Price and non-price determinants and supply response of rice in Côte d'Ivoire

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PRICE AND NON-PRICE DETERMINANTS AND SUPPLY RESPONSE OF RICE IN CÔTE D'IVOIRE

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ABSTRACT

Characterized by weak local rice productivity, inefficient marketing and processing of paddy among other constraints, the local rice sector in Côte d'Ivoire has failed to meet domestic rice consumption needs. In the absence of comprehension action, the country is expected to face a deficit of 1,731,583 Mt in supply of rice by the year 2020, which could consequently result in huge drainage of foreign exchange through imports. To inform future policy decisions on rice towards mitigation of the adverse effect such occurrence may have on producers, consumers and the country as a whole, this study analyzed the acreage and output responses of rice in Côte d'Ivoire for the period 1966-2009. The results suggest that rice farmers respond more to changes in price of competitive maize crop than they do own-price due to inefficiency of collection, processing and marketing in the local rice industry, limited participation of various stakeholders in development of the rice supply chain, failure of most buyers to observe contract terms and surtax on producer price due to high cost of transportation. The stagnation observed in output between the years 1988 and 2009, is found to result from a significant inverse association between area cultivated and yield of rice. As a major importer of rice and based on results of the current study, it is believed that Côte d'Ivoire could improve on its rice supply and effectively meet the anticipated deficit by putting in place measures to increase land area under cultivation, ensure a harmonization between yield and acreage cultivated, reduce labor shortages, ensure continuous government support to the sector, address the adverse fiscal effect of the exchange rate system and promote stakeholder participation in development of the rice supply chain.

Keywords: Acreage response, output response, nominal rate of assistance, deficit in supply

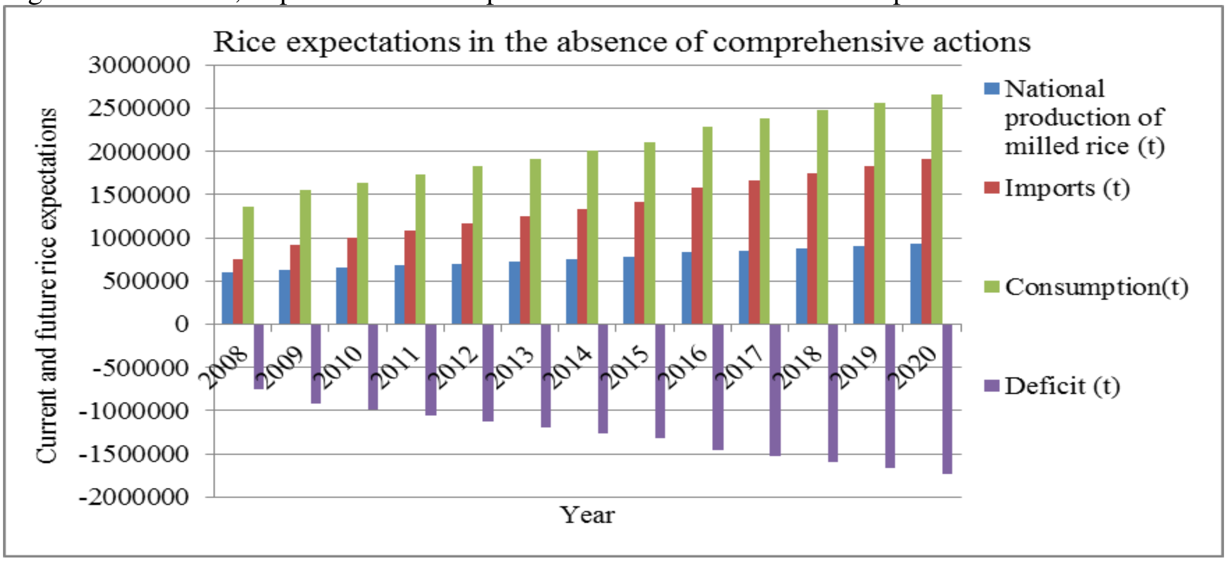
1.0 INTRODUCTION

Like many other West African countries, Côte d'Ivoire is blessed with assets favoring rice growing that could have allowed the country to produce enough to meet domestic demand and export surpluses should the need arise. The country hauls significant land area suitable for cultivation of rice, experienced farmers, high-yielding rice varieties with good sensory properties and satisfactory economic and institutional environment among others. In spite of all these boosters, Côte d'Ivoire is exposed to food insecurity for rice by virtue of its strong dependence on import. Self-sufficiency of the country in rice has generally remained below 50% for more than two decades in spite of various aggressive policy measures devised and implemented towards developing the local rice industry

As of the year 2012, national rice production (703,566 MT milled equivalent) met less that 40% of the domestic consumption (1,825,733 MT) needs with the gap (1,222,207 MT) been bridged through rice imports (MoA, 2012: NRDO, Côte d'Ivoire). Production and consumption forecast as published by the

Ministry of Agriculture shows that in the absence of comprehensive action, the country will have to import 1,731,583 MT of rice by the year 2020 to bridge the anticipated gap in supply. This would result in major outflow (drainage) of foreign exchange and expose the country to shocks on the world market by virtue of uncertainties in future supply and the volatile nature of prices on the market. To help inform future policy decisions in meeting the expected deficit in supply, there arises the need to identify and appropriately address the significant drivers of local rice supply. Identification and assessment of the magnitude and effects of such drivers on the acreage cultivated and output of rice in Côte d'Ivoire is the objective of the current study.

Fig 1.0 Production, imports and consumption of rice in the absence of comprehensive action



Source: Author's construct with data from the Ministry of Agriculture (2012)-NRDO

1.1 RICE POLICY AND GOVERNMENT ASSISTANCE

Rice in Côte d'Ivoire is reported to account for more than half of the cereal intake, and as a major staple food consumed in the country, the need to reach food security and attain self-sufficiency has been the focus of all the country's agricultural development policies. In its pursuit of providing food security and reducing poverty in the country, government in the 1960s and 1970s opted to manage the then situation of the rice industry using aggressive policy of intervention along the length of the supply chain (SATMACI (1960-1970) and SODERIZ (1970-1977)). This policy did contribute significantly towards the development of the local rice industry, with self-sufficiency in rice been attained in 1976 (MoA, 2012). The improvements observed were however short-lived due to the subsequent period of progressive disengagement from the sub-sector by various National Public Enterprises (NPEs) including SATMACI, SODEPALM, SODEFEL, CIDT, CIDV and ANADER between 1978 and 1995.

With rice losing its position as the prime target for these bodies, it no longer received the attention needed for effective development of the sub-sector. This had an adverse effect on the industry reflected by the deficits observed in supply as a result of irregular supply of local rice on the market. The Government was then prompted to set up the National Rice Project in 1996, which was later transformed and renamed the National Rice Program (NRP/PNR) to coordinate and monitor the implementation of rice-growing projects. In response to the commodity crisis of 2008, and in line with its Agricultural Development Master Plan 1992-2015, the Poverty Reduction Document (2009) and the National Agricultural Investment Program (26 July, 2010), the Government adopted the Rice Rehabilitation Strategy in June 2008 to help meet set production targets among other goals. The goals of this strategy were to be achieved through three stages, prominent among which was the Emergency Rice Program (ERP/PUR) 2008-2009. Given a target of obtaining an extra 200,000 tonnes of rice from

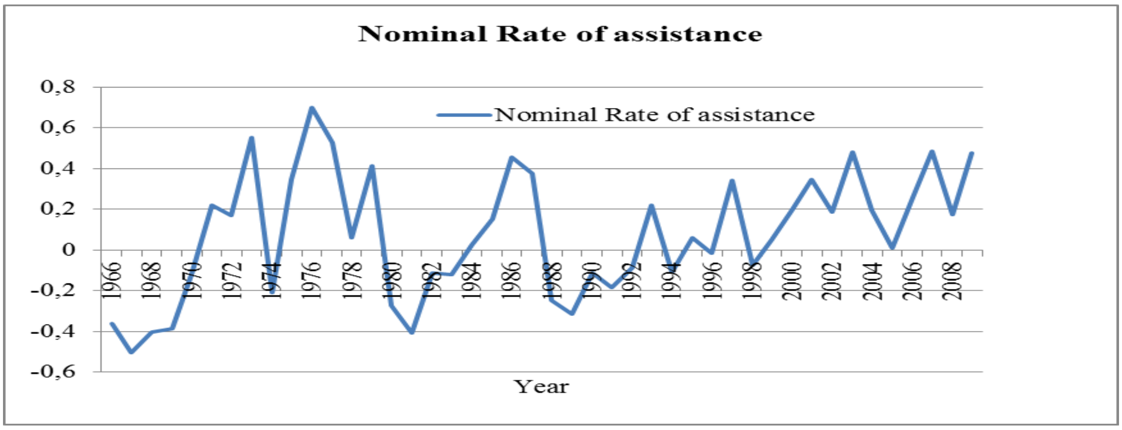
31,000 ha in a year, the program was able to achieve 38% of this target at a low cost. The entire strategy however failed to effectively address most of the problems with the local rice industry

This led to a revision of the strategy taking into account all important elements of the rice value chain in order to meet the requirements for sustainability of proposed action and to ease raising of funds. The Revised Strategy for Rice Development 2012-2020 is aimed at covering both national consumption requirements from 2016 onwards through production of 1,900,000 tonnes of milled rice and improving on this output to 2.1 million tonnes in 2018 (MoA, 2012). In summary, the management of the rice sub-sector in the country is marked generally by six distinct periods. These are

i) **From 1960-1970**: characterized by an aggressive interventionist State policy for the whole value chain, which resulted in a significant increase in national production without acting as a brake on imports
ii) **From 1970-1977**: characterized by an aggressive interventionist state policy for the whole value chain through SODERIZ (the Rice-growing Development Company specially created to promote rice). This policy ensured the attainment of self-sufficiency in 1976
iii) **From 1978-1988**: characterized by dissolution of SODERIZ and subsequent development of rice growing by means of various corporate bodies. A decline in performance of the local rice industry was observed due to the limited attention given to rice by such corporate bodies, as rice was no longer a prime target to them
iv) **From 1988-1995**: characterized by a global approach to food production through the Ivorian Food Development Company (CIDV) and the National Agency for Rural Development (ANADER). No major improvement was observed in the local rice industry
v) **From 1996-July 2010**: characterized by initiation of the National Rice Project in 1996, which was later transformed and renamed the National Rice Program in 2003 to coordinate and monitor the implementation of rice-related projects
vi) **July 2010 onward**: characterized by dissolution of the National Rice Program and establishment of the National Rice Development Office (NRDO) to take up the activities of the NRP

Côte d'Ivoire has seen series of successful and unsuccessful attempts by the previous governments to stimulate rice production towards meeting the ever increasing demand. In its effort of revive the local rice industry, the government has redirected its focus back to the 1970s where rice production was heavily subsidized. Nominal rate of assistance to producers as depicted in the figure below shows a general increase of State intervention through imposition of varying tariffs on imports and subsidization of production from the year 1990 to 2009.

Figure 2.0 Assistance for the local rice industry, 1966-2009



Source: Author's construct with data from Anderson and Nelgen (2012)

1.2 CHARACTERISTICS OF RICE PRODUCTION

Rice production in Côte d’Ivoire is characterized by three systems of production with distinct characteristics namely, the Rain-fed rice, flooded rice and the irrigated rice systems. The rain-fed rice ecology covers about 93% of total area planted to rice, and accounts for approximately 73% of national paddy output. This ecology records the lowest yield (0.8t/ha) among the three systems and makes use of only 7% of pedigree or ancestral seeds. Use of fertilizer and herbicides are very limited under this system and it’s hardly mechanized. Due to its high dependence on rain, only one cropping season/cycle is observed under the rain-fed rice ecology. The flooded rice systems covers about 2% of total area planted to rice and accounts for approximately 6% of total national paddy output. Use of fertilizer and herbicides are as well limited under this system and about 20% of seeds used in the flooded rice ecology are pedigree seeds. This system observes one cropping cycle and is relatively mechanized. Average yield observed for this system as reported by the Ministry of Agriculture for Côte d’Ivoire is 2.5t/ha. The irrigated rice system records the highest yield of 3.5t/ha, covers about 5% of total area, and accounts for approximately 21% of total national paddy output. Due to the regular availability of water, this system observes a double cropping cycle in a year and is mostly mechanized. It as well involves relatively high usage of fertilizer and herbicides, as 60% of the total area is been reported to involve the use of these inputs of production. About 60% of the seeds used in the irrigated ecology are pedigree seeds.

Table 1.0 Characteristics of the three rice cropping systems

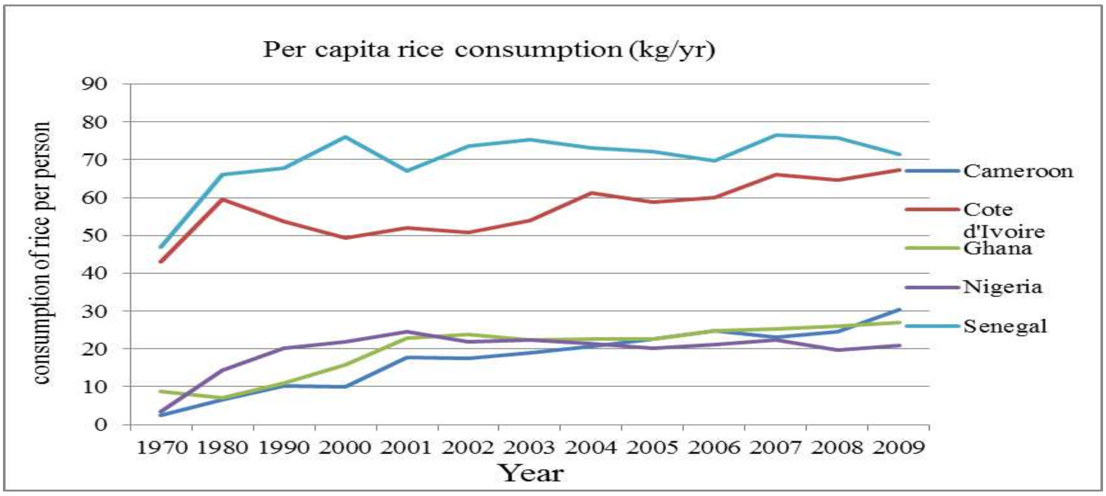
Indicator	Rainfed rice	Flooded rice	Irrigated rice
Area planted	About 600,000 ha, or 93% of total area	About 15,000ha or 2% of total area	35,000 ha or 5% of total area
Average yield	0.8t/ha	2.5t/ha	3.5t/ha
Number of cycles/year	1	1	2
Production	About 480,000 t of paddy	About 37,000 t of paddy	About 140,000 t of paddy
Use of pedigree seed	7% of total area	20% of total area	60% of total area
Use of fertilizer and herbicides	Low usage of herbicides and fertilizers		60% of total area
Mechanization	Hardly any tractors	Use of tractors, rotary tillers and threshers	
Development services	ANADER, Agricultural Professional Organizations (OPA), NGOs		
Producers’ organizations	44 Cooperatives, two Union of Cooperatives, one National Association (ANARIZCI), one Development Management Council (CGA) for each developed scheme		

Source: MoA (2012), NRDO – Côte d’Ivoire: NRDS 2012-2020

1.3 RICE CONSUMPTION AND PERFORMANCE IN SUPPLY

Like many other West African countries, national average annual consumption of rice per person in Côte d’Ivoire has undergone major dramatic changes since the 1970s. Regarded as one of the major rice consumption and importing countries in the sub-region, rice consumption per capita in Côte d’Ivoire increased from 43kg in 1970, 59.4kg in 1980, to 67.3kg in 2009. These consumption figures observed for the respective years are well above the current 17kg/person observed for wheat and 40kg/person for maize in the country. Likewise, current per capita consumption of rice in neighboring countries like Senegal, Cameroon, Nigeria and Ghana are major improvement on consumption figures for the years1970, 1980 and 1990. Per capita consumption for Cameroon increased from 2.4kg in 1970 to 30.3kg in 2009, with that for Ghana, Nigeria and Senegal increasing respectively from 8.8kg, 3.5kg and 47kg in 1970 to 26.9kg, 20.9kg and 71.5kg in 2009. Recent reports suggest further increases in these figures.

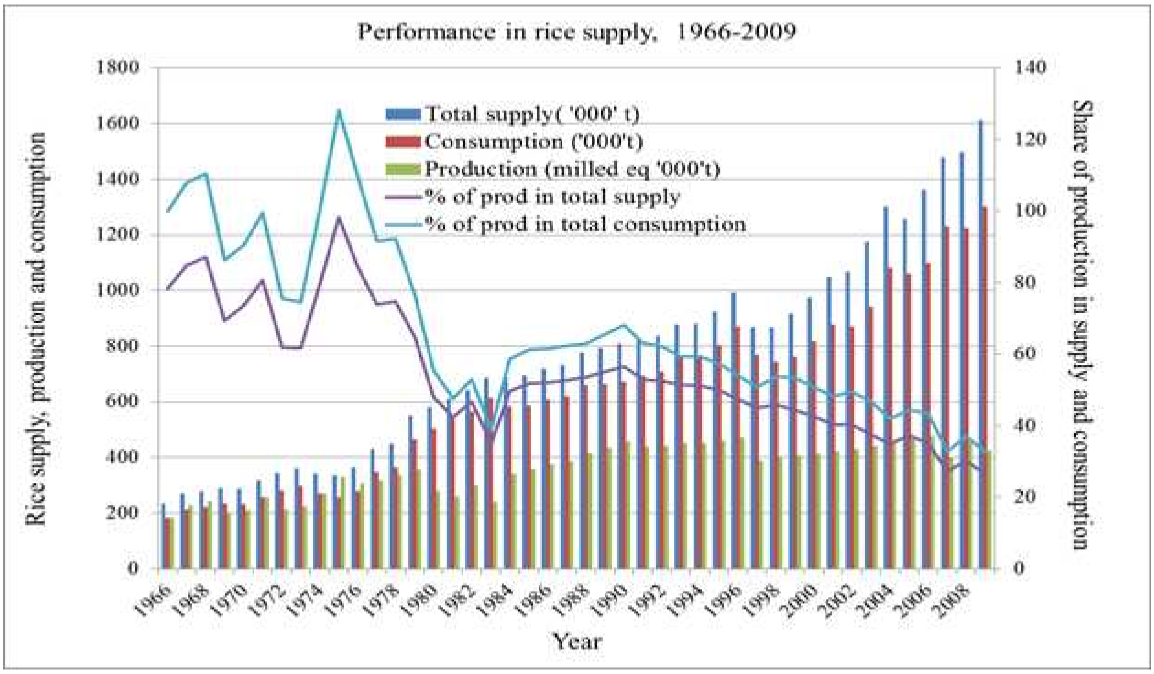
Figure 3.0 Per capita consumption of rice by country



Source: Author's construct with data from IRRI – (World Rice Statistics, FAO data)

In spite of the increasing consumption of rice, domestic production has failed to catch up with demand; the gap between the two widening since the early 1990s. Domestic production of rice in Côte d'Ivoire as of the year 2009, met only a third (32.62%) of domestic demand, with the deficit been bridged through imports. The country was virtually self-sufficient in rice in the mid-1960s and mid-1970s. Its performance in meeting domestic demand declined from the over 128% and 110% for the years 1975 and 1976 to as low as 39.09% in 1983. It however picked up gradually until the year 1990 and has since then declined continuously.

Fig. 4.0 Performance in rice supply

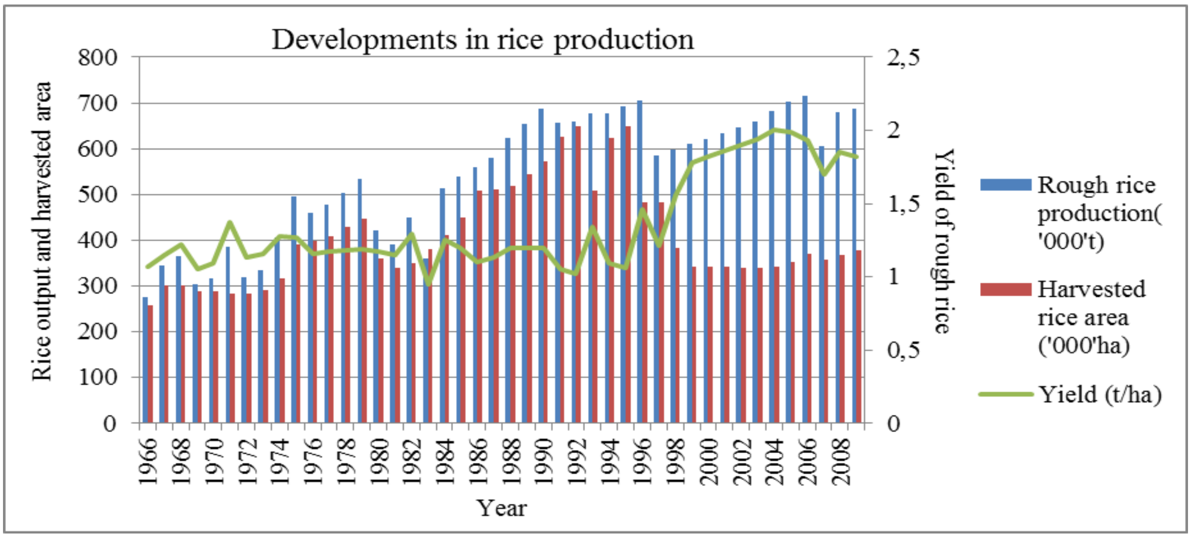


Source: Author's construct with data from IRRI- (World Rice Statistics, FAO data)

1.4 DEVELOPMENTS IN RICE PRODUCTION

Local rice supply as characterized by the dimensions of output, acreage and yield has undergone some dramatic changes between the years 1966 and 2009. Significant improvements in both output and area harvested of rice were observed in the mid-1970s and late 1980s, with growth in yield more or less stagnating between the 1960s and 1980s. Improvements in output and harvested area in the 1970s reflect outcome of the aggressive policy of intervention applied by the then government during the period. The dissolution of SODERIZ thereafter and the progressive disengagement by the National Public Enterprises from the rice sub-sector, as well as the regular initiation and revision of strategies to address flaws have shaped trends in the three dimensions of supply with yield of rice responding positively since the mid- 1990s. Output of rice has more or less stagnated between the years 1988 and 2009. Contrary to the improvements observed in yield and the stagnation in output, area harvested of rice has declined dramatically from 650 ("000") hectares for the year 1995 to 377 ("000") hectares in the year 2009 (a decrease of approximately 42%). This observation has been attributed among others by Rakotoarisoa (2006) to migration out of rural areas (due to political instability in Côte d'Ivoire) and to unfavorable rainfall distribution. This could as well be due to security effects from the land tenure system in the country. With output stagnating in-between the two aforementioned periods (1988 and 2009) in spite of the improvements observed in yield, it is believed that bridging of the anticipated deficit in future supply will require in addition to improvements in yield, the development and appropriate implementation of policies to help put more land under cultivation.

Figure 5.0 Developments in output, acreage and yield of rough rice



Source: Author's construct with data from IRRI- (World Rice Statistics, FAO data)

1.5 ROLE OF RICE IN ECONOMIC DEVELOPMENT OF CÔTE D'IVOIRE

Rice, through production, processing and marketing serves as an important element in the fight against rural poverty in Côte d'Ivoire. It is a source of livelihood through production to over 2 million growers (MoA, 2012) and contributes significantly to sustenance of most households who depend on it through processing and marketing. Local rice production serves as a driver for economic development through its gradual substitution of imports, thereby ensuring the reservation of a portion of foreign exchange that could have been drained through imports. Such reserves could be invested in other vital areas to help promote food security and reduce poverty in the country.

2.0 MODEL SPECIFICATION AND DATA

Supply response according to Cummings (1975) and Holt (1999) could be assumed to be equivalent to response of acreage under cultivation to changes in vital price and non-price factors. Defoer *et al* (2004) also distinguished three major options for increasing rice production: area expansion, increase in cropping intensity and increase in yield (producer per unit area). With the area under rice cultivation in Côte d'Ivoire being the current pressing issue among the three options and based on suggestions from the aforementioned researchers, the primary implicit supply response function for the current study is expressed as:

$$HA_t = f\,(RPR_t, RPM_t, Y_t, EXR_t, AL_t, WPU_t, NRA_t, (WPR/RPR)_t, (WPCORN/RPM)_t, u_t)$$

To help identify how improvements in the components of output (thus, harvested area and yield) translate into the final output of paddy rice, the following regression is estimated thereafter capturing the effects of own price incentives, labor availability and State intervention in the process:

$$\ln PROD_t = \beta_0 + \beta_1 \ln HA_{t-1} + \beta_2 \ln Y_{t-1} + \beta_3 \ln RPR_{t-1} + \beta 4 \ln AL_{t-1} + \beta_5 NRA_{t-2}$$

Where HA_t -Harvested area of rough rice ("000" ha)
$PROD_t$ - Output of rough rice ("000" t)
RPR_t -Real producer price of rice (LCU units – Constant 2005)
RPM_t -Real producer price of maize (LCU units – Constant 2005)
Y_t -Yield of rough rice (Mt/ha)
EXR_t -Exchange rate (FCFA/US$)
AL_t -Availability of labor (Agricultural labor force as proxy, "000" persons)
WPU_t -Price of urea fertilizer (World price as proxy, US$/t fob)
NRA_t -Nominal Rate of Assistance (%)
$(WPR/RPR)_t$ -World price of rice to real local producer price of rice ratio
$(WPCORN/RPM)_t$ -World price of corn to real local producer price of maize ratio
u_t -Stochastic error term assumed to be *iidN(0,Σ)*

Data (1966-2009) on all the variables were collected from the IRRI website (World Rice Statistics) and the agricultural production database of the FAO (FAOSTAT). Nominal values for the producer prices of rice and maize were sourced from FAOSTAT and deflated with the 2005-based Consumer Price Index series of IRRI (World Rice Statistics). Agricultural labor force was used as a proxy for availability of labor due to its fair reflection of labor per unit area in a given country, and due to lack of proper documentation of farm hands in the rice sub-sector. World price of urea was used as a proxy for local price due to insufficient number of observations for data on local price and due to the high dependence of most West African countries on imported fertilizer, herbicides and pesticides for production. Incorporation of the price ratios into the implicit supply function is to help capture the indirect effects of world prices of rice and maize of the production decisions of local rice farmers.

3.0 RESULTS

Prior to estimation of the acreage and output responses of rice in Côte d'Ivoire, the whole set of data (with all variables in log except nominal rate of assistance (NRA)) was verified to ascertain the order of integration of the individual series, as this is a vital step in the data generation process and choice of estimator. Verification of the data set was done with the Augmented Dickey-Fuller and Phillips-Perron unit root tests (trend and intercept at level, intercept at first difference). Results of the tests show that all the variables excluding the nominal rate of assistance (NRA) are non-stationary at level, but become stationary at first difference at the 1% level. Nominal rate of assistance was found stationary at level at the 5% significance level. The results of the unit root test therefore underscore the presence of unit root in all data series.

Table 2.0 Unit root test of variables (Augmented Dickey-Fuller and Phillips-Perron test)

	Level		First Difference	
Variables	ADF	PP	ADF	PP
HA	-1.572826	-1.718310	-6.066738***	-6.099501***
PROD	-3.254381	-3.278883	-8.316140***	-8.316140***
RPR	-2.407302	-2.407302	-7.253931***	-7.339162***
RPM	-2.175574	-2.188235	-7.550421***	-7.548053***
Y	-1.924620	-3.132048	-8.444161***	-11.27085***
EXR	-2.063591	-2.316076	-5.645635***	-5.648315***
AL	0.407773	0.430102	-4.605654***	-4.680079***
WPU	-2.520567	-2.630823	-5.314694***	-5.631326***
NRA	-4.065891**	-4.020379**	-4.512668***	-9.643454***
(WPR/RPR)	-3.485451	-3.410761	-6.946528***	-10.92322***
(WPCORN/RPM)	-3.236505	-2.995068	-6.569168***	-10.19776***
Critical value	-3.518090	-3.518090		

NB: 95 percent confidence level for critical value, ***1%, **5%

Having known the order of integration of the respective series, the acreage response function was estimated for the long-run and short run effects using the Engle-Granger approach to co-integration. Nominal rate of assistance was included in the long-run equation to help capture the effect of distortion through State intervention on supply of rice (reflected by acreage response) in Côte d'Ivoire. The output response equation was estimated thereafter.

3.1 ACREAGE RESPONSE OF RICE

Diagnostic tests for normality, serial correlation, structural stability and misspecification of the function through a Reset test were applied on both the long run and short estimates, and the results show that the function passed all the diagnostic tests. The Jarque-Bera values observed for both the long- and short-run estimates were below the critical values, thus, implying a normal distribution in the residuals for the respective equations. The Breusch-Godfrey serial correlation LM test and the Q-stat values indicate the absence of first and second order serial correlation in the residuals of both the long- and short-run equations, with the ARCH test confirming a homoscedastic nature of the residual series. The insignificant value for the Reset test observed for both the long-run and short-run equations reflect appropriate specification of the regression equations. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUM of squares) were applied as a check on the stability of estimates, and the results show that they remain within the boundary in both the long-run and the short-run.

Table 3.0 Long-run and short-run estimates of acreage response of rice

	Short-run		Long-run	
Variables	Coefficients	t-statistic	Coefficients	t-statistic
Intercept	-0.017063	-1.285180	-5.664506	-2.551074**
Δ ln HA_{t-1}	0.300697	2.547896**		
ln $RPPR_t$			0.023708	0.251961
Δ ln $RPPR_t$	-0.024499	-0.309764		
ln $RPPM_t$			-0.211351	1.691980*
Δ ln $RPPM_t$	-0.214052	-2.253907**		
ln Y_t			-0.860404	-9.381363***
Δ ln Y_t	-0.574389	-6.662467***		
ln EXR_t			-0.258069	-3.392694***
Δ ln EXR_t	0.015976	0.179509		
ln AL_t			1.708119	8.373778***
Δ ln AL_t	2.004337	3.784297***		

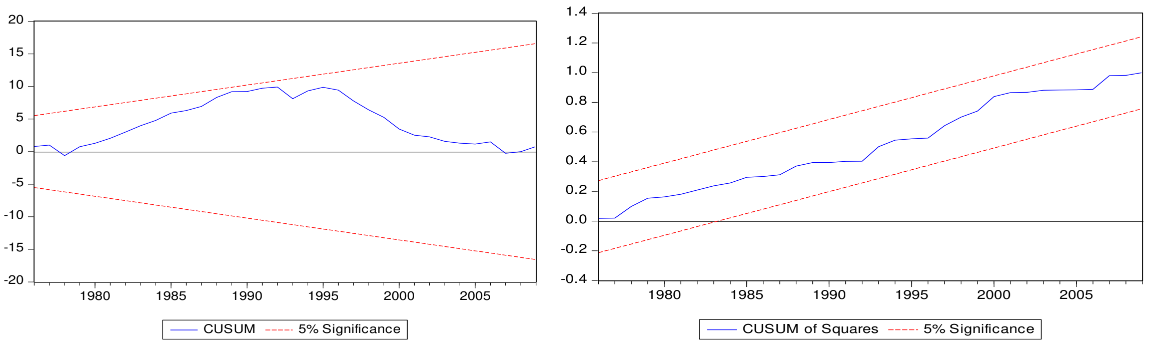
ln WPU_t			0.134001	2.243332**
Δ ln WPU_t	0.141027	3.210788***		
NRA_t	0.018665	0.500459	-0.028655	-0.429275
ln $(WPR/RPPR)_t$			-0.097566	-1.147212
Δ ln $(WPR/RPPR)_t$	-0.037940	-0.639126		
ln $(WPCORN/RPPM)_t$			-0.146334	-1.267346
Δ ln $(WPCORN/RPPM)_t$	-0.227938	-3.014933***		
RESIDUAL (-1)	-0.759117	-4.634475***		
Adj. R^2	0.646000		0.890708	
F-statistic	7.801734		39.93783	
Prob. (F-statistic)	0.000004		0.000000	
Log likelihood	65.26560		53.17374	
Durbin Watson	2.192836		1.927645	
Akaike info criterion	-2.536457		-1.962443	
Schwarz criterion	-2.039980		-1.556945	
Hannan-Quinn criter.	-2.354479		-1.812065	
Mean dependent var	0.005392		5.977222	
S.E of regression	0.060528		0.082207	

Table 4.0 Diagnostic tests

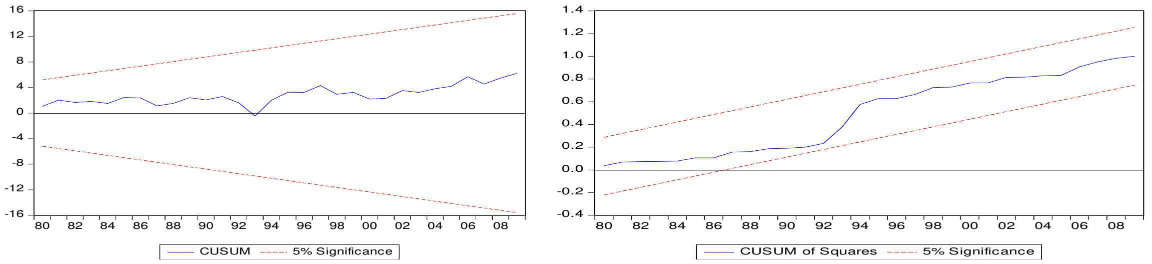
		Short-run estimates	Long-run estimates
Jarque-Bera		1.270283 (0.529860)	0.825828 (0.661719)
B-G LM	(1)	1.563419 (0.2212)	0.011428 (0.9155)
	(2)	1.361128 (0.2728)	0.289344 (0.7507)
Q-stat	(1)	0.5253 (0.469)	0.0122 (0.912)
	(2)	1.6990 (0.428)	0.6732 (0.714)
ARCH Test (1)		0.196682 (0.6599)	0.114590 (0.7367)
Reset test		1.786366 (0.1918)	2.182009 (0.1491)

Figure 6.0 CUSUM and CUSUM of Squares tests

Long-run



Short-run



In interpreting the results, the responses of rice farmers to local and international own-price incentives are found to be insignificant in both the long- and short-run. Farmers however are observed to respond significantly to changes in the local and international prices of maize. The insignificant response of farmers to own price incentives is attributed to local challenges in the rice markets including inefficiency in collection, processing and marketing of paddy, lack of confirmed and regular buyers (MoA, 2012), high cost of collection and transport which creates surtax on the producer price (adversely affecting the profit share of local farmers), non-remunerative prices for producers or the absence of a guarantee mechanism for incentive prices and the failure of most buyers to observe contract terms. This could as well be attributed to the un-organized nature of the stakeholders and their limited participation in development of the supply chain. The significant negative (-0.211) coefficient of the real producer price of maize in the long-run, is attributed to reallocation of resources from rice production into maize production in pursuit of making higher returns due to the relatively structured nature and better transmission of prices on the maize market. In the short run, unit increases in the real producer price of maize and the price ratio for maize lead to decreases of 0.214% and 0.228% respectively in harvested area of rice. The coefficient for the former is significant at the 5% level with that for the latter being significant at the 1% level.

Yield of rice is found to have a significant inverse relationship with acreage cultivated of rice. A unit increase in yield of rice leads to decreases of 0.860% and 0.574% in area harvested respectively in the long-run and short-run. Both effects are significant at the 1% level. Although this reflect influences from consolidation and efficient production with decreasing area of harvest and increase in the use of improved varieties, this observation is not appropriate and needs addressing if the country is to meet the anticipated deficit in future supply. Output of rice is observed to stagnate in-between the years 1988 and 2009 because of this inverse association between yield and area harvested of rice. Improvements in supply could be achieved through development and implementation of policies that ensure harmonization in the two variables (harvested area and yield)

Labor availability had coeffecients of 1.708 and 2.004 respectively in the long- and short-run, implying that, a unit increase in available farm hands leads to a 1.708% increase in area harvested of rice in the long run and 2.004% in the short-run. Each of these effects are significant at the 1% level. This reflects the importance of labor to cultivation of rice in Côte d'Ivoire and affirms the labor intensive nature of rice production in the country. These elastic responses indicate that shortage in labor (mostly as a result of migration from rural areas due to political instability and chaos in the country) is a major course of the dramatic decline in area cultivated of rice in the country. Measures to reduce such shortages could do more to enhance the production of rice in the country than adjustments in producer price of rice.

A unit increase in exchange rate, as a reflection of depreciation in the currency, leads to a 0.258% decrease in area harvested of rice in the long-run and this decrease was significant at the 1% level. Depreciation of the currency although stimulates exports, it leads to an increase in the cost of production by virtue of the adverse effect it has on the prices of imported inputs which are vital to rice production like fertilizer, pesticides and herbicides among others. It indirectly leads to a diversion of land from rice production towards the production of export commodities, thereby increasing the cost of land for rice production. Measure to improve supply of rice should as well look into this adverse fiscal effect from depreciation of the currency. Mixed significant signals were observed in the coefficients for price of urea fertilizer. This could be due to the limited usage of fertilizer in the rain-fed ecology which accounts for about 93% of the total rice area and to the likely difference between the world and local price of urea by virtue of local government subsidy on fertilizer. State intervention, through nominal rate of assistance is observed to have insignifican effect on acreage cultivated in both the long-run and short-run. The coeffecient of lagged harvested area 0.301 is significant at the 5% level, implying that area harvested of rice in the previous year and expertize of farmers do play a significant role in decision making on the total area harvested in the short-run.

A total of about 89.07% and 64.60% respectively for the long-run and short-run in the variations observed in acreage cultivated of rice in Côte d'Ivore are explained by movements in the variables of the acreage response function. A total of about 75.91% of deviations from the long-run equilibrium are restored in the current period and this restoration is significant at the 1% level. The overall effect of the variables in both the long-run and short-run as reflected by the F-statistic is highly significant.

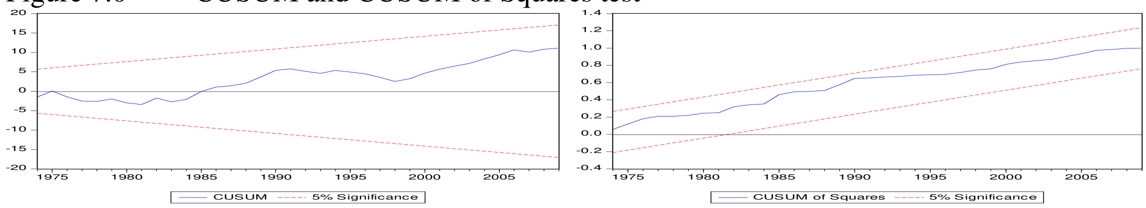
3.2 OUTPUT RESPONSE

Diagnostic tests of normality, serial correction, heteroskedasticity, structural stability and equation misspecification were applied in estimation of the output response of rice. The specified equation passed all the test, implying that, the residual series for the estimates is normality distributed, free from serial correlation and is homoskedastic. The insignificant value of the Reset test and ability of the estimates to remain within the 5% critical boundary for the CUSUM and CUSUM of Squares tests affirms appropriate specification of the regression equation and stability of the estimates
Output of rice is observed to be driven significantly and positively by area harvested of rice, availability of labour and nominal rate of assistance. A unit increase in lagged area harvested of rice leads to a 0.340% increase in output, and this was significant at the 5% level. An increase in the number of farm hards (reflected by availability of labour) leads to a 0.875% increase in output of rice, with increases in government support leading to a significant 0.112% increase in output. Increases yield and own-price of rice are found to have insignificant effects on output. This once again confirms that meeting the decifit in future supply will require increases in area harvested of rice and a reduction in labour shortages. Although nominal rate of assistance was found to have insignificant effect on acreage cultivated of rice, its effect on the final output is significant at the 5% level. Measures to boost production should therefore place much emphasis on increasing area cultivated of rice, reducing labor shortages in the country and increasing government support to local farmers.

Table 5.0 Estimates of output response of rice

Variables	Coefficients	Std. Error	t-Statistic
Intercept	-3.000004	1.676628	-1.789308*
$\ln HA_{t-1}$	0.340213	0.145626	2.336211**
$\ln Y_{t-1}$	0.165059	0.165917	0.994831
$\ln RPR_{t-1}$	0.032459	0.058521	0.554650
$\ln AL_{t-1}$	0.874518	0.229128	3.816726***
NRA_{t-2}	0.111974	0.055127	2.031198**
Adj. R^2	0.875696	Mean dependent var	6.282231
Durbin Watson stat	1.814776	S.D. dependent var	0.261584
Log likelihood	43.74932	S.E. of regression	0.092226
F-statistic	58.76748	Akaike info criterion	-1.797587
Prob(F-statistic)	0.000000	Schwarz criterion	-1.549348
Jarque-Bera	3.419162 (0.180942)	Hannan-Quinn criter.	-1.706597
B-G LM (1)	0.541068 (0.4669)	Q-stat (1)	0.1715(0.679)
B-G LM (2)	0.272000 (0.7635)	Q-stat (2)	0.1765(0.916)
Reset test :	0.212730(0.6475)	ADF-test of residual	-6.054265***
ARCH test (1):	1.358100(0.2509)		

Figure 7.0 CUSUM and CUSUM of Squares test



4.0 CONCLUSIONS AND RECOMMENDATIONS

Characterized by weak local rice productivity, inefficient marketing and processing of paddy among other constraints, the local rice sector in Côte d'Ivoire has failed to meet domestic rice consumption needs. In the absence of comprehensive action, the country is anticipated to face a deficit of 1,731,583 Mt in supply of rice by the year 2020, which could consequently result in huge drainage of foreign exchange through imports. To inform future policy decisions on rice towards mitigation of the adverse effects such occurrence may have on producers, consumers and the country as a whole, this study analyzed the acreage and output responses of rice in Côte d'Ivoire.

Findings from the study show that rice farmers in the country respond more to price incentives for maize than they do own-price incentives, as the coefficients for own-price were insignificant in both the acreage and output response functions (equations). Stagnation in output of rice in the country is attributed to the significant inverse association observed between yield and acreage cultivated of rice and the insignificant effect of yield on output. Increase in farm hands (captured by availability of labor) leads to significant increases in both the area cultivated of rice and output. Government support through nominal rate of assistance, although was found to have insignificant effect on area cultivated of rice, its positive effect on output was found to be significant at the 5% level. Depreciation in the currency is observed to have an adverse effect on the area cultivated of rice by virtue of its effect on cost of imported inputs and the diversion of land from the cultivation of food crops like rice and maize to the production of export crops. Mixed signals were observed for the effect of price of urea on area cultivated of rice in both the long and short-run. This is attributed to the limited usage of fertilizer in the rain-fed ecology which accounts for about 93% of total area cultivated, and to a possible wedge between the world price and local price of fertilizer resulting from government subsidy on the input.
Based on these findings, it is believed that Côte d'Ivoire could improve on its rice supply and effectively meet the anticipated deficit by putting in place measures to increase land area under cultivation, reduce labor shortages, ensure a harmonization between yield and acreage cultivated of rice, ensure government's continuous support to the sector, address the adverse fiscal effects of the exchange rate system and promote stakeholder participation in the development of the rice supply chain as well as address collection, processing and marketing challenges in the local rice industry.

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