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ASSESSING THE STATE OF THE RICE MILLING SECTOR IN NIGERIA: THE ROLE OF POLICY FOR GROWTH AND MODERNIZATION

By

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Food Security Policy *Research Papers*

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ABSTRACT
We use an industry profit maximization model to conduct an ex-post impact assessment on the extent the rice milling sector in Nigeria has grown and improved its performance in producing high quality premium rice following major public sector interventions made under the Agricultural Transformation Agenda. Given challenges with the availability and quality of data, this assessment looks at the changes between two periods, 2009 and 2013, and simulates the performance of the sector under different technology capacities and policy scenarios. We find that the government has been successful in expanding quality paddy production and milling capacity in the country along with an increase in capacity utilization in the medium and large-scale milling sub-sectors. As a result, the production of premium quality rice has increased by approximately 0.5 million metric tons between the two periods. Despite these gains, the industry did not see any overall increase in employment in the medium and large-scale sub-sectors. Further focus by the government on expanding the supply of high quality rice paddy, while maintaining high tariffs to keep the medium and large scale milling sector viable, may provide the best opportunity for Nigeria to reach its goal of self-sufficiency in rice production.

Keywords: Nigeria, rice, rice processing, rice production, agricultural policies, imports

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1. INTRODUCTION

Since the 1970s, the Federal Government of Nigeria (FGN) has recognized agriculture as central to the food security of the country. Rice, in particular, has been a key focal commodity, as consumption is estimated to be rising at 5.1 percent annually and is expected to reach 36 million metric tons (mt) by 2050 (FMARD 2011). Consumption has already outpaced domestic production and as a result, Nigeria is the leading importer of rice in the world today, with an 8.2 percent share of imports in the global market (Gyimah-Brempong et al. 2016). As oil accounts for 70 percent of the government's revenue, a strategy to diversify the economy into agriculture has been implemented by recent administrations to reduce the strain on the country's foreign currency reserves due to the economic risks associated with volatile global oil prices.

The negative effects of these risks on the Nigerian economy are evident in the recent global slump in oil prices that started in mid-2014. The decline in revenues from oil exports along with the country's heavy dependence on imports, decreased Nigeria's foreign reserves by 17.4 percent in 2015 (CBN 2015). In response, the government implemented various currency and price control policies, such as restricting access to foreign exchange for the import of goods that are produced domestically, in order to stem the flow of foreign currency out of the country. These policies were intended to give a boost to domestic production to displace imports. However, in the short-run they have resulted in price inflation, with the cost of food increasing by approximately 10 percent in 2015 (CBN 2015).

Under the current Buhari administration, the Federal Ministry of Agriculture and Rural Development (FMARD) has developed the Agriculture Promotion Policy (APP) to increase production to meet domestic consumption and to raise quality standards to promote exports with the overall goal of increasing the amount of foreign reserves flowing into the country through the agriculture sector. This strategy builds off the Agricultural Transformation Agenda (ATA) of the previous Jonathan administration, adopting a private-sector led approach with the government prioritizing crops that are domestically consumed or have a high potential for export. Rice has been designated as priority crop by APP and sets a strategy to increase rice production through improvements in yield by increasing farmers' access to seed of improved varieties and to other inputs.

APP seeks to reach rice self-sufficiency in 2018 by increasing annual domestic production of rice by 4 million metric tons to meet an estimated 6.3 million mt of demand. FMARD (2016) estimates suggest that ATA produced an additional 1.2 million to 1.5 million mt of milled rice. FMARD (2011) estimated that domestic production was approximately 3 million mt when ATA began. This would mean that total domestic production of rice should be between 4.2 and 4.7 million mt. However, the APP estimates that the current supply of milled rice is at 2.3 million mt. Addressing these data discrepancies so that clear estimates of the current state of industry can be made is important to the rice policy making process in Nigeria.

In November 2016, FMARD announced a plan to facilitate the procurement of 40 new large integrated rice mills. This plan would almost triple the current number of such mills that are operational in the country. Johnson and Ajibola (2016) found that the large integrated rice milling sub-sector had the most potential to compete with imports, but often has operated well below maximum capacity due to insufficient access to high-quality paddy. Johnson (2016) went further and demonstrated the dependence of the large-scale sector on import tariffs to stay operational and the im-portance of access to imported brown rice to mitigate risks of insufficient supply and price fluctuations. While an expansion of the capacity to mill premium quality rice is necessary to reach self-sufficiency, this expansion may undermine government's efforts to increase foreign reserves, since large-scale millers will seek to import brown rice to meet their capacity needs. As a result, a clearer situation analysis of rice production and the rice milling sector in Nigeria is needed.

The overall objective of this paper is to assess the extent to which the rice milling sector in Nigeria has grown and improved its performance in increasing the output of higher quality premium rice to displace imports following recent public sector interventions. A key goal of this research is to determine whether the policy of promoting growth through the establishment of large-scale integrated mills, combined with improvements in seed and fertilizer adoption, has resulted in increased output of high quality rice. In addition, the research examines whether the sector as a whole has benefited from these changes with regard to output and employment.

Given the challenges related to the availability and quality of data in Nigeria, this assessment utilizes a rice milling model described in more detail in Johnson (2016) as an ex-post impact assessment tool that makes use of the limited data available between 2009 and 2013. The results of this assessment provide important insights on the extent to which past investments and policies may be having a positive impact, and from this, inform future strategies to promote growth in Nigeria's rice sector.

This paper is organized as follows: Section 2 provides a brief overview of the Nigerian rice milling sector; Section 3 discusses some of the data issues that exist among various sources of information; Section 4 provides a rationale and explanation of the rice milling model; Section 5 provides the results of the model in assessing production, milling capacities, and industry growth; Section 6 simulates production, milling capacities, and industry growth out-comes under different policy scenarios; and Section 7 provides summary conclusions and policy recommendations.

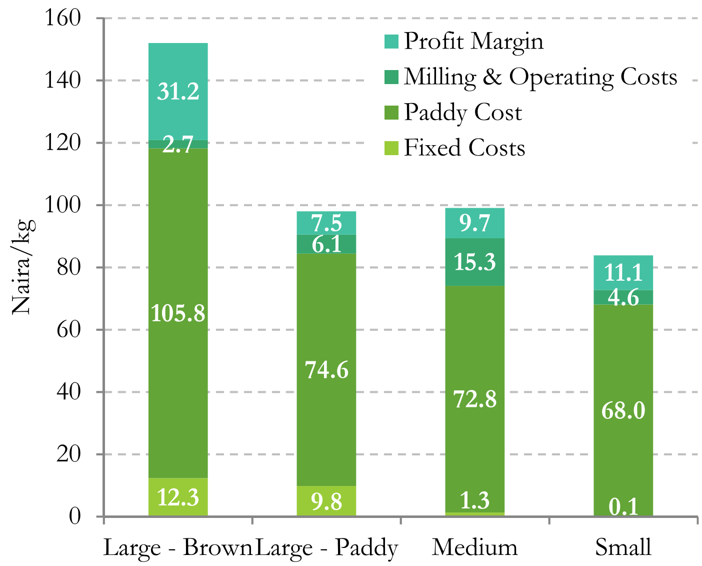
2. BRIEF OVERVIEW OF THE RICE MILLING INDUSTRY IN NIGERIA

Rice milling in Nigeria has become a significant agro-processing sector, employing thousands of traders, millers, and parboilers as demand for rice has grown over the years. The sector was largely a "cottage industry" in the early-2000s, consisting primarily of small-and-medium-scale operations (Lançon et al. 2003a). Additionally, there were three government-owned large-scale industrial mills—Badeggi, Uzo-Uwani, and Agbede—that often were not operational due to poor maintenance and a lack of spare parts (Ezedinma 2005). Under ATA, which started in 2011, the FGN made large investments to build national capacity for rice production, processing, and marketing. These investments, along with concessions from government, attracted private investors into the rice sector. As a result, Nigeria had 24 operational large-scale mills by 2014.

Despite these investments, performance of the rice value chain has been shown to be less competitive than other major international rice producers, such as those in Asia. Johnson and Ajibola (2016) found the average paddy production costs, including rice milling and marketing costs, in Nigeria to be much higher than those in Thailand. The higher milling costs in Nigeria were primarily due to the high costs of procuring paddy which involve high search costs and a price premium for the scarce superior paddy varieties sought by large mill operators. Trade and marketing costs also are high because of the distance to urban markets throughout the country.

The modern rice milling sector in Nigeria, as the primary competitor with imports, cannot compete without protective tariffs at the border. The preference for higher quality imported rice among Nigerian consumers means that, even in the presence of tariffs, imports will not be prevented completely. Consequently, imported rice often fetches a higher premium price relative to domestic rice – about 25 percent higher according to estimates (Johnson and Ajibola 2016). The higher premium can be viewed as an amount domestic producers could potentially absorb as additional costs in processing more competitive higher quality rice.

Figure 1. Milling production costs and profit margins by type of rice miller, 2012



Source: Based on fields visits and interviews undertake in 2012 and subsequently used in the Rice Milling Model described more fully in Johnson (2016).

The poor performance of the entire Nigerian rice value chain relative to that of Asian countries leaves significant room for improvement. The share of the final retail cost of rice made up by the costs of paddy traders or millers tends to be small – as depicted in Figure 1 above. Only brown rice milling by large mills appears to be profitable, but whether it is so will depend on the global price and the tariff paid for importing it. Given the dominant share of the cost of domestic paddy in the final price of milled rice, simply raising the productivity of paddy production, thereby lowering its price, can have a significant effect on the competitiveness of domestically produced milled rice.

Small-Scale Milling Operations

Small-scale milling operators serve a large number of people, including smallholder paddy farmers, rural traders, wholesalers, retailers, and final consumers and supply almost 70 percent of the domestic rice consumed in Nigeria. Small-scale millers make up the most significant sub-sector of the domestic rice milling industry in Nigeria. Mostly a cottage industry, the small milling sector has a highly disaggregated and fragmented supply chain, with rice sometimes changing hands several times between the farm and the final consumer. Actors in the supply chain have varied skills and degrees of access to technologies, services, and information, and rarely upgrade to better paddy varieties and processing technologies. Because of this, the quality of the milled rice varies widely. The final milled rice is often discolored, with broken grains, and contains unwanted foreign debris, especially small stones. As a result, consumers often view this rice as inferior to and even non-substitutable with the higher quality premium rice obtained from modern mills or importers.

The principal challenge for the small-scale rice milling sub-sector in Nigeria is the numerous obstacles such millers face for improving productivity and product quality. As a cottage industry, one large challenge is the necessity to deal with many producers, traders, and processors who have variable skills and access to technologies and credit, and who interact only at the point of sale or for servicing. As a fragmented processing and marketing system, small rice millers have limited abilities or incentives to upgrade to better technologies or market and brand their product, especially in the downstream part of the value chain. While they may wish to invest in modern equipment, many of the smaller scale operators have poor access to credit to afford such investments. Additionally, the existing marketing system has no consistent grades and standards, exhibits poor record keeping, and has poor organizational capacities. Lastly, small-scale millers lack incentives to improve the quality of their product. As a result, they mill paddy for a fee, leaving the decision on the quality of rice milled up to the trader or consumer to whom they are providing the milling service.

Large-Scale Milling Operations

The large industrial rice milling sub-sector enjoys the advantage of having higher milling capacity and modern technologies for supplying premium-grade rice and thus has greater potential to compete with imports. However, the sub-sector is usually unable to take full advantage of its greater economies of scale as it is often forced to operate well below maximum capacity due to insufficient access to quality paddy. This is a major challenge as much of the paddy in Nigeria is produced by smallholder farmers. As the dominant supplier of paddy, the smallholder rice farming sector in Nigeria varies widely with regard to paddy yield achieved, the varieties of rice grown, the type of production system and inputs used, and distance to major rice processing centers and markets.

This heterogeneous rice farming section introduces a major logistical challenge for large-scale millers in procuring the right quality and quantity of paddy in a timely and well-coordinated fashion. Large millers resort to traveling great distances or establishing outgrower systems to procure sufficient quantities of quality paddy. However, these tactics do not always guarantee a sufficient supply. Many have found it too costly to stay in business due to the higher per-unit operating costs that result from their inability to utilize the full capacity of their mills and the added search and administrative costs they face in securing sufficient paddy as input to their mills. Some large-scale millers have chosen to start growing their own paddy on large-scale irrigated lands to try and circumvent these problems, but it is too early to tell whether such an approach to surmounting their supply problems will prove successful. In addition to their challenges in sourcing paddy, large scale operators also face periodic breakdown in utility services, such as electricity and water, and problems in finding replacement machinery parts, which have to be imported from the mill manufacturers overseas.

Given these challenges, the FGN has used tariffs on imported rice as a tool to attract private sector investment in rice milling. In 2005, under the Presidential Initiative on Increased Rice Production and Export, the Obasanjo administration was able to attract two multi-national companies, Olam and Veetee, to create two large-scale integrated rice mills by providing them with a special license that allowed them to import brown rice at a preferential tariff of 50 percent (rather than 100 percent). In return, Olam and Veetee would invest in the construction of large-scale integrated mills and in contract farming schemes to supply their mills with paddy.

A similar arrangement was made under ATA to attract private sector investment. Investors were asked by the FGN to provide a Domestic Rice Production Plan (DRPP) to show evidence of an existing or planned (within a three-year period) investment in domestic rice production. The DRPP required that the investment include a large-scale integrated rice milling facility, which included a parboiler and dehullers, and a plan to setup outgrower schemes and paddy aggregation centers to source local paddy. In return, FGN would allocate a specific import quota to investors that would allow them to import rice at a preferential tariff of 30 percent. Non-investors (rice traders) would also be allowed to import rice up to a specific quota, but at the regular 70 percent tariff. The quota was determined annually based on the supply gap between domestic production and consumption. Seventy percent of the quota would be allocated to investors, while 30 percent would be allocated to rice traders. In 2014, the quota was set at 1.5 million mt, with 26 investors receiving quotas up to 1 million mt at the preferential tariff rate.

The investments in parboilers and dehullers ensured that rice was milled for the domestic market and able to compete domestically with milled imports. Almost all the rice produced in Nigeria is parboiled before it is milled because consumer prefer its taste and texture when preparing local dishes. This is why Nigerian consumers have a preference for imported Thai parboiled rice among rice imports (Ogunbiyi 2011). Lançon et al. (2003b) found that Nigerian consumers will choose imported rice over domestically produced rice primarily due to cleanliness, i.e., absence of foreign matter, but will choose domestically produced rice over imported rice based on taste and price. This demonstrates an opportunity for large-scale millers to compete against imports on quality and consumer preference, if they are able to lower the price.

Nevertheless, the milling of local paddy remains inadequate. As such, most large-scale millers are forced to import paddy and brown rice during off seasons or when local paddy is scarce to ensure that they can maintain their milling operations throughout the year. In addition, most of these large-scale operators import milled rice to guard against uncertainties related to global price volatility (Johnson and Abijola 2016). An unstable policy environment adds to the risks associated with declining domestic rice prices, particularly if the government should choose to lower the rice import tariff. Therefore, while the large milling sector has potential to compete with imports on quality, it may not be able to do so on price.

It is important to note that in both of the cases of government working with investors in the rice sector, there was a policy reversal by the FGN within a couple years of attracting the investments. In the case of Olam and Veetee, the FGN revoked the special license each received two years after both companies made investments in Nigeria. In the case of the DRPP investors, the preferential tariff was discontinued the following year. This followed evidence of lack of transparency in the selection process for investors' receiving rice import quotas and allegations by the FGN that certain DRPP investors had imported more rice than they were allocated or had sold their allocation to rice traders. These policy reversals resulted in the large-scale mills having difficulties sourcing sufficient paddy to meet their mills' capacity. These policy reversals are relevant, as Asiedu (2002) found that in Africa the promise of high returns may not be enough to induce investment in an environment where the risk of a policy reversal exists due to the irreversibility of those investments.

Medium-Scale Milling Operations and Industrial Clusters

Between the large and small scale operators are two types of millers: medium-scale modern mill operators, who process up to 10,000 mt per year, and industrial clusters of small scale millers, who together process between 3,000 and 10,000 mt per year. Areas with high volumes of paddy production usually have large clusters of mills nearby. Relative to small millers found in villages or rural markets, these clusters tend to be more organized in procuring, milling, and selling their rice. Some notable examples are the clusters found in Lafia, Otukpo and Abakaliki, usually with eight or more millers (in the past, Abakaliki had as many as 100 millers). Capacity utilization is usually highest during the months of October through December after the rainfed rice harvest. Throughout the rest of the year, paddy is procured from further afield.

The main differences between the clusters and other small scale operators is that they not only handle larger volumes in the same location, but often serve the dual role of miller and trader—that is, they will buy their own paddy to mill and sell. As miller-traders, they have the advantage of being more selective in the paddy variety they wish to mill, even handling the parboiling task before milling, and, in the process, ensuring a better-quality product. There is also more vertical market integration, implying stronger links in the supply chain. The result of these vertical links creates a certain standard of quality and, therefore, the prevalence of branding among these clusters is higher. Brands, such as Abakaliki rice, provide the consumer with a guarantee of a certain quality product and can carry an extra premium.

Based on field visits by the authors to two such milling clusters in Benue and Kano states, cluster members appear to benefit from both economies of scale and location. The cluster not only enables shared access to infrastructure, technologies, and best practices, but offers lower costs for accessing paddy among suppliers who prefer to deal in bulk. This is also the case for access to rice traders who by their milled rice. These traders often are willing to travel long distances to the cluster, given the cluster's reputation for quality, price, and timely delivery. These linkages between the cluster and traders seems also to attract additional medium scale operators to set up their mills nearby. Aside from the proximity to input and output markets, the clusters also provide members with the opportunity to sub-contract further processing of their rice as an additional service if the technology to do so exists in the cluster. This can be of particular value to small scale operators who are unable to afford to obtain these specialized processing technologies on their own.

The small- to medium-scale milling sub-sectors have remained quite vibrant in their ability to procure, process, and market the bulk of the paddy being produced by thousands of smallholder farmers scattered all over Nigeria. Although still very much cottage industries, the sub-sectors are the largest employers within the Nigerian rice industry. Therefore, any increases in productivity, output, and product quality in Nigeria's rice sector has the potential to have large and broad effects on overall rural employment and welfare. The sector not only employs many processors and traders, including women, but also provides a cheaper rice alternative for millions of poor consumers in the country.

3. THE RICE MILLING MODEL

Given the difficulties with accessing sufficient information and data on the rice milling sector in Nigeria to conduct an empirical assessment of prospects for its performance, we chose to use an economic model

previously developed to assess the performance of Nigeria's rice sector, drawing on its primary data and parameters collected for this purpose. The original model was calibrated for 2009. We recalibrated the model for 2013 to allow comparisons be made with results from the 2009 version of the model. There were several advantages in taking this approach. First, poor data availability makes a simulation type approach more desirable in estimating other unknown yet important parameters. Second, the use of the model helps maintain theoretical consistency in assumptions and the underlying economic relationships. Finally, the model is able to provide measurable estimates of the viability and implications for raising the quality of milled rice and employment in the milling industry, especially when comparing across various types of milling technologies.
The Rice Milling Model (RMM), described in detail in Johnson (2016), was developed using mathematical programming techniques to reflect as much as possible the underlying economic structure of the rice milling industry in Nigeria. The model builds on the literature of industrial location, industrial clusters, and industrial organization theories that generally analyze the optimal scale, numbers, and locations of processing plants, given a spatial distribution of access to raw input sources, transportation and input costs, and output markets. The application of these industrial location and organization concepts to agriculture is especially suitable because of the spatial nature of agriculture as a supplier of raw and perishable inputs to agro-industries, yet the concepts are rarely applied (exceptions include Brown, Florax, and McNamara 2009; Lucas and Chhajed 2004). This is despite a growing interest in the analysis of supply chains and industrial clustering. As large multi-national firms become more dependent on multiple resource and input suppliers in production processes, the optimization of the complete supply chain becomes critical in maximizing a firm's profits. Optimizing the supply chain involves choosing the number, location, capacity, and types of industrial plants or warehouses; from whom and in what quantity to buy raw inputs; the type and volume of products to produce and which markets to target; and what quantities to hold in inventory. The agglomeration effect is also important in explaining industrial clustering – for instance, lowering the cost of producing or marketing a product in a particular location due to economies of scale (McCann and Sheppard 2003; Jones and Woods 2002). In Nigeria, this is particularly relevant in explaining the appearance of rice milling clusters of small and medium-scale operators in many parts of the country.

For our purposes, we use the RMM as an industry profit maximization model, as in Durham and Sexton (1996). This enables us to assess the profitability of the current scale mix and efficiencies across the different milling sectors in order to empirically estimate the entire industry's ability to increase the output of quality milled rice and employment in the sector. Accessing sufficient quantities of a higher quality (or premium) paddy variety becomes critical in this regard. While the largest cost share of milled rice is paddy, the price of which is affected by transport costs from the farm to the mill, transport costs to product markets are expected to be just as large, since destinations are typically not the same as the paddy source. Other costs include rice marketing or trader costs, which can be quite high in Nigeria (Johnson and Ajibola 2016).

The model is calibrated to represent three industry scales for milling rice in Nigeria and under conditions in both assessment years with respect to their maximum milling capacities, technologies available and in use (e.g. high quality rice paddy seed varieties), paddy production, prices, and costs. For example, both transport and marketing costs are explicitly included in the model. Basically, the model determines the profitability of the various types of mills by location subject to supply, capacity, and storage constraints, exogenous market prices, production technology, resource costs, and transportation and marketing costs.

The model calculates the optimal production output of the industry across different scales of milling operations based on current scale technologies, two differentiated paddy rice varieties (common and superior quality) and corresponding types of milled rice (standard and premium quality), and two production seasons. Superior paddy varieties refer to the most preferred rice seed for milling premium quality rice among medium and large scale millers, such as FARO 44. Common paddy varieties, on the other hand, refer to both traditional and other older improved rice varieties that are considered inferior for milling and branding purposes and, thus, are used to produce only standard quality rice. The model assumes that these standard rice varieties are only milled by the small milling sector. While the geographic unit of analysis is at the state level, the results are presented at the geopolitical zone level for brevity.

The model is calibrated for both 2009 and 2013 in terms of quantities produced and given the current levels of input and output prices, operating costs, transportation costs and milling capacities in each state. Prices are assumed to be exogenous to the model, while the quantities of paddy and rice milled are treated as the decision variables. As the most likely competitor with imports, the price of milled premium rice is explicitly linked to the world price, the rice import tariff, and any inland transportation and marketing costs. The price of premium rice produced by the medium-scale sector (which is inclusive of milling clusters) is assumed to lie halfway between the large-and-small-scale miller prices. This assumption reflects the fact that medium-scale operators, including small-scale milling industrial clusters, produce better quality rice than the bulk of small-scale millers but lower quality than the large-scale industrial millers.

Although local paddy can be purchased from any state subject to transportation and marketing costs, this is limited to the superior variety of paddy rice preferred by both medium and large-scale operators. The superior paddy is also assumed to capture a price premium over more common varieties. The small-scale milling sector, on the other hand, is assumed to only purchase paddy within their respective state and with no restriction on the variety milled. This is referred to as standard rice in the model, because the final product is inferior. Finally, to account for any changes in output, as prices are made to adjust to tariff or world price changes, inverse supply functions of both paddy varieties are introduced into the model to allow them to adjust accordingly.

4. DATA

All the data and underlying assumptions are based on various secondary sources and the author's own field work. Among the secondary data sources, production data was taken from the National Agricultural Extension and Research Liaison Services (NAERLS 2010) for the 2009 production season, while the prices used were annual averages from the National Bureau of Statistics (NBS) for the same year (for paddy, local, and imported rice). For 2013, both production figures from the NAERLS and NBS were compared and ultimately adjusted more closely to the NBS figures. Estimates from the USDA Foreign Agricultural Services were also used to come up with an average national level of rice production consistent with import and consumption figures. Other secondary data sources included a stock taking exercise of rice mills in Nigeria by Chemonics and Africa Rice (2015), which was further corroborated with other sources from the media and primary data from the authors' field visits.

Table 1 Nigeria paddy rice production, 2007-2015, million mt

	Data Source					
Year	**NBS/FMARD**	**USDA**	**NAERLS**	**NBS**	**FAOSTAT**	**RMM Model***
2007	3.64	3.29	3.28	3.28	3.19	-
2008	3.43	4.31	3.59	3.57	4.18	-
2009	3.56	3.66	3.93	3.37	3.55	3.78
2010	4.65	4.62	4.54	3.54	4.47	-
2011	4.61	4.72	4.57	-	4.61	-
2012	5.43	3.89	5.44	-	5.43	-
2013	-	4.54	5.82	-	4.82	5.21
2014	-	4.65	-	-	6.73	-
2015	-	4.44	-	-	-	-
Annual growth 2009 to 2013, %	13.4	2.6	10.2	-	8.4	8.4

Source: Various noted in the column headings. *Final national totals used in the GAMS model for the two periods, 2009 (calibrated model in Johnson et al. 2016) and for 2013 (updated values in the 2009 period GAMS model).

Inconsistencies in the amount of paddy production, for example, are quite evident in Table 1, but more so in recent years. To reconcile some of these inconsistencies in national paddy production, a review of articles published between 2011 and 2014 by both the local Nigerian media and international sources, along with official government documents where available, was conducted to get a better understanding of the FGN's story on rice paddy production. As there are a number issues with the accuracy of reporting in the Nigerian media (Adeyemi 2013), this review focused specifically on interviews and quotations from speeches of former Federal Minister of Agriculture and Rural Development Adesina. Multiple sources reporting the same figures were required before any production figures were included. Multiple sources were also used to contextualize the information being reported as best as possible.

ATA sought to increase rice paddy production by an additional 3.2 million mt by 2015 in order to reach national self-sufficiency. The ATA Blueprint stated that domestic milled rice production at the start of the initiative was approximately 3 million mt (FMARD 2011), which is an estimated 4.6 million mt using a 0.65 paddy-to-milled rice conversion used by FMARD[1]. In various speeches and interviews, Minister Adesina claimed that rice paddy production increased by 1.4 million mt in 2012 and by 2.94 million mt in 2013 (Babatunde 2014; Kramer 2014; Leadership 2014). Based on these figures rice paddy production would be an estimated 6.0 million mt in 2012 and 7.64 million mt in 2013. This would mean that Nigeria was 92 percent of the way to their 3.2 million metric ton goal of national rice self-sufficiency by the end of 2013.

These figures seem to be further corroborated by import figures reported in COMTRADE that shows only 0.3 million mt of semi-milled or wholly milled rice being exported from the rest of the world to Nigeria in 2013. Although, we know this import figure is not accurate as it was widely reported that large quantities of milled rice were being smuggled into the country from Benin in 2013 to evade the 110 percent tariff (Premium Times 2014a, 2014b; Udo 2014. Johnson and Dorosh (2015) look into this in more depth.) In addition,

[1] The 0.65 paddy-to-milled rice conversion factor was calculated by dividing the reported paddy production by the report milled rice equivalent reported by FMARD in Table A4 of the Annex.

FMARD allocated waivers for the import of 1.5 million mt of milled or brown rice in 2014 to meet the supply gap (Adekoya 2015; Okereocha 2015).

The 2013 ATA Score Card provides a similar story with local production of milled rice estimated to be 3.3 million mt at the start of ATA, or approximately 5 million mt of rice paddy equivalent. The 2013 ATA Score Card estimated an additional 1.4 million mt of local rice paddy production in 2012 and 2.95 million mt in 2013 (Annex Table A3). According to these figures, local rice paddy production would be estimated at 6.4 million mt (4.2 million mt of milled rice) in 2012 and 7.95 million mt (5.2 million mt of milled rice) in 2013, which would suggest that Nigeria should now be self-sufficient in rice production. In the same document, the key performance indicators (see Annex Table A4) seem to contradict these numbers, stating that domestic production is at 5.5 million mt of rice paddy (3.58 million mt of milled rice) in 2012 and 6.5 million mt of rice paddy (4.2 million mt of milled rice) in 2013. This would result in an increase in rice paddy production of 0.5 million mt in 2012 and 1.5 million mt in 2013.

One possible explanation for these inconsistencies in rice paddy production numbers may be due to the use of estimates as actual figures. In a presentation prepared by FMARD, it is stated that 267,591 farmers received seed and fertilizer for dry season farming under the Growth Enhancement Scheme (GES), and the estimated paddy production from this intervention was 1,070,364 mt, using an assumption of each beneficiary farmer producing 4.0 mt (Annex Figure A1). This same figure of 267,591 farmers can be seen in Annex Figure A1 as the number of hectares cultivated – each farmer cultivated one hectare of rice. The assumption was that the two bags of fertilizer and the improved seed distributed to each rice farmer under the GES would be enough to plant one hectare; although other studies (Propcom Mai-karfi 2016; Olomola 2015) have suggested that this was not the case. This estimate of approximately 1.1 million mt of rice paddy production in the 2012/13 dry season was then cited on numerous occasions as a major achievement of ATA (Adesina 2013a, 2013b, 2014; Ajayi 2014; Leadership 2014; Premium Times 2013; Udo 2014).

Under the new Buhari administration, APP told an entirely different story. APP estimated that the domestic supply of milled rice was 2.3 million mt in 2016, which would be the equivalent of approximately 3.5 million mt in rice paddy, using numerous non-government sources to determine that figure (FMARD 2016). APP also estimates that ATA increased production of rice paddy in the country by between 2.0 million and 2.5 million mt. This would mean that rice paddy production at the start of ATA would only have been between 1.0 million and 1.5 million mt or the equivalent of approximately 700,000 to 1.0 million mt of milled rice. While the increase in paddy production seems to be in line with claims from ATA, the APP's 2016 estimate of 3.5 million mt of rice paddy production figures is lower than the 4.5 million mt starting point in 2011 estimated by ATA, which seems unrealistic.

These two estimates are further complicated if you look at estimates from the National Bureau of Statistics (NBS) and the National Agricultural Research and Extension Liaison Services (NARELS), both of whom are also government entities. NBS and NAERLS seem to agree with the ATA figures that rice paddy production was approximately 4.6 million mt in 2011. NBS and NAERLS also appear to be in agreement that rice paddy production was around 5.4 million mt in 2012. This is a 0.6 million metric ton difference with the ATA figures.

NBS did not have data available beyond 2012, but NAERLS estimated that rice paddy production was at 5.8 million mt in 2013. This is a 1.8 million metric ton difference in comparison with the ATA figures and indicates an increase of 1.2 million mt of production between 2011 and 2013.

The inconsistencies in rice paddy production figures reported by various government entities demonstrates FGN's urgent need for much higher quality agricultural production data. As this data informs policymakers making decisions on the best ways that government can support the rice sector, it's important to have a clear understanding of what is the current state of the sector. Depending on the source of data, the government may determine different priorities or policies to which to allocate limited resources, which may or may not help the government accomplish its goals.

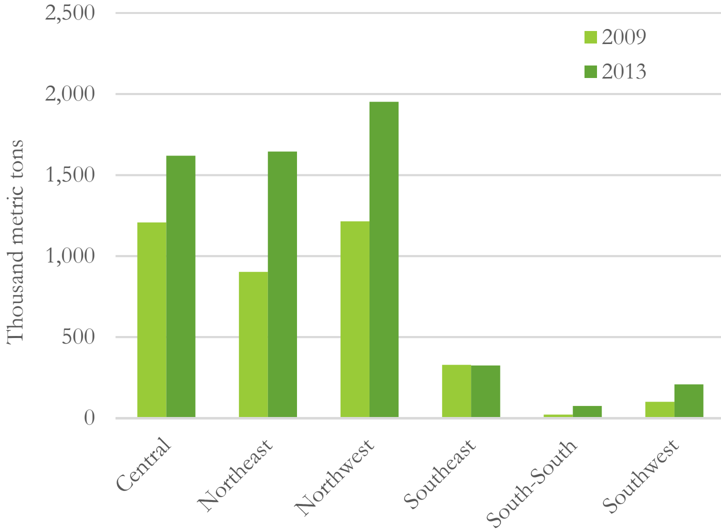
Due to uncertainties in the production data beyond 2013, we chose to use 2013 as our most recent period in this study. Production by state and zone was obtained from NAERLS, although adjusted to reflect national totals. Appendix Table A1 presents annual percentage growth rates of paddy production across the states based on this data. Figure 2 below summarizes the volumes by zone for each period. Clearly, there was a significant increase in paddy production between the two periods in the Northeast, Northwest, and Central zones of the country, which also happen to be the most conducive for rice growing.

Aside from the quantity of paddy produced, having good price data is also useful for the Nigeria RMM. Our primary sources of price data are both NBS and NAERLS, which collect monthly spot markets prices for key commodities, such as rice. Table 2 summarizes zonal average prices from 2009 to 2013. The NBS data reports much higher growth rates for prices than NAERLS, although this may be due to the unavailability of comparable NBS data prior to 2011.

As much as possible, model parameters were estimated based both on past data and on field observations by the authors. For example, estimation of both fixed and operational cost data relied heavily on data collected from field visits in 2013, including milling capacity and technologies, production costs (material, labor and other inputs), output, and prices. The model was calibrated to a baseline year of 2009 with a 30 percent tariff rate for rice imports and values adjusted for inflation. Although the data used came from various sources and relates to various years, every effort was made to update to either model year whenever possible using estimates in quantity growth rates and the Consumer Price Index (CPI) to capture inflation.[2]

[2] The CPI for Nigeria was taken from the World Bank's Development Indicators database (2016) and is estimated to have grown about 11.25 percent per year, or a 45 percent change between 2009 and 2013.

Figure 2 Total paddy rice production by zone, 2009 and 2013



Source: Authors calculations based on NAERLS data (2009 to 2013).

Table 2 Annual average prices for rice and paddy, by geopolitical zone, 2009 to 2013 (Naira/kg)

Zone	2009	2010	2011	2012	2013	Annual % Growth	% Change (2013/2009)
Local Milled Rice (NAERLS)							
Northeast	130.7	127.5	129.9	155.7	158.7	6.1	21.4
Northwest	125.2	118.5	135.6	142.6	159.4	6.9	27.3
Central	126.8	109.6	111.2	133.5	150.3	5.5	18.5
Southeast	111.0	105.6	113.2	137.5	137.5	7.2	23.9
South-South	120.1	108.4	112.1	129.6	152.6	6.8	27.1
Southwest	120.0	-	-	-	147.0	5.2	22.5
NATIONAL	122.3	113.9	120.4	139.8	147.6	6.0	20.7
Paddy rice							
Northeast	57.9	47.0	51.5	54.8	70.0	5.5	21.0
Northwest	45.1	43.4	47.7	52.6	58.6	7.4	29.9
Central	50.7	43.9	44.5	53.4	60.1	5.5	18.5
Southeast	45.5	41.9	45.6	57.1	56.2	7.6	23.4
South-South	50.0	43.3	44.8	51.9	61.0	5.9	22.0
Southwest	40.0	-	-	-	58.8	10.1	47.0
NATIONAL	47.7	40.6	48.3	54.8	61.6	8.5	29.2
Other NBS national statistics							
Rice, high quality	*174.7*	*162.7*	169.2	197.4	291.4	12.9	66.8
Rice agric.	*142.2*	*132.5*	138.7	167.1	230.3	12.7	61.9
Rice local	*122.3*	*113.9*	118.7	144.3	207.4	13.8	69.6

Source: Calculated from NAERLS and NBS data. Numbers in italics under the national NBS statistics are based on estimates by NAERLS for local rice – while for *high quality* and *agric. rice*, this is a factor of the local rice estimates (1.43 and 1.16, respectively) based on the general pattern between 2011 and 2013 in the NBS data.

5. ASSESSMENT OF PRODUCTION, MILLING CAPACITY, AND INDUSTRY GROWTH

Table 3 reports the base values of quantity of rice produced and milling capacities in the Nigeria Rice Milling Model for 2009 and 2013 based on the data available and parameters discussed in the previous section. Overall, much of the production of paddy in Nigeria occurs in the Central and Northwest geopolitical zones of the country. Both zones are endowed with land that is very conducive for rice production, especially in the lowland (irrigable *fadama* land) areas along the Niger and Benue rivers, as well as irrigated areas in the north. For the total milling capacity of larger mills, local estimates ranged between 0.8 and 1.2 million mt.

Table 3 Estimates of paddy production and maximum milling capacities by geopolitical zone, 2009 and 2013 (in 1,000 mt paddy equivalent weight per annum)

		Rice Milling Volume (with current capacities)					
		Large Mills					
Zone	Paddy Volume	Local Paddy	Brown rice*	Total	Medium Mills**	Small Mills (residual)
2009						
Northeast	896	0	0	0	21	875
Northwest	1,263	201	145	346	13	1,050
Central	1,166	43	129	173		1,101
Southeast	331	21	152	173	8	302
South-South	31	0	0	0	10	22
Southwest	88	0	234	234	4	84
Total	*3,775*	*264*	*660*	*925*	*75*	*3,435*
Share of total, %		*6.0*	*14.9*	*20.9*	*1.7*	*77.4*
2013						
Northeast	1,242	87	0	87	25	1,130
Northwest	1,858	480	116	596	54	1,324
Central	1,588	237	24	262	58	1,293
Southeast	362	138	46	183	15	209
South-South	45	0	0	0	11	34
Southwest	118	0	176	176	12	105
Total	*5,212*	*942*	*362*	*1,304*	*176*	*4,094*
Share of total, %		16.9	6.5	23.4	3.2	73.4
Changes, 2009 - 2013						
Annual growth, %	8.4	37.4	-13.9	9.0	23.6	4.5
Total change, %	33.6	149.5	-55.8	35.9	94.2	17.9

Source: Authors' calculations based on NAERLS data and others (see Table 1).
Notes. * The media sometimes reports brown rice as imported paddy. **Rough estimates based on stock taking and assumptions of some growth in Northwest, Northeast, Central and Southeast zones between 2009 and 2014. The maximum capacities by mill type was estimated using as much information as was available from a census of rice mills in Nigeria, including small rice milling clusters (see Annex Table A1 for full list).

Altogether, paddy production in Nigeria is estimated to have grown by an average of 8.4 percent per year between 2009 and 2013. This is quite high relative to growth rates before 2010 which averaged between 1 and 2 percent in both the NBS and NAERLS data sets. The higher rates may be explained by the significant investments and support the rice sector began receiving following the world food price crisis in 2008. For example, the introduction of GES under ATA supplied fertilizer and improved rice seeds to a large share of farmers. The 8.4 percent annual growth in paddy production is consistent with figures in the FAOSTAT database and NAERLS estimates. Other international sources however, especially USDA, have remained much more pessimistic with an estimate of about 2.6 percent growth per year in paddy rice production over the same period (USDA 2016).

One striking observation in Table 3 is the growth at national level of about 36 percent in the milling volume of large-scale mills which are currently operational.[3] Some of this expansion may be a direct result of efforts by government to promote their establishment through import and credit incentives, such as the two-tier import tariff previously discussed. While this incentive was proposed in 2013, the two-tier tariff system is not introduced into the model, as this change did not occur until 2014. Instead, we chose to use a lower effective tariff rate of 70 percent for imported milled rice, while maintaining the official 40 percent for brown (non-milled, but already parboiled) rice. Although the official tariff rate in 2013 was 110 percent, a recent study by Johnson and Dorosh (2015) showed how the smuggling of imported rice through Benin and via Niger increases at tariff rates beyond 40 percent. We chose the 70 percent tariff rate here because our model projected import volumes through Lagos that were closer to actual observed levels.[4] For 2009, the corresponding tariff rates were 30 percent for imported milled rice and 10 percent for brown rice.

The higher tariff rates in 2013, including the government's import and credit incentives to invest in large mills, partially explain a dramatic increase in large milling capacities in Nigeria. The growth in milling capacities appears to have occurred more rapidly in zones with higher shares of national paddy production, especially the Northwest and Central zones (Table 4). Figure 3 also illustrates this spatial aspect. Most of the modern rice mills among the medium and large-scale operators are situated close to major urban centers, such as Kano. However, some of the newer modern mills are situated close to paddy growers, as part of a backward integration scheme, or on their own farms.

Table 4 Maximum milling capacities, 2009 and 2013, by geopolitical zone

	2009 (,000 mt of paddy)		2013 (,000 mt of paddy)		Annual growth (%) 2009 - 2013		% change 2009 – 2013	
Zone	**Medium**	**Large**	**Medium**	**Large**	**Medium**	**Large**	**Medium**	**Large**
Northeast	22.9	0.0	25.3	86.8	2.5	-	10.0	100.0
Northwest	61.2	345.6	71.0	596.4	3.8	14.6	15.1	58.5
Central	49.3	172.8	62.9	261.8	6.3	10.9	25.2	43.8
Southeast	31.2	172.8	36.2	183.4	3.8	1.5	15.1	6.0
South-South	13.7	0.0	13.7	0.0	0.0	0.0	0.0	0.0
Southwest	30.6	233.6	30.6	176.0	0.0	-6.8	0.0	-27.3
TOTAL	209.0	924.8	239.7	1,304.4	3.5	9.0	14.0	35.9

Source: Authors calculations based on previous work Johnson (2016) for 2009 and Appendix A for 2013.

Relative to the Northwest and Central zones, the southern zones have not grown as much. Aside from the Southeast (SE) zone which has a few large-scale integrated mills, the Southwest (SW) has been dominated by large-scale millers in Lagos, who mostly mill imported brown rice, producing more than half the rice in the

[3] A list of these mills are available in Appendix Table A2.
[4] The Rice Milling Model does not have an option for smuggling rice.

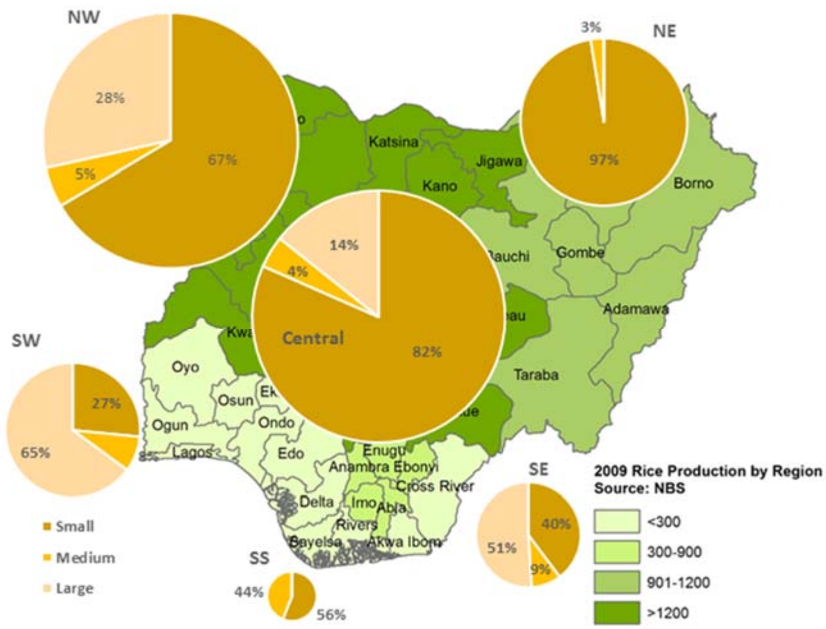
area, as shown in Figure 3 (some of these own large-scale integrated mills elsewhere in the country, such as Stallion Rice). The Southeast, on the other hand, has several industrial milling clusters, especially the Abakaliki rice mill cluster in Ebonyi state.

Due to insufficient data on industrial milling clusters in Nigeria, which we defined to include clusters of 8 or more small-scale millers producing more than 7,000 mt of rice per year, we estimated a conservative increase of 15 percent (or 3 percent per year) for our modeling exercise. Although a rough estimate, its accuracy does not affect the overall results much given the sectors' small share of national rice production. Individual operators of medium-scale mills with a capacity of 10,000 mt per year or less, on the other hand, is based on the information gathered on their existence and capacities.[5] Recall that we lumped the clusters and medium-scale mills into a single category of medium capacity mills, as they typically compete for the same quality paddy for milling. The small-scale milling sector is treated as a residual, due to its resilience and capacity to easily mop up the rest of the paddy produced in Nigeria.

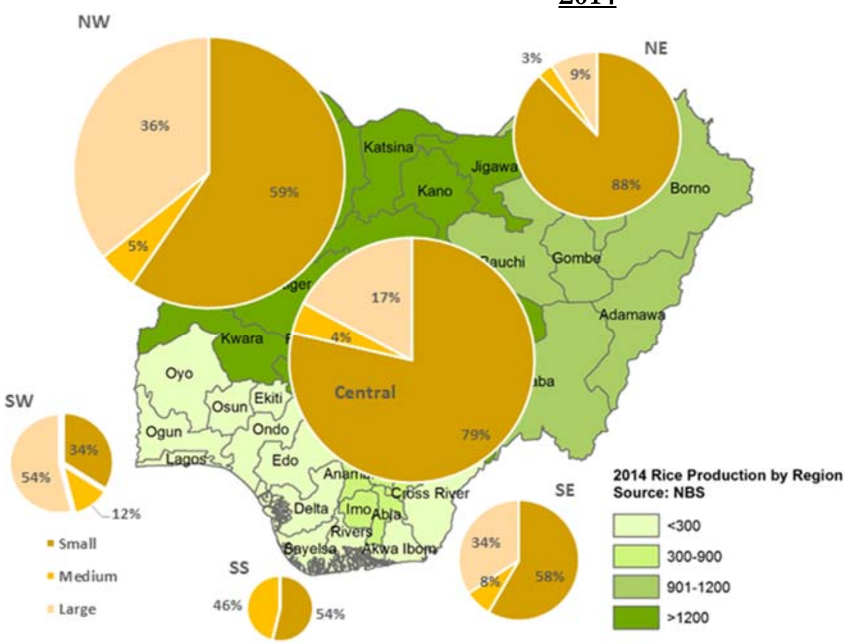
[5] A full list of these mills is available in Annex Table A2.

Figure 3 Paddy production and maximum rice milling capacities by geopolitical zone, 2009 and 2014

2009



2014



Source: For maximum milling capacity shares by miller type, authors calculations based on in Annex Table A1. Small scale is a residual based on total capacity of medium and large in each zone. Paddy production is based on national level estimates in the USDA international database for Nigeria (2016). NE=Northeast zone; NW=Northwest; SE=Southeast; SS=South-South; SW=Southwest.

A common challenge for medium and large-scale millers, and to some degree for milling clusters as well, is procuring and storing enough quality paddy to maximize capacity utilization throughout the year. In fact, for the large-scale operators, they prefer to always have the option to mill imported brown rice due to the insufficient supply of quality paddy throughout the year, as pointed out by Johnson (2016). Many have to import rice from different regions within Nigeria, as well as from global markets in the case of brown rice.[6] Table 5 provides model results on the potential capacity utilization for premium rice milling among medium and large-scale millers given conditions in 2009 and 2013 with respect to the supply of quality paddy, imported brown rice, and prices and costs.

Table 5 Capacity utilization by miller type, 2009 and 2013

	Capacity utilization by mill size, %		**Local paddy and imported brown rice milled by large mills, %**		**Premium rice milled as share of total rice milled, %**
Zone	**Medium**	**Large**	**Local**	**Imported**	
2009					
Northeast	90	-	-	-	2
Northwest	21	100	58	42	25
Central	43	100	25	75	15
Southeast	25	100	12	88	37
South-South	69	-	-	-	30
Southwest	12	100	0	100	74
TOTAL	36	100	29	71	23
2013					
Northeast	100	100	100	0	9
Northwest	76	100	81	19	33
Central	92	100	91	9	20
Southeast	42	100	75	25	49
South-South	83	-	-	-	25
Southwest	40	100	0	100	64
TOTAL	73	100	72	28	27

Source: Model results

From Table 5, clearly large-scale millers in 2009 were more likely to resort to milling imported brown rice—about 71 percent of the rice they milled was imported in order to utilize their plants at full operating capacity. According to our simulations, this appears to have potentially changed significantly by 2013, when 72 percent of the rice milled by the large-scale integrated mills was local paddy. For the medium-scale millers and industrial clusters, however, capacity utilization was much lower in 2009 (36 percent) due to insufficient supply of local quality paddy, since we assumed that these medium-scale millers opt not to mill imported brown rice. By 2013, as more quality paddy was made available in the country, the medium-scale milling sector is able to operate closer to full capacity (73 percent). The increase in domestic paddy is based on our presumption that the government's GES, as well as other programs after 2009, had a significant effect on seed and fertilizer availability for rice growers in the country. Basically, we assume adoption rates of improved seed and fertilizer tripled between the two periods, essentially increasing the supply of quality paddy and explaining the observed rapid annual growth of 8.4 percent in total paddy production in the country. We will later remove this assumption in further simulations in Section 5.

[6] See Annex Figure A2 for these potential trade flows between the zones and the world.

The increase in both total capacity and capacity utilization among medium and large-scale millers implies that the share of premium rice milled in the country should have increased as well. This is what we find—premium rice rising from 23 percent of the total rice milled in Nigeria in 2009 to 27 percent by 2013 (Table 5, last column). Although this may not appear to be a big increase, it is substantial in terms of volume – an increase of about 0.5 million mt (from 1.0 million mt in 2009 to about 1.5 million mt by 2013). Moreover, given imports have on average grown at about 13 percent per year—from 1.7 million mt of rice (or 2.6 million mt in paddy weight) in 2009 to 2.4 million mt of rice (or 4.3 million mt in paddy weight) by 2013 – in the absence of this additional half a million tons – imports could have risen to 2.9 million mt of rice (4.8 million mt in paddy weight).[7]

Table 6 Change in output of the rice milling industry, annual growth 2009-2013, percent

	By mill size			By type of rice		
Zone	**Large**	**Medium**	**Small**	**Standard**	**Premium**	**Total**
Northeast	-	5.2	6.6	6.6	52.7	8.5
Northwest	14.6	43.8	6.0	6.0	16.1	8.8
Central	10.9	28.4	4.1	4.1	13.3	5.6
Southeast	1.5	18.0	-8.8	-8.8	2.4	-4.2
South-South	-	4.6	11.6	11.6	4.6	9.6
Southwest	-6.8	-	5.7	5.7	-5.6	-2.2
Annual growth, %	9.0	23.6	4.5	4.5	10.3	5.9
Total change, %	35.9	94.2	17.9	17.9	41.2	23.5

Source: Model results.

Table 6 and Table 7 shows the projected changes in rice production and employment between the two years. Since rice milling would have increased substantially by 2013, we expect employment in the sector to have also risen. From Table 6, annual growth in the national output of the rice milling industry (5.9 percent per year on average) and in the volume of locally milled premium rice (10.3 percent per year), could have potentially raised overall employment in the rice milling sector by about 20 percent between 2009 and 2013 (Table 7). A counterintuitive result is the dramatic rise in employment despite an increase in the share of rice milled by the more capital intensive large-scale millers. While output of rice from this sector grew by 35 percent overall between the two periods, employment grew even more, by almost 50 percent. The main explanation for this is because of the shift from milling brown rice to local quality paddy. The latter requires an initial step of parboiling the paddy before milling, which can be labor intensive. The medium-scale milling sector has a stronger one-to-one corresponding relationship between output growth and employment – while the small-scale sector does not grow as much as the increase in quality paddy during this period is quickly absorbed by the medium and large-scale millers.

Table 7 Change in employment in the Nigerian rice milling industry, by mill size, 2009-2013, percent

Zone	Small	Medium	Large	Total
Employees - 2009				
Northeast	14,618	95	0	14,713
Northwest	17,539	58	866	18,463

[7] We use a standard conversion rate of 0.61 from paddy weight to the weight of milled rice.

Central	18,391	98	393	18,882
Southeast	5,047	36	377	5,460
South-South	363	44	0	407
Southwest	1,408	17	491	1,916
Total	57,366	347	2,127	59,841
Employees - 2013				
Northeast	18,864	116	243	19,223
Northwest	22,110	248	1,589	23,948
Central	21,589	266	716	22,570
Southeast	3,489	70	481	4,040
South-South	563	52	0	616
Southwest	1,759	57	370	2,185
Total	68,374	809	3,399	72,582
Annual growth, 2009-2013, %				
Northeast	6.6	5.2	-	6.9
Northwest	6.0	43.8	16.4	6.7
Central	4.1	28.4	16.2	4.6
Southeast	-8.8	18.0	6.3	-7.3
South-South	11.6	4.6	0.0	10.9
Southwest	5.7	-	-6.8	3.3
Total annual growth	4.5	23.6	12.4	4.9
Total change, 2009-2013, %	17.9	94.2	49.7	19.8

Source: Model results

6. SIMULATION OF VARYING MILLING TECHNOLOGY CAPACITIES AND POLICY ALTERNATIVES

One of the principle challenges facing Nigeria has been to promote the expansion of large-scale modern integrated mills in order to meet the domestic demand for higher quality premium rice that is often met through imports. As mentioned before, a key challenge facing such large-scale mills is procuring sufficient quantities of quality paddy year round. Much of the time they are forced to import brown rice in order to fully utilize their milling capacity throughout the year. This was shown above and previously in Johnson (2016). The ability to import brown rice, however, can be hampered by policy. For example, raising tariffs on brown rice can potentially put large mills out of business if they find it unprofitable to mill the imported brown rice and cannot access local quality paddy. This reliance on brown rice also means that the current milling capacities of large-scale mills are too high given insufficient supplies of local quality paddy throughout the year. It is partly for this reason that government encouraged large-scale millers to establish paddy out-grower schemes after 2013 for both wet and dry seasons. However, at the time of this writing, little data is available to evaluate whether such schemes have grown in scale and are working effectively.

The principle challenge that remains is just how much the expansion of large-scale milling capacities can lead to the country's goal of achieving self-sufficiency in domestic rice production. One thing that will affect this goal, as we showed in the previous section, is expanding the supply of quality paddy throughout the year. This will require off-season paddy production, which is only possible with irrigation. Another factor potentially affecting the self-sufficiency goal is the differentiated tariff rates that often are imposed between imported milled and imported brown rice. So long as large-scale operators frequently face shortages of paddy during the off-season, the extent to which they can substitute local paddy with imported brown rice can determine whether they can stay in business or not. The tariffs not only influence the price of premium rice in domestic markets (via the tariff for imported milled rice), but also the operating costs of large-scale millers who import brown rice to mill (via the tariff on imported brown rice). Ultimately, the import parity price differentials between milled rice versus brown rice defines whether the option to mill brown rice remains profitable.

Both factors, access to local quality paddy and trade policies for rice, have important implications for whether highly capitalized large rice mills can remain viable and sustainable enterprises in Nigeria. We test this by varying both of these factors in the RMM for 2013. More specifically, the following four simulations are introduced into the model, starting with the most pessimistic and ending with the most optimistic scenario with regard to milling capacities and access to quality rice seeds:

a) No change in seed adoption *Most pessimistic*

S1. At 2013 milling capacity (medium & large mills)

S2. Planned future milling capacity (medium & large mills)

b) With increased seed adoption

S3. At 2013 milling capacity (medium & large mills)

S4. Planned future milling capacity (medium & large mills) *Most optimistic*

Seed adoption here refers to the use of improved higher quality rice seeds which are typically demanded by the medium and large-scale millers because of their consistency and quality for milling premium quality rice. Simulation S3 was used in the previous section as representative of the actual milling capacities and adoption of higher quality rice seeds in 2013. Planned future milling capacities rely on the same source of data, but includes information on planned mills that are yet to be operational.

Each simulation is exposed to six different tariff rate combinations for both imported milled rice and imported brown rice (already parboiled, but not yet milled), as follows:

Tariff Simulation	Rice tariff rate (%)	Brown rice tariff rate (%)
1	110	40
2	70	40
3	50	40
4	40	40
5	30	10
6	0	0

The highlighted tariff combination was used in the analysis in Section 5 as the most likely condition in 2013. Table 8 shows the results for each of the other seed and tariff simulation scenarios. Some key observations of these results include:

- Generally, at the higher tariff rates, the share of premium rice in total domestically produced rice increases as millers face higher prices under this protective policy regime. This ranges from about 8 to 35 percent under the most optimistic scenario (S4) or 6 to 25 percent under the most pessimistic scenario (S1).
- The shares of domestic premium rice only increase marginally when access to domestic quality paddy is improved (i.e. S1 and S2 versus S3 and S4). This is primarily because at the higher tariff rates in our example, the tariff gap between imported milled rice and brown rice is much wider. This increases the profitability for milling brown rice among large-scale millers. Notice the lower share of milled paddy at these higher tariff rates for imported milled rice, especially at the 70/40 percent and 110/40 percent tariff levels (milled rice tariff / brown rice tariff rates). However, as large millers switch to milling brown rice, it releases access to local higher quality paddy to medium-scale millers, as evident in the higher volumes milled at these higher tariff rates.[8]

Table 8. Rice milled, percent local and premium, and capacity utilization based on varying seed adoption, mill capacity, and tariff rates in 2013

Tariffs Rates, %		Total Rice Milled (,000 mt)					Capacity Utilization (%)	
		Small	Medium	Large				
Rice	Brown			Total	Share of local paddy milled, %	Share of premium rice milled, %	Large	Medium
No change in seed adoption								
S1 - At 2013 milling capacity								
110	40	4,687	217	1,304	24	25	100	90
70	40	4,526	117	1,304	44	24	100	49
50	40	4,640	89	483	100	11	37	37
40	40	4,757	72	384	100	9	29	30
30	10	4,989	92	1,272	10	21	98	38
0	0	5,139	37	264	14	6	20	16
S2 - With planned future milling capacity								
110	40	4,589	291	1,889	18	32	100	85
70	40	4,510	159	1,859	29	31	98	46
50	40	4,620	121	472	100	11	25	35
40	40	4,717	94	401	100	9	21	27
30	10	4,972	123	1,776	7	28	94	36
0	0	5,126	50	331	11	7	18	15
With increased seed adoption								
S3 - At 2013 milling capacity								
110	40	4,317	239	1,304	50	26	100	100
* 70	40	4,094	176	1,304	72	27	100	73
50	40	4,228	140	844	100	19	65	59
40	40	4,360	109	743	100	16	57	46
30	10	4,802	131	1,304	21	23	100	55
0	0	5,061	49	331	31	7	25	21
S4 - With planned future milling capacity								

[8] Recall that we have assumed medium millers (which includes industrial clusters of smaller mills) will only mill local paddy.

110	40	4,090	338	1,889	42	35	100	98
70	40	3,716	219	1,889	68	36	100	64
50	40	3,938	178	1,096	100	24	58	52
40	40	4,141	136	935	100	21	49	40
30	10	4,735	166	1,889	17	30	100	48
0	0	5,050	62	396	25	8	21	18

Source: Model results.
Notes: *Highlighted row is the base model results reported in the Section 5, a simulation which assumed these tariff rates and increased seed adoption. The results here are consistent with those in Tables 3, 4, and 5.

- As would be expected, the share of local paddy used for producing premium rice increases with greater adoption of improved quality seeds as the availability of quality paddy rises.
- Capacity utilization for large millers rises to full capacity whenever it is more profitable to also mill imported brown rice. This occurs whenever the tariff gap between imported milled rice and brown rice is large – at the 110/40 and 70/40 rates. Under these policy regimes, large millers are able to maintain full operations throughout the year, even when local paddy is unavailable or in short supply.
- As the gap between the two tariff rates narrows, such as at the 50/40 and 40/40 rates, millers stop importing brown rice altogether and mill local paddy only. Given insufficient supplies throughout the year, however, the millers are forced to mill at below full capacity. Under conditions when there is greater supply of quality paddy from increased seed adoption (S3 and S4), this is at about half the full capacity for both medium and large-scale mills. They are able to maintain slightly higher capacity utilization levels when total milling capacity is restricted to current conditions (S3).
- Increasing the volume of quality paddy produced in Nigeria has important implications on the capacity utilization of medium and large mill operators, as well as the share of premium rice produced in the country—increasing from 11 to 19 percent under current capacity levels or from 11 to 24 percent with greater planned capacities.

These various responses among millers to changing tariff policy regimes and the availability of quality paddy has important implications on the goals of the government to achieve self-sufficiency in rice production and employment creation in the milling sector. Table 9 presents the resulting self-sufficiency ratios and employment effects among each of the seed and tariff simulation scenarios.

Table 9. National rice self-sufficiency ratios (share of domestic milled rice in total consumption) and employment based on varying seed adoption, mill capacity, and tariff rates in 2013

Tariffs Rates, %		With brown milled, %		With local paddy milled only, %		Employment		
Rice	Brown	Premium	Total	Premium	Total	Total, '000s	Medium mills share, %	Large mills share, %
No change in seed adoption								
S1 - At 2013 milling capacity								
110	40	42	63	8	53	94.4	1.2	3.2
70	40	36	60	15	53	87.9	1.2	3.8
50	40	12	53	10	53	85.2	0.4	4.1
40	40	10	53	8	53	85.1	0.1	3.5
30	10	39	64	4	53	91.8	0.0	3.5
0	0	7	55	1	53	99.7	0.0	2.5
S2 - With planned future milling capacity								
110	40	71	69	11	53	92.4	1.8	4.8
70	40	61	66	16	53	87.0	1.7	5.5
50	40	13	53	10	53	82.2	0.4	6.2
40	40	11	53	9	53	81.1	0.0	5.1
30	10	64	70	4	53	90.3	0.0	5.2
0	0	9	56	1	53	100.8	0.0	3.6
With increased seed adoption								
S3 - At 2013 milling capacity								
110	40	39	59	16	53	93.3	1.2	3.3
* 70	40	35	57	22	53	82.7	1.4	4.3
50	40	21	53	18	53	82.5	0.7	4.4
40	40	18	53	16	53	83.1	0.2	4.0
30	10	40	63	8	53	85.9	0.0	4.1
0	0	9	55	2	53	99.7	0.0	2.5
S4 - With planned future milling capacity								
110	40	63	64	22	53	91.9	1.8	4.9
70	40	52	59	32	53	77.9	2.1	6.7
50	40	27	53	24	53	76.8	0.9	7.0
40	40	23	53	20	53	77.2	0.3	6.4
35	30	67	69	10	53	83.0	0.0	6.1
0	0	11	56	2	53	100.8	0.0	3.6

Source: Model results.
Notes: *Highlighted row is the base model results reported in the Section 5, a simulation which assumed these tariff rates and increased seed adoption. The results here are consistent with those in Tables 3, 4 and 5.

Some key observations in these results include:

- If we consider local paddy as the only source of local milled rice, the self-sufficiency ratio of 53 percent naturally does not change, since we assumed total paddy produced is fixed. In other words, increased adoption of improved seed in our example does not increase total volume, but simply replaces local seed.[9]

[9] It is otherwise logical to think total output will also increase with greater adoption rates as higher quality seeds tend to also be higher yielding.

- If we consider local premium rice as including any imported brown rice that is milled locally, then the self-sufficiency ratios do rise as millers approach full capacity utilization at the higher 110/40 and 70/40 tariff rate combinations. This can be close to 70 percent at very high tariff rates, since large millers switch to milling mostly imported brown rice. However, this can hardly be viewed as a move towards self-sufficiency as much of the 'local' premium rice would actually be milled using imported brown rice.

- The effects on total employment across the various simulations is minimal given that small millers employ the largest share. What is interesting are the marginal changes in employment among large millers as they increasingly mill local paddy only. This occurs because of the higher labor intensive requirement to first parboil the rice, something they do not have to do when milling imported brown rice. Naturally, employment among large millers also rises as the total capacity of this sector increases.

- At lower tariff rates, large millers increasingly operate at well below capacity, such that much of the premium rice consumed in the country has to be imported. Evidently, large millers rely on the tariffs to remain viable.

These results emphasize two important things. First, larger capital-intensive millers rely heavily on the tariff structure for both imported milled and brown rice to remain viable. Whenever there is a higher tariff rate for imported milled rice relative to imported brown rice, they are able to operate at maximum capacity. But this comes at the cost of milling less local paddy and more imported brown rice, which does not contribute to the country's self-sufficiency goal for rice production. Large millers are less able to compete with imports if tariffs are too low. Under such tariff policies, they would resort to milling imported brown rice instead. Second, the poor availability of local quality paddy throughout the year constrains the growth of medium and large millers from operating at full capacity. Reversing this can have a major impact on the ability of the sector to displace imports over the long run. The effects on employment can also be positive as operations expand, including that from increased parboiling activities.

Altogether, our results suggest that if the government has been successful in expanding quality paddy production in the country, it is quite possible that modern medium and large-scale milling operations have also responded and many of them now may be operating at closer to full capacity. However, this still needs to be verified.

7. SUMMARY CONCLUSION AND POLICY IMPLICATIONS

The overall objective of this paper was to assess the extent to which the rice milling sector in Nigeria has grown and improved performance in the more recent period following the government's efforts to improve the rice sector overall between 2009 and 2013, especially with the goal of increasing output of higher quality premium rice to displace imports. In particular, one key objective of the paper was to determine how the combination of policies the government has been focusing attention on, such as through the establishment of a greater number of large-scale mills, combined with increases in improved seed and fertilizer adoption, is sufficient and can have its intended effects of achieving national self-sufficiency in rice production.

Our results have shown that there has indeed been an expansion of both paddy and milling capacities. What remains in question, however, is the extent to which the share of quality paddy from greater improved seed adoption has occurred. The potential increase in the volume of premium quality rice being milled in Nigeria is up to an additional 0.5 million mt from the volumes in 2009. This translates into the share of premium rice in total production of 27 percent, up from 23 percent in 2009. With imports reaching 2.4 million mt in 2013 (from 1.9 million mt in 2009), the absence of this additional half million tons of domestic premium rice could have resulted in imports rising to 2.9 million mt.

Results also showed that for the large-scale milling sector, gains in output and employment have been driven primarily by the increase in capacity. The medium-scale sector benefitted more from increased investments in expanding access to improved seed and fertilizer to generate greater volumes of higher quality paddy. Despite the gains in both the medium and large-scale sectors, the industry did not see any overall increase in employment.

Maintaining access to adequate quantities of local quality paddy and trade policies for rice are important to whether the highly capitalized large millers can remain a viable and sustainable enterprise in Nigeria. A policy of high tariff rates increase the share of premium milled rice produce domestically and allows the medium and large-scale milling sub-sectors to operate at almost full capacity and stay viable. However, this policy needs to be accompanied with an increase in the domestic production of rice paddy, otherwise the large-scale milling sector will substitute imported brown rice for domestically produced paddy. Increasing the country's milling capacity under this scenario is likely to only spread the local paddy supply across the large-scale millers and have a negative effect on the viability of the medium-scale millers. The effects on total employment in the medium and large-scale rice mills across the various simulations is minimal given that small-scale millers employ the largest share. However, there are some small gains to employment in the large-and-medium scale milling sub-sectors as more locally produced paddy is milled, likely due to the increased labor required for parboiling.

The need for good quality data is also evident here, as accurate information is key to informing policy for Nigeria to reach its goal of self-sufficiency. For example, while the large-scale milling sector requires high tariffs to stay viable and to increase the share of domestically produced premium rice, the determination by the large-scale milling sector to mill locally produced rice versus imported brown rice is determined by the supply of locally produced rice paddy. An overestimate of domestic rice production can shift the policy focus from those that increase improved seed adoption to those that increase the country's milling capacity. As a result, the share of locally produced rice being milled into premium rice would decline and be substituted for by imported brown rice. This overestimation would result in an increased import bill and undermine the country's goal of becoming self-sufficient. Good quality data is necessary to truly have a sense of the current state of the industry is in order to make informed policy decisions that address the country's goals.

REFERENCES

Adekoya, Femi. 2015, May 11. "Nigeria: Govt to Reduce Import in 2015." *The Guardian*. Retrieved from http://allafrica.com/stories/201505110969.html.

Adesina, Akinwumi. 2014. "Score Card: Agricultural Transformation Agenda 2013 Report." Federal Ministry of Agriculture and Rural Development, Federal Government of Nigeria.

Adesina, Akinwumi. 2013a. "Transforming Nigeria's Agriculture." Presentation at inauguration of the Agriculture and Food Security Center of the Earth Institute, 10 September 2013, Colombia University, New York, NY.

Adesina, Akinwumi. 2013b. "Nigeria's Agricultural Transformation Agenda (ATA) Mid-Term Review" Federal Ministry of Agriculture and Rural Development (FMARD) PowerPoint Presentation, June 2013. Abuja: FMARD.

Ajayi, Ola. 2014, September 9. "FG set to ban 'ponmo'." *Vanguard*. Retrieved from http://www.vanguardngr.com/2014/09/fg-set-ban-hides-skin-ponmo/.

Asiedu, Elizabeth. 2002. "On the Determinants of Foreign Direct Investment to Developing Countries: Is Africa Different?" *World Development* 30 (1): 107-119.

Babatunde, Jimoh. 2014, April 11 "FG upgrades Olam Farms to staple crop processing zone." *Vanguard*. Retrieved from http://www.vanguardngr.com/2014/04/fg-upgrades-olam-farms-staple-crop-processing-zone/.

Brown, J.P., R.J.G.M. Florax, and K.T. McNamara. 2009. "Determinants of Investment Flows in U.S. Manufacturing." *Review of Regional Studies* 39 (3): 269–286.

Central Bank of Nigeria. 2015. *Statistical Bulletin Vol. 26, December 2015* Abuja: Central Bank of Nigeria.

Chemonics and Africa Rice. 2015. *Feasibility of the Establishment of Paddy Aggregation Centers in Nigeria*. Produced for review by the United States Agency for International Development (USAID) and the Federal Ministry of Agriculture and Rural Development. Abuja: USAID/Nigeria.

Durham, Catherine A. and Richard J. Sexton. 1996. "Spatial Competition, Uniform Pricing, and Transportation Efficiency in the California Processing Tomato Industry" *American Journal of Agricultural Economics* 78 (1): 115-125.

Ezedinma, C. 2005. *Impact of Trade on Domestic Rice Production and the Challenge of Self-Sufficiency in Nigeria*. Ibadan, Nigeria: International Institute of Tropical Agriculture. Accessed on December 5, 2016. http://africarice.org/workshop/RicePolicy/Chuma.E/Chuma.E.Nigeria.Paper.pdf

FAO (Food and Agriculture Organization of the United Nations). 1998. FAOSTAT statistics database. Rome: FAO.

Federal Ministry of Agriculture and Rural Development. 2016. "The Agricultural Promotion Policy (2016-2020): Building on the Successes of the ATA, Closing Key Gaps" Federal Government of Nigeria Policy and Strategy Document.

Federal Ministry of Agriculture and Rural Development. 2014. "Nigeria's Agricultural Transformation Agenda (ATA): Turning Nigeria into a Global Powerhouse in Agriculture." PowerPoint Presentation. Accessed on December 5, 2016. https://issuu.com/oaktv/docs/20130614_ata_score_card_without_fig

Federal Ministry of Agriculture and Rural Development. 2011. "Agricultural Transformation Agenda: We Will Grow Nigeria's Agricultural Sector." Abuja: Federal Government of Nigeria.

Gyimah-Brempong, Kwabena, Michael Johnson and Hiroyuki Takeshima, eds. 2016. *The Nigerian Rice Economy: Policy Options for Transforming Production, Marketing and Trade*. Philadelphia: University of Pennsylvania Press.

Johnson, Michael and Akeem Ajibola. 2016. "Post-harvest Processing, Marketing, and Competitiveness of Domestic Rice." In Gyimah-Brempong, Kwabena, Michael Johnson and Hiroyuki Takeshima (eds.), *The Nigerian Rice Economy: Policy Options for Transforming Production, Marketing and Trade*. Philadelphia: University of Pennsylvania Press.

Johnson, Michael. 2016. "Policy Options for Modernizing the Milling Sector." In Gyimah-Brempong, Kwabena, Michael Johnson and Hiroyuki Takeshima (eds.) *The Nigerian Rice Economy: Policy Options for Transforming Production, Marketing and Trade*. Philadelphia: University of Pennsylvania Press. pp 139-158

Johnson, Michael and Paul Dorosh. 2015. *Optimal Tariffs with Smuggling: A Spatial Analysis of Nigerian Rice Policy Options*. IFPRI Discussion Paper No. 01493. Washington, DC: International Food Policy Research Institute.

Jones, L.L., and M.D. Woods. 2002. *Economic Location Theory and Practice*. Unpublished mimeo. College Station, TX, USA: Texas A&M University.

Kramer, Reed. 2014, May 3. "Nigeria: Dismissed as Poverty Trap, Agriculture is Nigeria's 'New Oil' and Can Curb Conflict – Minister Adesina." *AllAfrica*. Retrieved from http://allafrica.com/stories/201405030434.html.

Lançon, Frederic; Olaf Erenstein; S.O. Akande; S.O. Titilola; G. Akpokodje; and O.O. Ogundele. 2003a. *Imported Rice Retailing and Purchasing in Nigeria: A Survey*. West Africa Rice Development Association (WARDA) and Nigeria Institute for Social Economic Research (NISER), Cotonou, Benin. Accessed on December 5, 2015. http://pdf.usaid.gov/pdf_docs/Pnadb848.pdf

Lançon, Frederic; Olaf Erenstein; S.O. Akande; S.O. Titilola; G. Akpokodje; and O.O. Ogundele. 2003b. *Rice Processing in Nigeria: A Survey*. West Africa Rice Development Association (WARDA) and Nigeria Institute for Social Economic Research (NISER), Cotonou, Benin. Accessed on December 5, 2015. http://opf-labs.org/format-corpus/govdocs1-error-pdfs/error_set_2/219789.pdf

Leadership. 2014, May 29. "Food Security Through Agricultural Transformation Agenda." *Leadership*. Retrieved from http://leadership.ng/business/372565/food-security-agricultural-transformation-agenda

Lucas, M.T. and D. Chhajed. 2004. "Applications of Location Analysis in Agriculture: A Survey." *Journal of the Operational Research Society* 55 (6): 561-578.

McCann, Philip and Stephen Sheppard. 2003. "The Rise, Fall and Rise Again of Industrial Location Theory." *Regional Studies* 37 (6-7): 649-663.

NAERLS (National Agricultural Extension Research Liaison Services) and Federal Department of Agricultural Extension. 2013. *Agricultural Performance Survey of 2013 Wet Season in Nigeria*. Zaria: NAERLS Press.

NAERLS (National Agricultural Extension Research Liaison Services) and National Programme on Agriculture and Food Security. 2010. *Agricultural Performance Survey of 2010 Wet Season in Nigeria*. Zaria: NAERLS Press.

NBS (National Bureau of Statistics). 2016. CountrySTAT: Nigeria database. Abuja: NBS.

Ogunbiyi, M.O. 2011. "Assessment of Postharvest Handling and Quality Control Practices of Rice in North Central Nigeria: A Case Study of Lafia, Nasarawa State." *Journal of Developments in Sustainable Agriculture* 6: 143-163.

Okereocha, Chikodi. 2015, May 12. "Fed Govt unveils 2015 rice import allocations." *The Nation*. Retrieved from http://thenationonlineng.net/fed-govt-unveils-2015-rice-import-allocations/

Olomola, Aderbigbe S. 2015. *Driving Agricultural Transformation with the Power of Information and Communication Technology: The Performance of Nigeria's Growth Enhancement Support Scheme*. Nigeria Strategy Support Program Working Paper No. 30. Abuja: International Food Policy Research Institute.

Premium Times. 2014a, March 28. "8,000 bags of rice smuggled into Nigeria daily – Agriculture Minister" *Premium Times*. Retrieved from http://www.premiumtimesng.com/news/157592-8000-bags-rice-smuggled-nigeria-daily-agriculture-minister.html.

Premium Times 2014b, March 24. "Aftermath Nigeria's policy reversal, rice ships flood Lagos port." *Premium Times*. Retrieved from http://www.premiumtimesng.com/news/157372-aftermath-nigerias-policy-reversal-rice-ships-flood-lagos-port.html

Premium Times. 2013, July 2. "13 million Nigerians suffer from hunger- Agriculture Minister." *Premium Times*. Retrieved from http://www.premiumtimesng.com/news/140098-13-million-nigerians-suffer-from-hunger-agriculture-minister.html.

Propcom Maikarfi. 2016. *The Future of Agricultural Inputs Market in Nigeria – Policy Recommendations and Actions*. Propcom Maikarfi Final Report. Abuja: Propcom Maikarfi.

Udo, Betsy. 2014, March 8. "Confusion trails Nigeria's rice policy, as Okonjo-Iweala, Adesina express divergent views." *Premium Times*. Retrieved from http://www.premiumtimesng.com/news/156375-confusion-trails-nigerias-rice-policy-okonjo-iweala-adesina-express-divergent-views.html.

USDA (United States Department of Agriculture). 2016. USDA Foreign Agricultural Services Production, Supply and Distribution database. Washington DC: USDA.

ANNEX

Table A 1. Average annual paddy rice production growth rates by state in Nigeria, 2009–2013, percent

Zone	State	Annual growth
Northeast	Adamawa	15.1
	Bauchi	8.3
	Borno	-0.6
	Gombe	10.9
	Taraba	1.4
	Yobe	54.1
Northwest	Jigawa	44.0
	Kaduna	-3.6
	Kano	-0.1
	Katsina	20.9
	Kebbi	33.9
	Sokoto	21.5
	Zamfara	55.3
Central	Benue	-4.6
	FCT-Abuja	51.9
	Kogi	2.0
	Kwara	0.5
	Nasarawa	2.1
	Niger	8.3
	Plateau	7.7
Southeast	Abia	8.7
	Anambra	61.1
	Ebonyi	-10.7
	Enugu	9.4
	Imo	36.6
South-South	Akwa-Ibom	18.3
	Bayelsa	18.6
	Cross River	-23.9
	Delta	26.5
	Edo	38.3
	Rivers	55.8
Southwest	Ekiti	13.4
	Lagos	31.6
	Ogun	14.9
	Ondo	17.3
	Osun	21.8
	Oyo	71.2

Source: Authors calculations based on annual data from NAERLS (2010, 2011, 2012, and 2013) annual reports (http://www.naerls.gov.ng/)

Table A 2. Estimated stock and capacities of medium (inclusive of milling clusters) and large scale rice milling operations in Nigeria, as of 2015

State	Name	Type	Number of mills, est.	Integrated?, Yes/No	Operational?, Yes/No	Maximum capacity, est., mt/yr *
Adamawa	*Yola South Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Adamawa	*Lamurde Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Adamawa	*Song Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Adamawa	*Meem Nigeria*	*Large*	*1*	*Y*	*N*	*20,000*
Anambra	Stine Rice Industries	Large	1	Y	Y	132,000
Anambra	*Omor*	*Medium*	*1*	*Y*	*N*	*10,000*
Anambra	*Anyamelum Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Bauchi	Gouria	Large	1	Y	Y	37,000
Benue	Ashi Foods Ltd.	Large	1	Y	Y	60,000
Benue	Miva 3/	Medium	1	Y	Y	10,000
Benue	Gboko Cluster	Medium	10	Y	Y	4,200
Benue	Otukpo Cluster	Medium	12	Y	Y	12,600
Benue	*Makurdi Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Cross River	*Obubra Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Cross River	Oni MP Farm	Medium	1	Y	N	8,000
Ebonyi	*Ebonyi Rice World*	*Large*	*1*	*Y*	*N*	*100,000*
Ebonyi	Abakaliki	Medium	20	Y	Y	21,000
Ebonyi	*Afikpo Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Ebonyi	*Ikwo Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Ebonyi	Ebonyi State government	Large	1	Y	N	0
Ebonyi	Ebonyi State government	Large	1	Y	N	0
Ebonyi	Ebonyi State government	Large	1	Y	N	0
Edo	*Akoko-Edo Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
FCT	*Abaji Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Jigawa	Three Brothers	Large	1	Y	Y	20,000
Jigawa	Atafi	Large	1	Y	Y	120,000
Jigawa	*Atahi Rice & Cereals*	*Large*	*1*	*Y*	*N*	*20,000*
Jigawa	*Dangote*	*Large*	*1*	*Y*	*N*	*120,000*
Jigawa	*Hadejia Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Jigawa	Danmodi	Medium	1	Y	Y	10,000
Kaduna	*Soba Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Kano	Popular Foods	Large	1	Y	Y	150,000
Kano	UMZA Rice	Large	1	Y	Y	72,000
Kano	IRS Rice Mill 2/	Large	1	N	Y	170,000
Kano	Arewa Rice	Large	1	Y	Y	40,000
Kano	*Sarinuya / Umza Int'l Farms*	*Large*	*1*	*Y*	*Y*	*20,000*
Kano	Savannah Mills	Large	1	Y	Y	100,000
Kano	Golden Grains Mill	Medium	1	Y	Y	8,400
Kano	Kura Rice Cluster	Medium	10	Y	Y	10,500
Kano	*Bagwai Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Kano	*Dembatta Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Katsina	*Katsina Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Kwara	*Patigi Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Kwara	*Ilorin South Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Kwara	Hillcrest	Large	1	Y	n.a.	n.a.
Kwara	*Nigeria Starch Mill*	*Large*	*1*	*Y*	*N*	*25,000*
Kwara	Quarra Rice	Large	1	Y	Y	25,000
Lagos	*Flour Mill of Nigeria*	*Large*	*1*	*N*	*Y*	*15,000*
Lagos	Stallion	Large	1	N	Y	60,000
Lagos	Dana Foods Mill	Large	1	N	Y	90,000
Lagos	BUA	Large	2	N	Y	30,000

State	Name	Type	Number of mills, est.	Integrated?, Yes/No	Operational?, Yes/No	Maximum capacity, est., mt/yr *
Lagos	Sherati Rice	Large	1	N	Y	25,000
Lagos	*Imota Rice Mill*	*Medium*	*1*	*N*	*Y*	*10,000*
Lagos	*Lagos Shati Rice Mill*	*Medium*	*1*	*N*	*Y*	*10,000*
Lagos	Conti-Agro	Medium	2	N	Y	10,000
Nasarawa	Olam	Large	1	Y	N	160,000
Nasawara	*Clystars Global Resources*	*Large*	*1*	*Y*	*N*	*20,000*
Nasarawa	Lafia Mill Cluster	Medium	8	Y	Y	8400
Niger	ONYX	Large	1	Y	Y	24,000
Niger	*Badeggi Rice Mill (Gvt.)*	*Large*	*1*	*Y*	*Y*	*20,000*
Niger	Bida Rice Mill	Medium	1	Y	Y	6,300
Niger	*Deanshanger Rice Mill*	*Medium*	*1*	*Y*	*Y*	*10,000*
Ogun	*Ifo Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Ogun	*Ewekoro Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Ogun	Ofada Veetee Rice Mill	Large	1	N	N	0
Rivers	NDDC Rice	Medium	1	Y	N	0
Sokoto	*Wumo Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Sokoto	*Attajiri Rice Mill*	*Medium*	*1*	*Y*	*Y*	*10,000*
Sokoto	*Gangare Phosphate*	*Medium*	*1*	*Y*	*Y*	*10,000*
Taraba	Al Uma Rice	Medium	1	Y	Y	8,000
Taraba	*Gassol Cluster*	*Medium*	*8*	*Y*	*Y*	*7,200*
Taraba	Dominion Rice	Large	1	Y	N	30,000
Zamfara	Talatar Mafara Cluster	Medium	8	Y	Y	7,200
Zamfara	*Kare Hi-Tech Eng.*	*Large*	*1*	*Y*	*N*	*20,000*

Notes: * Rows in italics indicate rough estimates. Medium mills are considered those milling 10,000 mt/yr or less (inclusive of rice milling clusters with eight or more small mills).

Table A 3. Summary of cultivated area, total output, and yield per hectare under the Rice Value Chain program of the Agricultural Transformation Agenda

Year	Programme	Cultivated area, ha	Average yield, mt/ha	Total output, mt	
				Paddy	Milled rice
2012	Wet Season	135,631	2.5	339,078	220,400
2012/13	Dry Season	267,591	4.0	1,070,364	695,737
2013	Wet Season	496,949	3.5	1,739,322	1,130,559
2013/14	Dry Season (estimated)	305,159	4.0	1,220,634	793,412

Source: 2013 ATA Score Card (Adesina 2013)

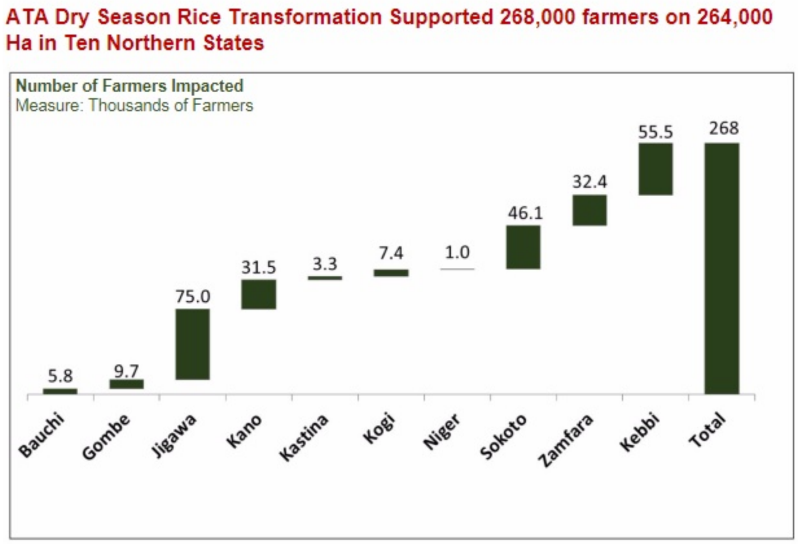
Table A 4. Key performance indicators for the Rice Value Chain under the Agricultural Transformation Agenda, 2013

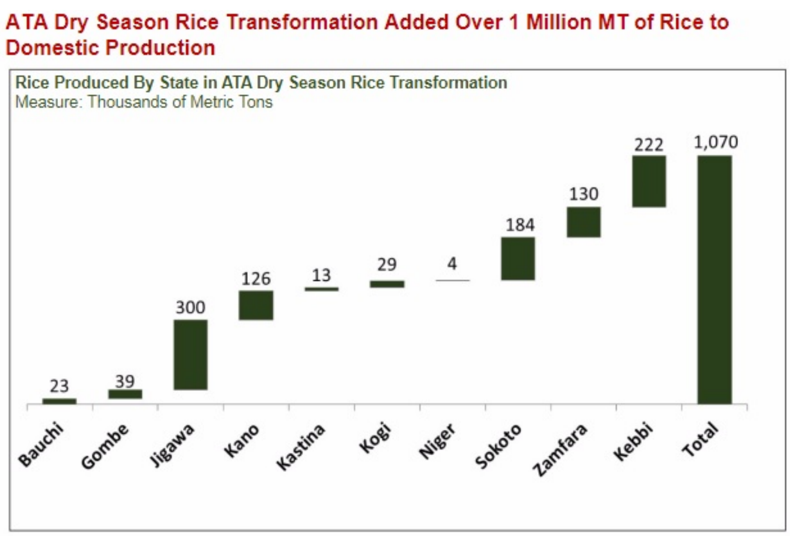
Indicators	Key performance indicators for 2012	Key performance indicators for 2012	Achievements	Next steps/ Timeline
Production	i. 5.5 million metric tons paddy ii. 3.58 million metric tons milled rice	i. 6.465 million metric tons paddy ii. 4.202 million metric tons milled rice	i. 5.59 million metric tons paddy ii. 3.64 million metric tons milled rice	To improve quality of paddy, more threshers, mechanical dryers, and rice harvesters will be deployed to rice growing regions in the 22 States by November 2013 for
Productivity	2.5 metric tons per hectare	3.5 metric tons per hectare	2.5 metric tons per hectare	
Post-harvest Processing	37 destoners	100 destoners	50 destoners	
I. Thresher (no.)	100 threshers	111 threshers	111 threshers	
II. Mechanical dryer (no.)	10 mechanical dryers	74 mechanical dryers	37 mechanical dryers	

III. Rice harvesters (no.)	10 rice harvesters	300 rice harvesters	37 rice harvesters	the dry season rice farming season
Adoption of improved varieties	12,500 metric tons of improved seed	12,500 metric tons of improved seed	11,840 metric tons of improved seed	
Extension Services and Training of Farmers	850 farmers	2400 farmers	2400 farmers	

Source: 2013 ATA Score Card (Adesina 2013)

Figure A 1. Dry season rice transformation under the Agricultural Transformation Agenda, selected slides from presentation by the Federal Ministry of Agriculture and Rural Development, 2014





ATA Dry Season Rice Transformation Supported 268,000 farmers on 264,000 Ha in Ten Northern States

The Dry Season farming added 1 million MT to Domestic Production

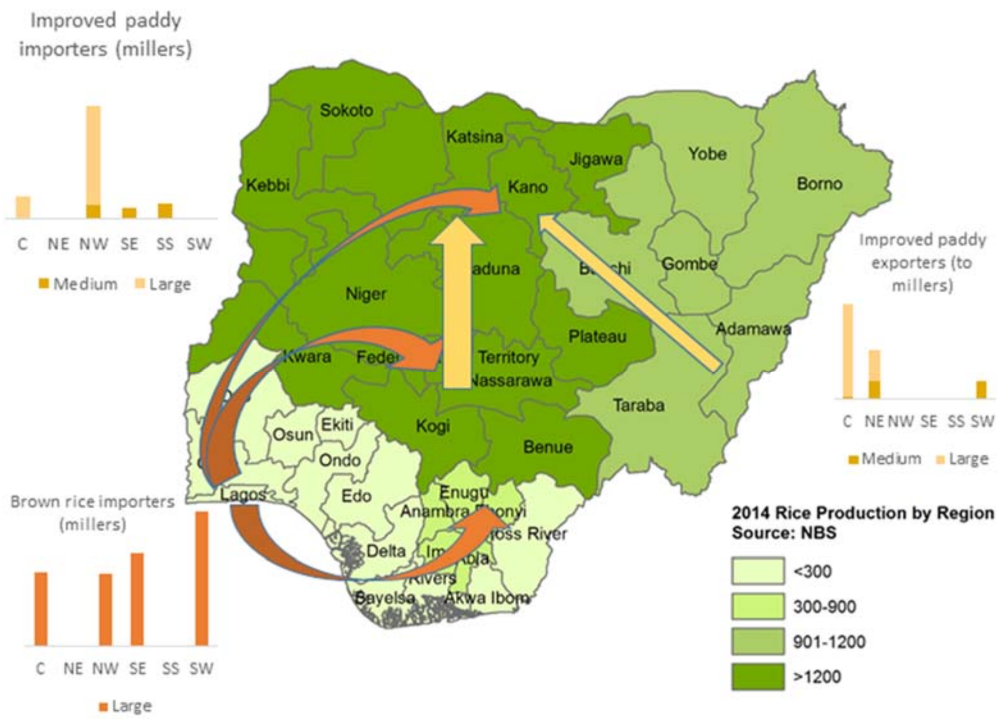
- In 2013, for first time ever, we launched Dry Season farming of rice to take advantage of irrigation capacity in the North of Nigeria
- For first time ever, Federal Government provided massive support for dry season rice cultivation in 10 states;
- 267,491 farmers received 50kg seeds, two bags of 15-15 NPK and one bag Urea
- This has added an additional **1,070,364 MT** of food in 2013. This is one-third of total paddy needed to be self-sufficient by 2015

State	Number of farmers	Estimated paddy production (MT)
Bauchi	5,822	23,288
Gombe	9,664	38,656
Jigawa	74,972	299,888
Kano	31,491	125,964
Kastina	3,334	13,336
Kogi	7,355	29,420
Niger	1,002	4,008
Sokoto	46,087	184,348
Zamfara	32,391	129,564
Kebbi	55,473	221,892
TOTAL	267,591	1,070,364

Source: Federal Ministry of Agriculture and Rural Development (2014). Slide 3 was not included in that presentation and is available here: http://slideplayer.com/slide/8655768/, but it summarizes figures provided in Slide 1 and Slide 2 which were presented.

Figure A 2. Trade flows of rice paddy and imported brown rice to millers between geopolitical zones, 2009 and 2014

2009



2014