; milled rice and rice consumption cover the period 1961-2013. We took different periods for the time series because rice data of Benin are not available in the same period.

In this study, the self-sufficiency level is calculated by using the following formula. Self-sufficiency level= (Usable production/Domestic use) x 100(FAO, 2012b; Van Oort et al. 2015; Demirbaş et al. 2017).

2.2.Methods used in data analysis

Different models are used in data estimation. In agriculture domain, ARIMA model was used in many studies to forecast milled rice production (Suleman and Sarpong, 2012), to forecast rice area, production and productivity (Rahmanet al. 2016; Hemavathi and Prabakaran, 2018), to forecast the price of medium quality rice to anticipate price fluctuations (Ohyver and Pudjihastuti, 2018), to forecast maize production (Sharma et al., 2018). In this study, ARIMA model is also used for data estimation.

ARIMA model

Future estimation of a variable can be made only by using the variable itself without anyother variables. These estimates are not based on a theoretical model. The movement of the variable in the past can be used to predict future movement. A linear time series models introduced by Box and

Jenkins (1970), are now widely used and accepted. According to them, the ARIMA model is

denoted by ARIMA (p, d, q) where ‘p’ is the order of the autoregressive process (AR); ‘d’ is the order of homogeneity i.e. the number of difference to make the series stationary; and ‘q’ the order of the moving average process (MA) (Box and Jenkins, 1970; Awajan et al., 2017).

The general form of the ARIMA (p, d, q) is

$Y_t = ς + β_1 Y_{t-1} + β_1 Y_{t-2} + ... + β_1 Y_{t-p} + ε_t + θ_1 ε_{t-1} + θ_2 ε_{t-2} + ... + θ_q ε_{t-q}$ (Kennedy, 2006:351).

Here, Yt gives the time series, εt error term, β model estimator, ς time series average.

Before doing an analysis of time series, we plot the data by using standard plots and summary statistics to see the behavior of the data. The sample ACF and the PACF pattern were done to see whether given data is stationary in its level and variability. Apart from rice exportation and rice consumption variables, the other variables are non- stationary in level since they have not fluctuated around constant mean and variance. Then we took the first difference of the data values and we selected the stationary levels of the data (Table1). The selection criterion is the probability (5%). To determine the orders (p, q) we referred to ACF and the PACF pattern. We estimated the parameters and fixed the fitted ARIMA model. Therefore, the fitted ARIMA model is the one that has more significant coefficients, less volatile, a higher R-squared, a lower Akaike Criterion (AIC) and a Theil’sinequality coefficient less than 1 (Table2). The final step of the validity of the fitted model was based on the distribution of residuals and of residuals square to find out whether the residuals are a white noise or not and find out whether all the information contained in the series have been exploited or not.

Test of forecast accuracy of the Box Jenkins method.

Theil’s U statistic measures the forecast accuracy (Theil, 1958). In this study, Theil's inequality coefficient is used to measure the predictive accuracy of models.

Theil Inequality Coefficient

$$U = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\Delta\hat{Y}_i - Y_i\right)^2}}{\sqrt{\frac{1}{n}\sum_{i=0}^{n}(\Delta Y_i)^2}}$$

ΔY_i = actual change of variable

$\Delta\hat{Y}i$ = predicted change of variable

n = Number of observations

The coefficient U is bounded between 0 and 1 ($0 \leq U \leq 1$). Theil’sinequality coefficient shows the predictive accuracy of the model. This coefficient should be less than 1 (Vergil and Ozkan, 2007; Okur, 2009, Özer and İlkdoğan, 2013). The prediction of the model will not be accurate if the calculated value is greater than 1. In that case, the model is not the most appropriate one. In This study, Theil'sinequality coefficient is used to select the most appropriate model for the estimation (Table2).

3. Results and Discussion

3.1. Unit root test

Augmented Dickey-Fuller test was carried out for the stability test. After the stationary studies of the series, only consumption and exportation series are stationary in level. Import, white rice production, paddy production and area series are stationary in first difference (Table 1).

Table1
The results of ADF unit root test.

Variables	Test atlevel					First difference test				
	Lag	Model	ADF	Critic	Processus	Lag	Model	ADF	Critic	Processus
Cons_b	8	Trend et constante	-5.26	-5.34	I (0)					
Exp01	8	Trend et constante	-5.26	-5.34	I (0)					
Imp	7	Trend et constante	-4.43	-4.85	Non stationnaire	0	constante	-11.52	-4.85	I (1)
PROB_b	7	Constante	0.73	-4.44	Non stationnaire	0	Trend et constante	-7.25	-4.85	I (1)
Prod_p	5	Trend et constante	-2.62	-4.65	Non stationnaire	0	constante	-6.43	-4.44	I (1)
Sup	2	Trend et constante	-4.38	-4.85	Non stationnaire	7	Trend et constante	-5.94	-4.85	I (1)

Tests are significant at 5%.

Table2
Summary of models

Variables	Order of integration	Model	Adjusted model	Theil'sinequality coefficient	Probability
Cons_b	I (0)	AR (1)	AR (1) AR (2) MA (7)	0.28	0.001
Exp01	I (0)	ARMA (1,1)		0.79	0.000018
Imp	I (1)	ARIMA (1,1,1)		0.52	0.00061
Prod_b	I (1)	ARIMA (3,1,3)		0.43	0.007
Prod_p	I (1)	ARIMA (5, 1, 3)		0.29	0.00015
Sup	I (1)	ARIMA(1,1, 12)		0.31	0.00016

The Theil's inequality coefficients for all the models are less than 1. So, the selected models are good for the prediction.

3.2.Estimates of rice consumption

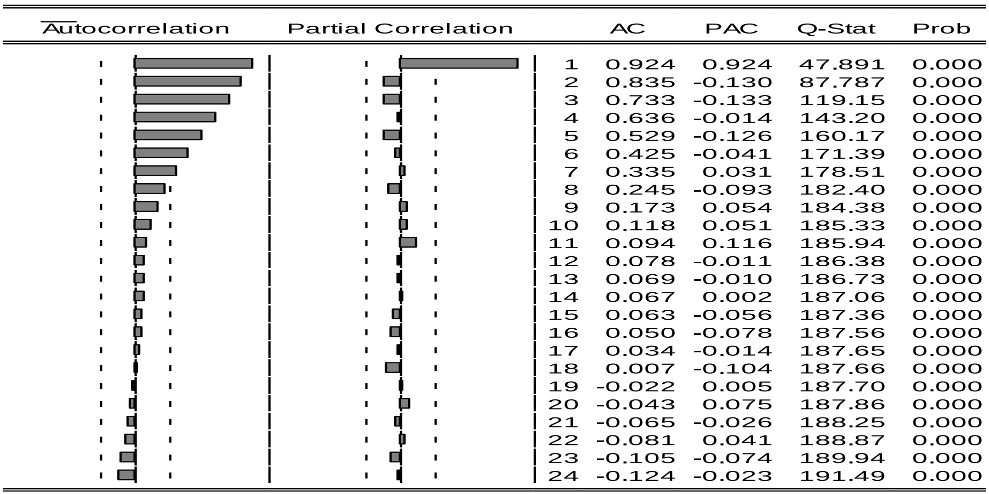


Figure1
Rice consumption ACF and PACF for stationary series.

The rice consumption series is an I(0). By observing the Figure1, the model to be estimated is AR (1) and its values are shown in the table3.

Table3
The values of AR(1) model

Model	Coefficient	Std. Error	t-Statistic	Probability
AR(1)	0.995	0.027	36.609	0.000

The residuals correlogram shows that there is unused information in the model like MA (3) and AR (2). That's why we need to estimate the adjusted model and choose the most appropriate model.

Table4
The values of R(2), AR(1) and MA(3) models

	AR (2)	AR (1) and MA (3)
Significant coefficients	2	2
Sigma^2 (volatility)	$5.52*10^8$	$5.47*10^8$
R^2adjusted	0.98	0.98
AIC	23.21	23.22

The most appropriate model is the one that has more significant coefficients, less volatile, a higher R-squared, and a lower Akaike Criterion (AIC). This model is the model AR (2). To validate this model, we analyzed the correlogram of residuals and residuals squared.

When one still observes the correlogram of the residuals squared, one notices that there is serial autocorrelation. It must be corrected by integrating an AR (7) or MA (7). After estimation, it is the MA (7) that corrects it (Table4).

The correlogram of the residuals on this adjusted model shows that all the information is integrated into the model and the correlogram of the residuals squared shows that there is no more serial correlation.

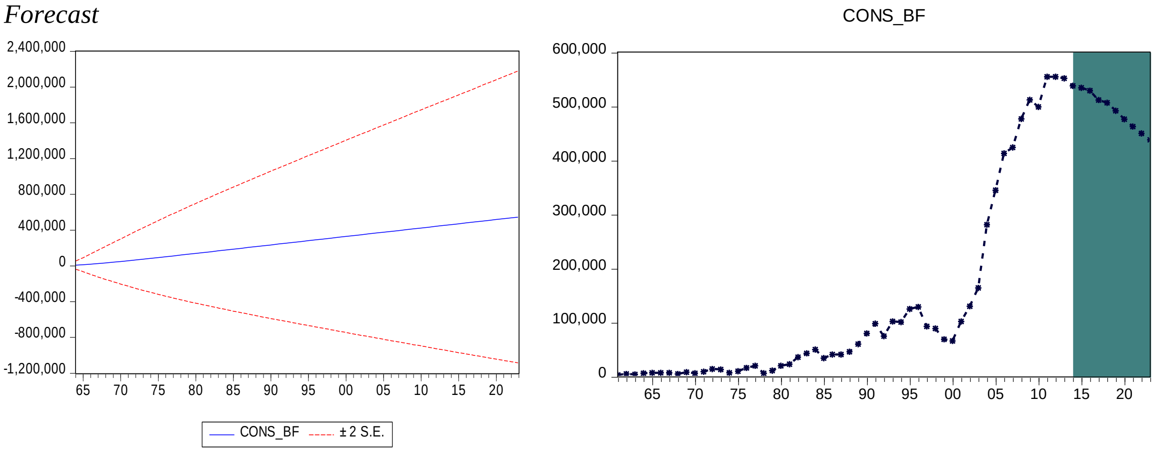


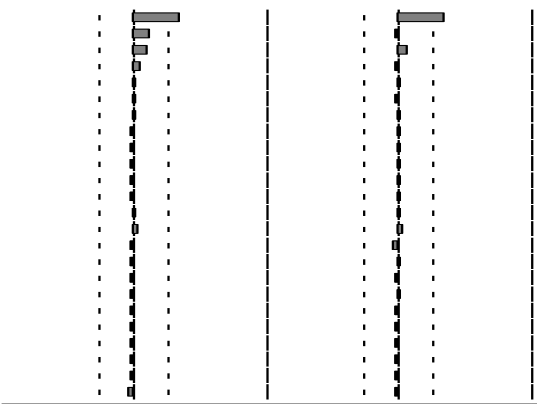
Figure2
Plot of rice consumption forecast.

Table4
Forecast values of rice consumption results

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Forecast (ton)	538003.5	534626.6	529279.5	511713.1	506690.0	491890.5	476481.4	462716.0	450114.1	438388.4

Rice consumption will decrease from 491890.5 tons in 2019 to 438388.4 tons in 2023 (Table5, Figure2).

3.3.Estimates of rice exportation



	AC	PAC	Q-Stat	Prob
1	0.368	0.368	7.5869	0.006
2	0.119	-0.018	8.4020	0.015
3	0.105	0.078	9.0471	0.029
4	0.046	-0.019	9.1749	0.057
5	0.017	0.002	9.1931	0.102
6	-0.002	-0.015	9.1933	0.163
7	-0.008	-0.004	9.1969	0.239
8	-0.008	-0.005	9.2014	0.326
9	-0.009	-0.003	9.2067	0.418
10	-0.008	-0.003	9.2115	0.512
11	-0.011	-0.007	9.2207	0.602
12	-0.008	-0.001	9.2255	0.684
13	0.004	0.010	9.2268	0.756
14	0.025	0.025	9.2722	0.813
15	-0.017	-0.040	9.2946	0.862
16	-0.015	0.002	9.3136	0.900
17	-0.014	-0.013	9.3284	0.929
18	-0.019	-0.008	9.3590	0.951
19	-0.020	-0.010	9.3939	0.966
20	-0.021	-0.009	9.4333	0.977
21	-0.022	-0.011	9.4786	0.985
22	-0.023	-0.011	9.5298	0.990
23	-0.024	-0.011	9.5876	0.994
24	-0.025	-0.012	9.6526	0.996

Figure3
Rice exportation ACF and PACF for stationary series.

The Rice exportation series is an I(0). By observing the Figure3, the model to be estimated is the ARMA model (1,1) and the its values are shown in the table5

Table5
The values of AR(1) and MA(1) models

Model	Coefficient	Std. Error	t-Statistic	Probability
AR(1)	0.292	0.801	0.365	0.016
MA(1)	0.081	0.907	0.089	0.029

Forecast

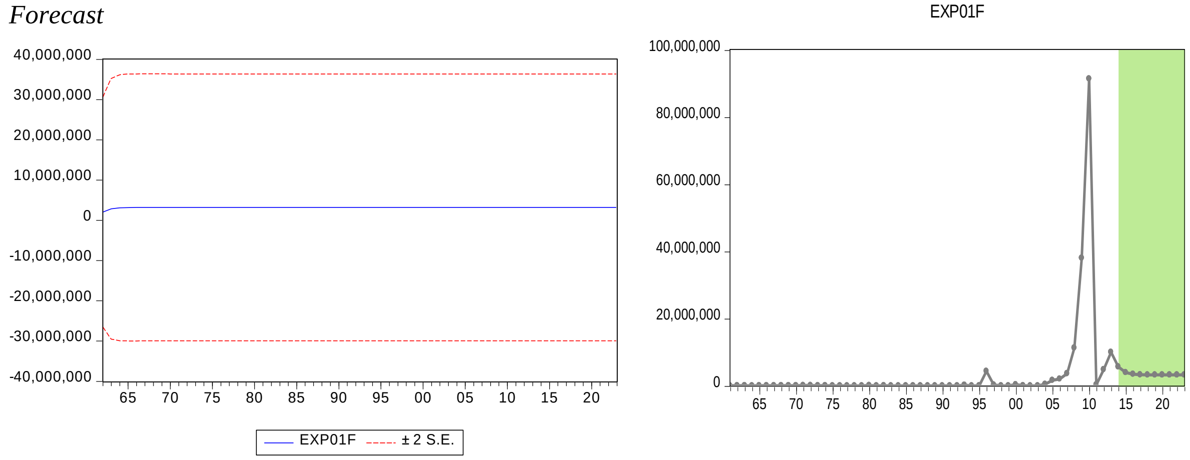


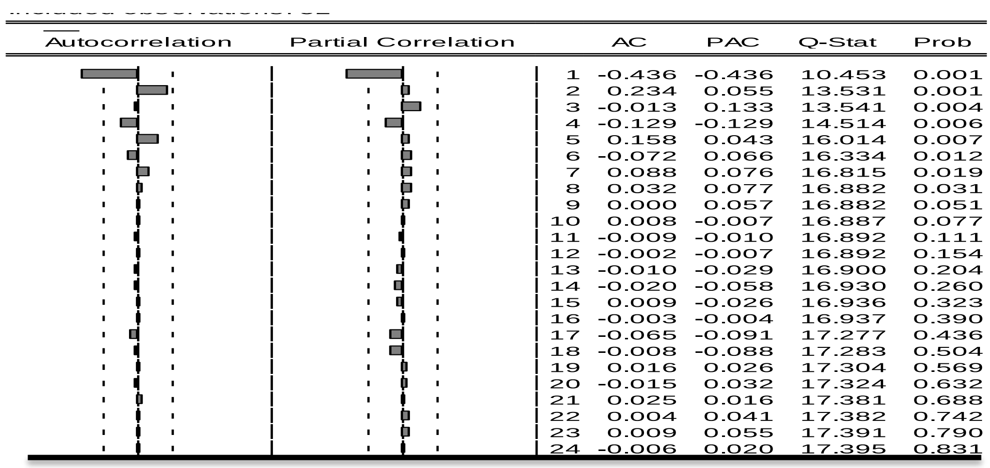
Figure4
Exportation forecast graphs

Table6
Forecast for rice exportation

Year	2016	2017	2018	2019	2020	2021	2022	2023
Forecast (ton)	3426473.63	3278216.33	3234802.85	3222090.29	3218367.73	3217277.67	3216958.47	3216865

Rice Exportations will decrease slightly from 3222090.29 tons in 2019 to 3216865 tons in 2023(Table6, Figure4).

3.4.Estimates of rice importation



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.436	-0.436	10.453	0.001
		2	0.234	0.055	13.531	0.001
		3	-0.013	0.133	13.541	0.004
		4	-0.129	-0.129	14.514	0.006
		5	0.158	0.043	16.014	0.007
		6	-0.072	0.066	16.334	0.012
		7	0.088	0.076	16.815	0.019
		8	0.032	0.077	16.882	0.031
		9	0.000	0.057	16.882	0.051
		10	0.008	-0.007	16.887	0.077
		11	-0.009	-0.010	16.892	0.111
		12	-0.002	-0.007	16.892	0.154
		13	-0.010	-0.029	16.900	0.204
		14	-0.020	-0.058	16.930	0.260
		15	0.009	-0.026	16.936	0.323
		16	-0.003	-0.004	16.937	0.390
		17	-0.065	-0.091	17.277	0.436
		18	-0.008	-0.088	17.283	0.504
		19	0.016	0.026	17.304	0.569
		20	-0.015	0.032	17.324	0.632
		21	0.025	0.016	17.381	0.688
		22	0.004	0.041	17.382	0.742
		23	0.009	0.055	17.391	0.790
		24	-0.006	0.020	17.395	0.831

Figure5
Rice importation ACF and PACF for stationary series.

The series of import is an I(1). By observing the Figure5, the model to be estimate is ARIMA(1,1,1) and the its values are shown in the table7.

Table7
The values of AR(1) and MA(1) models

Model	Coefficient	Std. Error	t-Statistic	Probability
AR(1)	-0.749	0.225	-3.315	0.0018
MA(1)	0.251	0.494	0.507	0.0061

Forecast

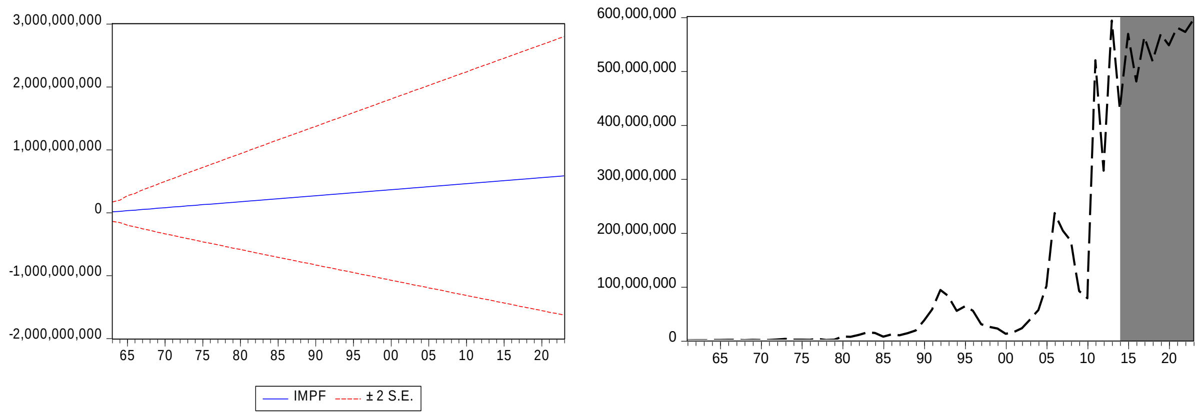


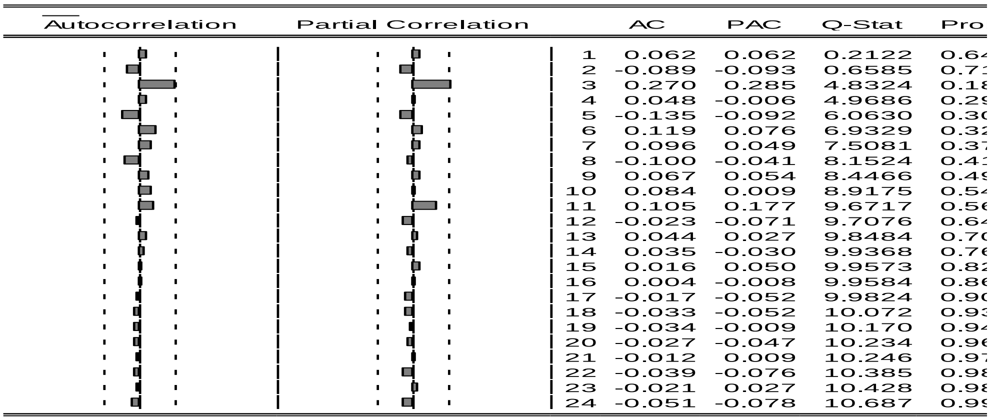
Figure6
Plots of importation forecast

Table8
Forecast for rice importation

Year	2017	2018	2019	2020	2021	2022	2023
Forecast(ton)	563000000	518000000	569000000	547000000	580000000	572000000	595000000

Imported rice will decrease from 569000000 tons in 2019 to 595000000 tons in 2023 (Table8, Figure6). These quantities of imported rice meet both domestic demand and re-exportations to neighboring countries.

3.5.Estimates of milled rice



	AC	PAC	Q-Stat	Pro
1	0.062	0.062	0.2122	0.64
2	-0.089	-0.093	0.6585	0.71
3	0.270	0.285	4.8324	0.18
4	0.048	-0.006	4.9686	0.29
5	-0.135	-0.092	6.0630	0.30
6	0.119	0.076	6.9329	0.32
7	0.096	0.049	7.5081	0.37
8	-0.100	-0.041	8.1524	0.41
9	0.067	0.054	8.4466	0.49
10	0.084	0.009	8.9175	0.54
11	0.105	0.177	9.6717	0.56
12	-0.023	-0.071	9.7076	0.64
13	0.044	0.027	9.8484	0.70
14	0.035	-0.030	9.9368	0.76
15	0.016	0.050	9.9573	0.82
16	0.004	-0.008	9.9584	0.86
17	-0.017	-0.052	9.9824	0.90
18	-0.033	-0.052	10.072	0.93
19	-0.034	-0.009	10.170	0.94
20	-0.027	-0.047	10.234	0.96
21	-0.012	0.009	10.246	0.97
22	-0.039	-0.076	10.385	0.98
23	-0.021	0.027	10.428	0.98
24	-0.051	-0.078	10.687	0.99

Figure7
Milled rice ACF and PACF for stationary series

The series of consumption is an I(1). By observing the Figure7 the model to be estimated is ARIMA(3,1,3) and the models values are shown in the table9.

Table9
The values of AR(3) and MA(3) models

Model	Coefficient	Std. Error	t-Statistic	Probability
AR(3)	0.811	0.316	2.564	0.013
MA(3)	0.066	0.501	0.132	0.0084

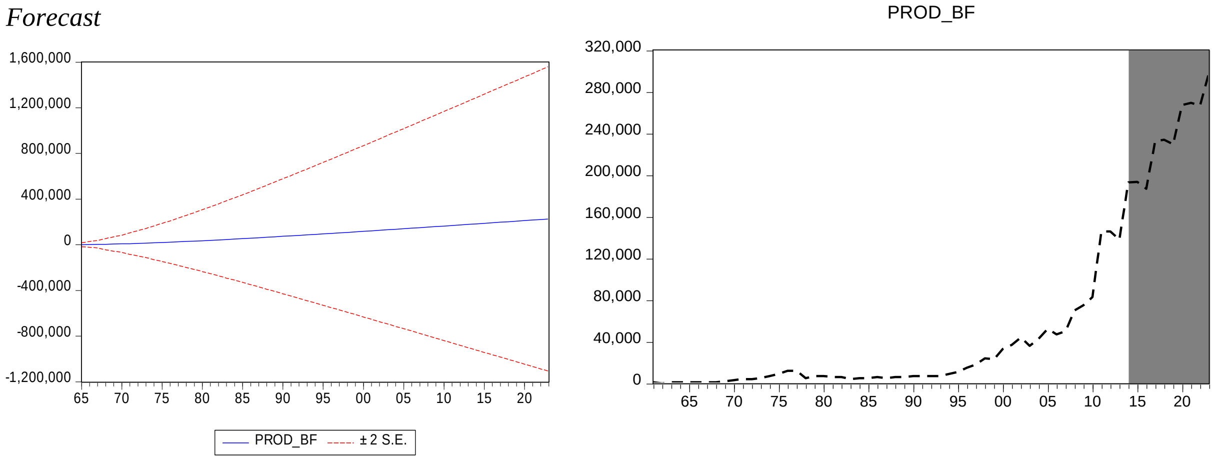


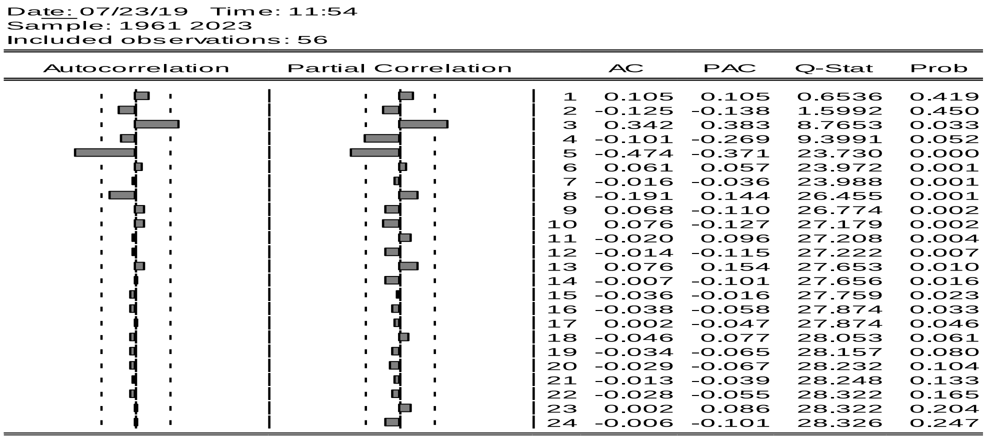
Figure8
Plot of milled rice forecast

Table10
Forecast for milled rice

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Forecast (ton)	193056.2	193612	186993.7	232599.9	233974.2	229526.1	267462.9	269501.5	266814.8	298527.1

Milled rice will increase from 229526.1 tons in 2019 to 298527.1 tons in 2023 (Table10, Figure8).

3.6.Estimates of paddy rice production


Date: 07/23/19 Time: 11:54
Sample: 1961 2023
Included observations: 56

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.105	0.105	0.6536	0.419
		2	-0.125	-0.138	1.5992	0.450
		3	0.342	0.383	8.7653	0.033
		4	-0.101	-0.269	9.3991	0.052
		5	-0.474	-0.371	23.730	0.000
		6	0.061	0.057	23.972	0.001
		7	-0.016	-0.036	23.988	0.001
		8	-0.191	0.144	26.455	0.001
		9	0.068	-0.110	26.774	0.002
		10	0.076	-0.127	27.179	0.002
		11	-0.020	0.096	27.208	0.004
		12	-0.014	-0.115	27.222	0.007
		13	0.076	0.154	27.653	0.010
		14	-0.007	-0.101	27.656	0.016
		15	-0.036	-0.016	27.759	0.023
		16	-0.038	-0.058	27.874	0.033
		17	0.002	-0.047	27.874	0.046
		18	-0.046	0.077	28.053	0.061
		19	-0.034	-0.065	28.157	0.080
		20	-0.029	-0.067	28.232	0.104
		21	-0.013	-0.039	28.248	0.133
		22	-0.028	-0.055	28.322	0.165
		23	0.002	0.086	28.322	0.204
		24	-0.006	-0.101	28.326	0.247

Figure9
Paddy rice ACF and PACF for stationary series.

The series of paddy rice is an I(1). The analysis of the ACF and PACF functions allows us to retain the following competing models (3,1,5); ARIMA (5, 1, 3); ARIMA (3,1,3); ARIMA (5,1,5)

Table11
Comparison of different ARIMA models with model fit statistics for paddy rice

	ARIMA (3,1,5)	ARIMA (5, 1, 3)	ARIMA (3,1,3)	ARIMA (5,1,5)
Significant coefficients	2	2	0	0
$Sigma^2$ (volatility)	$1.74.10^8$	$1.65.10^8$	$2.58.10^8$	$2.03.10^8$
Adjusted R^2	0.4504	0.4791	0.1840	0.35
AIC	22.01	21.97	22.37	22.16

The most appropriate model is one that has more significant coefficients, less volatility, a higher R-squared, and a lower Akaike Criterion (AIC).). Based on the Table11, the model ARIMA (5,1,3). was selected as the most appropriateon.

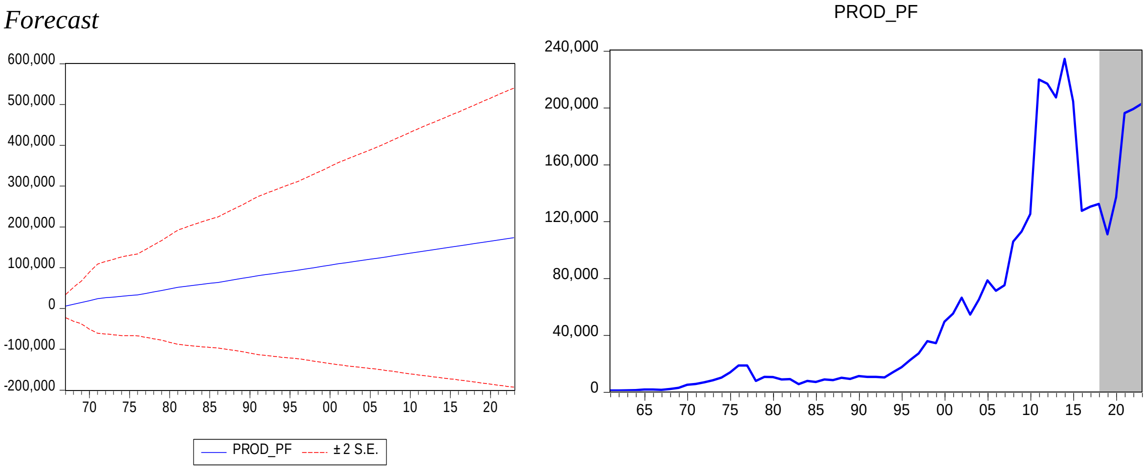


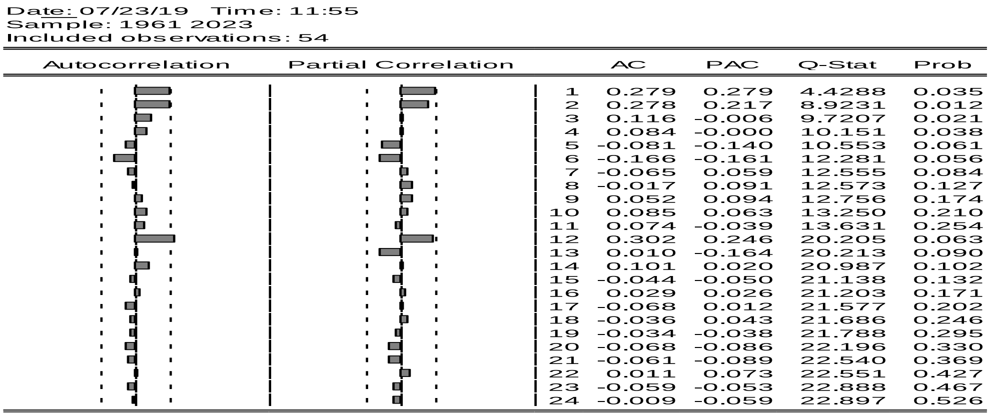
Figure10
Plots of paddy forecast

Table12
Forecast for paddy rice

Year	2017	2018	2019	2020	2021	2022	2023
Forecast (ton)	130189.8	132034.3	110682.8	136757.4	195994.9	198872.7	202584.1

Paddy rice will increase from 110682.8 tons in 2019 to and to 202584.1 tons in 2023 (Table12, Figure10).

3.7.Estimates of area of rice production



	AC	PAC	Q-Stat	Prob
1	0.279	0.279	4.4288	0.035
2	0.278	0.217	8.9231	0.012
3	0.116	-0.006	9.7207	0.021
4	0.084	-0.000	10.151	0.038
5	-0.081	-0.140	10.553	0.061
6	-0.166	-0.161	12.281	0.056
7	-0.065	0.059	12.555	0.084
8	-0.017	0.091	12.573	0.127
9	0.052	0.094	12.756	0.174
10	0.085	0.063	13.250	0.210
11	0.074	-0.039	13.631	0.254
12	0.302	0.246	20.205	0.063
13	0.010	-0.164	20.213	0.090
14	0.101	0.020	20.987	0.102
15	-0.044	-0.050	21.138	0.132
16	0.029	0.026	21.203	0.171
17	-0.068	0.012	21.577	0.202
18	-0.036	0.043	21.686	0.246
19	-0.034	-0.038	21.788	0.295
20	-0.068	-0.086	22.196	0.330
21	-0.061	-0.089	22.540	0.369
22	0.011	0.073	22.551	0.427
23	-0.059	-0.053	22.888	0.467
24	-0.009	-0.059	22.897	0.526

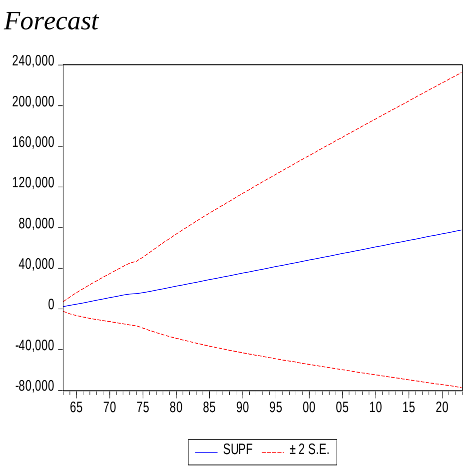
Figure11
Area ACF and PACF for stationary series

The series of area is an I(1). The analysis of the ACF and PACF functions allows us to retain the following competing models: ARIMA (1,1,12); ARIMA (12, 1, 1); ARIMA (12,1,12) ; ARIMA (1,1,1).

Table13
The values of ARIMA (1,1,12); ARIMA (12, 1, 1); ARIMA (12,1,12) ; ARIMA (1,1,1)

	ARIMA (1,1,12)	ARIMA (12, 1, 1)	ARIMA (12,1,12)	ARIMA (1,1,1)
Significant coefficients	1	2	1	1
Sigma2 (volatility)	4583815	6257622	4707474	8620418
Adjusted R2	0.5030	0.3215	0.48	0.06
AIC	18.70	18.75	18.77	18.95

The most appropriate model is one that has more significant coefficients, less volatility, a higher R-squared, and a lower Akaike Criterion (AIC). Based on the Table13, the ARIMA model (1, 1, 12) was selected as the most appropriate one.



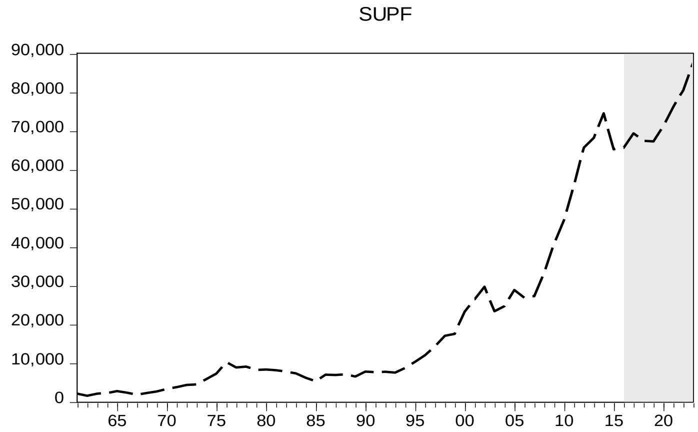


Figure12
Area forecast graphs

Table14
Forecast for area

Year	2017	2018	2019	2020	2021	2022	2023
Forecast (ha)	69394.72	67459.67	67317.95	71249.31	76254.26	80540.58	87708.02

The cultivated area will increase from 67317.95 ha in 2019 to 87708.02 ha in 2023 (Table14, Figure12).

Table15
Self-sufficiency rate (2019-2023)

Year	2019	2020	2021	2022	2023
Milled rice (ton)	229526.1	267462.9	269501.5	266814.8	298527.1
Rice consumption (ton)	491890.5	476481.4	462716	450114.1	438388.4
Self-sufficiency (%)	47	56	58	59	68

Based on Table15, one observes that the rate of self-sufficiency will increase and will reach its peak (68%) in 2023. It can be concluded that Benin will continue importing large quantities of rice to meet domestic demand and fill the gap of about 32% of the self-sufficiency rate remaining during the next five years.

According to estimates of theMinistry of Agriculture of Benin, Benin was expected to reach its self-sufficiency level in rice production since 2013 through domestic production (MAEP, 2010). However, this goal could not be achieved due to inadequate agricultural policies. Right now, the self-sufficiency level in rice production is around 60% and this, because of insufficient domestic production.

4. Conclusion and Suggestions

This study aims to give an overall idea of the rice sector in Benin and to forecast the variables of rice over the next five years by using the model. As a result, the self-sufficiency level will not be reached during the next five years. It will be about 68%. The fact is that annual rice consumption is increasing faster than annual rice production in Benin and in sub-Saharan Africa. Between 2010 and 2035, rice demand in sub-Saharan Africa is expected to increase by 130% (Secket al. 2012). Rice importations are likely to lose foreign exchange reserves and increase poverty and food insecurity. The rapid increase in local rice production is a significant challenge for sub-Saharan Africa (Catherine and Chapoto, 2017). To meet local consumption growth, rice production policies need to be redirected and revised. Because importation dependence can seriously affect food security and political stability, as demonstrated during the 2007-2008 food crisis (Berazneva and Lee, 2013). Sustainable food security cannot be based on importations, and it should be found on the development of domestic production for adequate protection against fluctuations in world prices (Larochea and Postolle, 2013).

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