

ASSESSMENT OF PROCESSING EFFICIENCY OF SME RICE MILLS IN NIGERIA



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Executive summary

At the present, about 80% of Nigerian population consumes rice as a staple food. Rice consumption of the country is increasing rapidly. Although Nigeria is currently the largest rice producer in West Africa; due to the large population, it is also the biggest rice consuming country of the region. The annual demand for milled rice of the country is about 5.2 million tons. Besides importing of 1.9 million tons yearly, the country has to still produce another 3.3 million tons to meet its annual demand. In order to meet need of milling the domestic produced rice; recent years, Nigerian government supported to build up tens of rice milling plants across the country. However, because of various reasons, many rice mills have operated at low efficiency. This has caused big losses for not only the investors but also the country economy and the social communities. Therefore, aims of the study are to find out the reasons and to propose solutions to fix the problems.

Thanking to the substantial supports of GIZ Nigeria, the study began by sending of questionnaires to selected rice mills. Feedbacks with basic information of the rice mills were collected for initial study. Then, field visits were carried out to 7 rice mills with different levels of technology, investment and milling capacity. During the field visits, in-depth interviews were implemented directly with managers and key technicians of the rice mills. Besides, the consultant also interviewed other stake-holders in the rice supply chain in Nigeria such as rice farmers, rice wholesalers and retailers at local markets, agricultural extension workers, etc. Data collected from the field visits was used for analyses, estimations and comparisons of economic and financial efficiencies between the rice mills at the GIZ office and Vietnam.

Based on technical specifications and milling capacity, rice mills in Nigeria could be classified into 3 typical rice mills being (1) Traditional and small rice milling enterprises, (2) Medium rice milling enterprises, and (3) Fully integrated rice milling plants. Rice mills of type 3 have highest investment cost with highest milling capacity and highest milling technology than those of types 2 and 1. Machines and equipment of rice mills of type 3 were mostly imported from overseas like Switzerland (Buhler), South Korea or India. Compared with rice mills of type 3, rice mills of types 1 and 2 have more technical problems. Rice mills of type 1 often have back-ward milling technology and machines leading to lower milled rice quality compared with the other 2 types. Most of rice mills of type 2 has non-integrated milling lines causing lower operation efficiency. In spite of these, results of the analyses showed that the smaller the capacity, the higher the financial efficiency for the rice mills. Small rice mills can pay back to the investment within only 1 year. Most of rice mills in Nigeria are suffering with shortages of supplies of national electricity, input raw paddy and spare parts, as well as with very high bank interest rate, up to 25%/year. Besides, lacks of well trained technicians and skilled labors are also causing considerable problems for operation and maintenance of the machines in the rice mills. Because of the problems, some fully integrated rice milling plants of type 3 often operate only some months a year with full milling capacity or several months per year with half or one-third of the full capacities. Together with other specific technical problems of each rice mill, these common problems caused low operational and financial efficiencies for the rice mills.



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Based on results of the study and achievements in rice milling industry of some Asian countries, two business models of rice mills with milling capacities ranging from 1.0 tons/hour to 2.5-3.0 tons/hour were proposed to the CARI project. These two business models with appropriate technologies and machines could be suitable to specific conditions of input raw paddy supply, investment capacity, technology standard and quality requirements of the local rice markets in Nigeria. For most of scenarios, the two business models can pay back to the investment within 1 year. For some bad situations, these could also return to the investment after 3 to 6 years of milling operation.

To improve quality of the parboiled milled rice and to enhance efficiencies of the rice mills in Nigeria, the study proposed that the CARI project should organize training courses on rice quality, quality control, post-harvest technology of rice, rice milling technology and machinery and rice business management for technicians and managers of the rice mills. The CARI project should also hold seminars on the aspects above so that the people can come and share their knowledge and experience for up-scaling of good business models in the rice milling industry. In addition, to ensure a sustainable development in rice production of the country, the government should also strengthen and develop the irrigation systems and upgrade the national electricity network so that water and electricity are supplied efficiently for the rice production and the rice milling industry.



COMPARISON OF EFFICIENCY BETWEEN RICE PROCESSING BUSINESS MODELS IN NIGERIA¹

Business Models	(Model I)	(Model II)	(Model III)	(Model IV)	(Model V)
A. Basic Information of Business Models					
Main technical characteristics of the rice milling plant	<p>The new rice milling factory invested equipment as the following:</p> <ul style="list-style-type: none"> + A Japan flatbed dryer of 1.5 tons of paddy/batch (2.5x2.5x0.5m) using kerosene fuel for direct drying; + A Japan cleaning machine combined with a Japan destoner of 5 tons of paddy per day for cleaning of input paddy before milling; + 5 SATAKE two-stage milling machines (husking + whitening) with capacity of 400 kg of paddy/hour using diesel engine 23 horse power (HP) for each milling machine. Peak milling 	<p>The mill has invested equipment and machinery for rice milling as follows:</p> <ul style="list-style-type: none"> + Traditional parboiling equipment using firewoods and a cement flat form of 300m² for parboiling and sun-drying of the parboiled paddy; + A Japan pre-cleaner and a mono-stage milling machine with capacity of 500kg – 700kg of paddy/hour using an electrical motor of about 7.5 kW for cleaning and milling of raw paddy or parboiled paddy; + A China paddy de- 	<p>The rice milling plant invested many machinery of parboiling, drying, milling from South Korea, China, Japan and Nigeria. However, most of the machinery is not integrated and co-ordinated together. Therefore, milling quality is not stable. It consists of:</p> <ul style="list-style-type: none"> + Three electricity generators of 240 KVA, 100 KVA and 60 KVA; + A parboiling system with 2 soaking tanks of 5 tons/batch (2 tanks x 5 tons of paddy), and 2 steaming tanks of 500kg/batch (2 tanks x 500kg of paddy). Average parboiling capacity 	<p>The rice milling plant has main machinery as follows:</p> <ul style="list-style-type: none"> + 2 electricity generators with capacity of 250kVA (2 x 250 kVA) and another one with capacity of 500 kVA; 1 trailer, 2 trucks and 3 transporting canters; + Three parboiling systems with capacity of 16 tons/batch (3 x 16 tons/batch = 48 tons) were built up in 2010, 2011 & 2012, imported from India & South Korea; + Two column dryers with capacity of 25 tons/batch (2 x 25 tons/batch = 50 tons) were built up in 2010, 2011 & 2012, imported from 	<p>The mill invested:</p> <ul style="list-style-type: none"> + 2 paddy parboiling systems and 4 column dryers with drying capacity of 33 tons of paddy/batch (4 x 33 tons/batch); and 4 round silos of 90 tons of paddy (4 x 90 tons). These are Indian technology; + 6 locally made warehouses of 30,000 tons (6x30,000 tons) with 2 cycles per year; + 2 Bühler fully integrated rice milling lines of 8tons of paddy/hour (8tons x 2 = 16 tons) in 2012; + 2 trucks for transportation of its products.

¹ The figures in the table are based on best estimates of available data and calculations provided by the consultant. They do not reflect actual balance sheet data. The characteristics and figures provided can be regarded for mills under similar conditions.



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	<p>seasons are from June to August, and from October to December yearly. + Another South Korea de-stoner of 400 kg milled rice/hour; + 3 warehouses with total storage area of 400 m² (3x (15x9)). Total storage capacity of the warehouse is about 500 tons of paddy. Peak season for storage is from September to November every year. It is harvesting season.</p>	<p>stoner and a South Korea milled rice de-stoner with capacity of 300kg/hour; + 2 warehouses built up locally in 2010 for bag storage with a total storage capacity of 30 tons with 4 storage cycles per year within 5 months from December to April yearly.</p>	<p>is about 1.0 tons of paddy/hour. The parboiling technology and equipment are from South Korea; + One South Korea circulation column dryer of 6.2 tons/batch, and other 4 flat-bed dryers with drying capacities ranging from 0.5 to 1.4 tons of paddy/batch imported from Japan or made locally. Total drying capacity of the rice milling plant is about 10 tons of paddy/day; + A locally made warehouse with a total storage capacity of 4,000 bags inside and another 4,000 bags outside with 2 storage cycles per year; + Rice milling machinery such as pre-cleaners, huskers, whiteners, de-stoners, graders and color sorters imported from Japan, China and South Korea. Average milling capacity of the rice milling plant is 0.54 tons of paddy/hour.</p>	<p>India and South Korea; + A warehouse imported from Turkey with a total storage capacity of 30,000 tons of paddy. The warehouse is often used from October to March next year; + There are two rice milling lines. One is a fully integrated rice milling line with capacity of 2.5 tons of paddy/ hour, imported from South Korea. Another one is also a fully rice integrated milling line with capacity of 6 tons of paddy/hour imported from India.</p>	<p>+ The rice mill is supplied almost 100% electricity energy from the national electricity system.</p>
<p>Business characteristics of the</p>	<p>It provides mainly milling service to local rice traders</p>	<p>Its function is buying parboiled paddy or raw</p>	<p>The rice milling plant has main activities as follows:</p>	<p>The rice mill mostly buys raw paddy from rice farmers</p>	<p>The rice milling plant often mostly buys raw dried</p>



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rice milling plant	and farmers Besides, it also buys parboiled paddy from farmers for milling and selling the parboiled milled rice to local communities, rural markets or individuals at the rice milling gate.	paddy for parboiling, drying, milling and selling the parboiled milled rice to wholesalers, retailers at rural small markets or to individuals at the rice mill gate. Besides, it also provides milling service to individuals of neighbor communities.	+ Mostly buying raw paddy from farmers or traders for parboiling, drying, milling, and selling its parboiled milled rice and the by-products to distributors, wholesalers and retailers for downstream delivery; governmental agencies or to individuals from the gate of the rice mill; + Providing parboiling service and/or milling services to individuals.	or traders for parboiling, drying, milling and selling its parboiled milled rice and other by-products to rice distributors, and wholesalers in Nigeria markets.	paddy at moisture content (MC) of 12-18%wb from mostly rice traders, middlemen, groups of rice farmers, etc. for parboiling, drying, milling and selling the parboiled milled rice and its by-products such as broken milled rice and rice bran to rice distributors, and wholesalers in Nigeria markets.
Initial investment cost (₦)	7,500,000	5,200,000	84,050,000	680,553,600	4,360,000,000
Estimated lifetime (years)	10	10	10	10	10
Total capacity (tons of paddy/hour)	2.00	0.50	0.54	8.50	16
Total operating time (days/year)	17	78	300	33	38

B. Criteria for comparison between Business Models

I. Milling quality of the rice milling plants	Percentage (%)	Selling price (₦/ton)								
Average milling yield	69		65		65		70		66	
Premium milled rice	0		30	200,000	0		40	252,000	58	190,000
Normal milled rice	64	190,000	20	180,000	58	230,000	20	240,000	0	150,000
Broken milled rice	5	100,000	15	90,000	7	83,000	10	120,000	8	120,000
Rice bran	10	20,000	13	5,000	13	5,000	8	24,000	11.50	30,000

Rice husk	21	0	22	0	22	0	22	-	22.50	-
II. Input of the milling line	Percentage (%)	Purchasing price (₦/ton)								
Raw paddy	0		0		93	71,000	100	90,000	100	95,000
Parboiled paddy	100	110,000	100	130,000	0.86		0		0	
III. Milling business and services	Percentage of total milling cap (%)	Service price (₦/ton of paddy)	Percentage of total milling cap (%)	Service price (₦/ton of paddy)	Percentage of total milling cap (%)	Service price (₦/ton of paddy)	Percentage of total milling cap (%)	Service price (₦/ton of paddy)	Percentage of total milling cap (%)	Service price (₦/ton of paddy)
Milling service	73.26	7,350	7.7	5,000	1	10,000	0		0	
Parboiling & milling service	0				6	28,571	0		0	
IV. Cost of milling	Self-financing (₦/ton)	100% of loans (₦/ton)								
1. Fixed cost:	9,750.00	19,115.63	4,757.41	9,317.41	7,714.99	15,145.09	30,176.07	59,108.71	107,360.20	211,045.23
2. Operating cost:	(₦/ton)	(%)								
Storage cost	11,990.00	83.68	2,834.00	64.08	46,434.00	55.19	58,860.00	91.95	62,130.00	88.55
Fuel cost	1,500.00	10.47	0	0.00	36,952.50	43.92	838.24	1.31	515.63	0.73
Electricity cost	0	0.00	66.67	1.51	29.51	0.04	299.26	0.47	656.25	0.94
Labor cost	322.67	2.25	1,270.83	28.74	311.60	0.37	2,421.57	3.78	1,150.00	1.64
Other costs	515.62	3.60	250.93	5.67	409.31	0.49	1,592.20	2.49	5,715.46	8.15
Total operating cost	14,328.29	14,328.29	4,422.43	4,422.43	84,136.92	84,136.92	64,011.27	64,011.27	70,167.34	70,167.34



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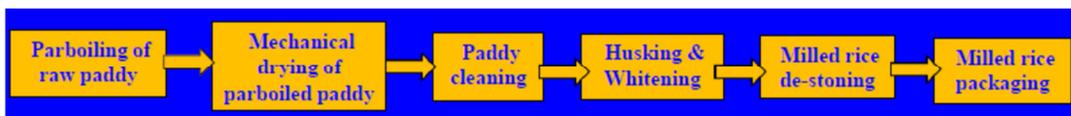
Total fixed and operating cost (₦/ton)	24,078.29	33,443.92	9,179.84	13,739.84	91,851.91	99,282.00	94,187.35	123,119.98	177,527.53	281,212.57
V. Profit from the milling line	Self-financing	100% of loans	Self-financing	100% of loans	Self-financing	100% of loans	Self-financing	100% of loans	Self-financing	100% of loans
Profit margin (%)	81	74	92	88	34	29	42	24	-44	-128
Revenue (₦/ton)	128,600.00	128,600.00	110,150.00	110,150.00	139,860.00	139,860.00	162,715.20	162,715.20	123,250.00	123,250.00
Profit (₦/ton)	104,521.71	95,156.08	100,970.16	96,410.16	48,008.09	40,578.00	68,527.85	39,595.22	-54,277.53	-157,962.57
Profit (₦/year)	9,831,736.67	9,082,486.67	11,904,777.81	11,412,297.81	93,724,586.36	84,737,141.36	153,776,606.4	88,851,671.36	-264,005,920	-768,329,920
VI. No. of labors working in rice mill	9 permanent labors		10 permanent labors		14 permanent labors & 18 casual labors		106 permanent labors		150 permanent labors & 50 casual labors	
VII. Profit/labor (₦/labor.year)	1,092,415.19	1,009,165.19	1,190,477.78	1,141,229.78	2,928,893.32	2,648,035.67	1,450,722.70	838,223.31	-1,320,029.60	-3,841,649.60
VIII. Return on Assets (ROA) (%)	131.09	121.10	228.94	219.47	111.51	100.82	22.60	13.06	-6.06	-17.62
IX. NPV	61,198,983.22	60,517,790.56	75,174,304.72	74,726,781.78	578,271,253.92	570,095,290.61	824,809,983	765,807,840	-3,024,884,685	-3,483,967,254
X. Internal Rate of return (%)	-	-	-	-	-	-	44	-	-7	-12
XI. Breakeven point (tons/year)	6.83	13.38	4.86	9.52	167.47	328.76	686.04	1,343.82	9,837.49	19,338.22
XII. Payback period (years)	1	1	1	1	1	1	4	4	n.a	n.a

Final recommendation

Current practice of big rice mills in Nigeria pointed out that over-investments often have less efficiency, even cause big losses for the investors. Beside electricity supply, supply of input raw paddy is one of the most essential factors affecting to efficiency of rice mills. However, it is quite difficult to estimate productivity of the rain-fed rice under conditions of climate changes. Therefore, in the future, any investment in rice mills in Nigeria should consider carefully electricity supply, input raw paddy supply and market requirements. Investigations on weather history and conditions, rice growing areas, number of rice crop a year, rice yields as well as potential risks causing losses for the rice productivity in the region should be carried out fully before making decisions on investment related to milling capacity, milling technology and machinery standard, and site for installation of the new rice mill.

Based on the previous analyses, recently practical conditions in Nigeria and experiences on popular and successful rice processing lines in Asia countries; business models of new rice mills proposed for Nigeria in the next few years must satisfy basic conditions as follows: (1) Being able to improve quality of the milled rice compared with that at the present, in order to meet requirements of the national markets or neighbor country markets, (2) Being able to get enough raw paddy supply to operate fully their milling capacity, (3) connecting different machines in the rice milling line together to maximize the milling capacity and to save labor cost for the rice mills, (4) using up paddy husk from the rice mills to save energy cost and to reduce the processing cost, (5) Being able to pay back to the investments within 1 to 5 years, and (6) Bring in the profit as much as possible for the investors. Based on the above conditions, milling capacity of proposed new rice mills should not be too high. Depending on location of installation, sources of the raw paddy supply and the markets; in the next 5 years, milling capacities of new rice mills should be ranging from 1 tons/hour (small size) to 2.5-3.0 tons/hour (medium size) which could be extended to 6 tons/hour in the future. For more convenient in spare parts supply; although storage facilities, electricity generators and boilers could be purchased from different suppliers; the other machines for parboiling, drying, milling and packaging should be purchased from only 1 or 2 suppliers. To meet requirements mentioned above, two business models of small and medium rice mills are suggested for new investments within the country in the near future, from 1 to 5 upcoming years. In order to increase operation efficiency of the rice mills and to improve gradually quality of the parboiled milled rice in Nigeria, the two business models consists of not only the milling section but also the parboiling section, drying and storage section for storage of raw paddy.

The first business model (Model A) is small rice mills with milling capacity of 1 tons of paddy/hour. Based on recent quotations and selling prices of storage facilities, parboiling equipment, dryers and rice milling machines from Nigerian, Vietnamese, Japanese or South Korean suppliers; and recent selling prices of electricity generators in Nigeria market; total investment cost of rice mills of Model A is about ₦ 91,400,000. Processing flow of the Model A is shown in Fig. 15.1.



A rice processing flow of small rice mills of 1 tons of paddy/hour

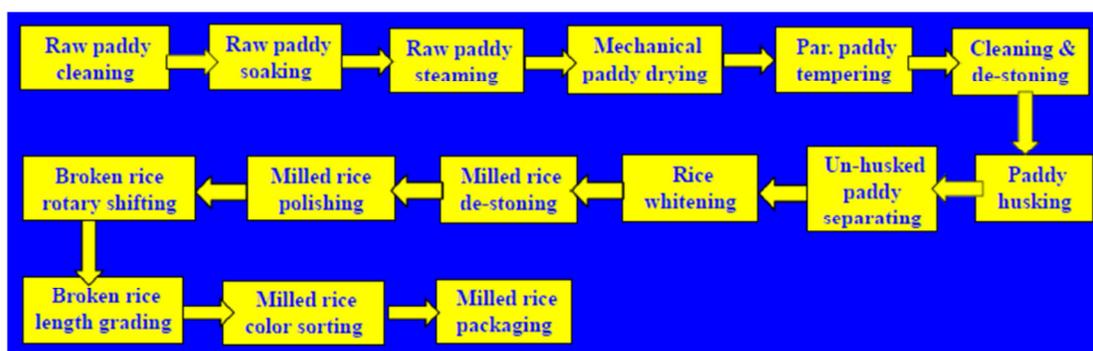
The rice mills are a combination of sections of parboiling, drying and milling. Equipment for parboiling and drying could be made in Nigeria or imported from overseas. The other machines and equipment of the milling section could be imported from Vietnam or other Asian countries. Purchasing prices of each machine are estimated as follows:

General information of initial investment cost	Unit	Quantity
+ 1 electricity generator of 100 KVA	NGN	1,600,000
+ 1 paddy pre-cleaning machine of 1 tons/hour	NGN	1,500,000
+ 1 parboiling system of 1 tons/hour: 2 soaking tanks x Cap. of 5 tons/batch (8-10 hrs) & 2 steaming tanks x Cap. 0.5 tons/batch (15-18 mins) & a paddy husk boiler.	NGN	45,000,000
+ 1 column dryer of 10 tons/batch with a paddy husk furnace	NGN	18,000,000
+ 1 storage facilities of 600 tons (L*W*H = 70*5*3.5 (m))	NGN	20,000,000
+ 2 Satake rice milling machinery of 0.4-0.5 tons of paddy/hour	NGN	1,800,000
+ 2 de-stoners of 400kg/hour	NGN	1,500,000
+ Other supporting equipment like conveyors, elevators, etc.	NGN	2,000,000
Total investment cost of the small rice mill of 1 tons/hour	NGN	91,400,000

(Notes: The figures of the general information of initial investment cost were from recent quotations and selling prices of storage facilities, parboiling equipment, dryers and rice milling machines from Nigerian, Vietnamese, Japanese or South Korean suppliers; and recent selling prices of electricity generators in Nigeria markets)

Financial analyses in Annex IV showed that under unfavorable conditions of a high bank interest rate of 22%/year and a low selling price of the parboiled milled rice of only ₦ 200/kg, the rice mill should be able to operate at least 150 days per year; and therefore, it could return the investment within 3-4 years. The rice mill should also store raw paddy within 5 months for its milling. The other scenarios of no.1 to no. 4 have NPV>0. These scenarios could bring in high profit to the rice mill. According to the analysis, profit is ranging from ₦ 11,589.63/ton of paddy to ₦ 150,009.71/ton of paddy; and from ₦ 13,907,560/year to ₦ 360,023,300/year. Payback period of scenarios of no.1 to no.3 is only 1 year after putting the rice mill into operation (Tab. 15.1). Small rice mills like could consider to upgrade their rice mills to the rice mill like Model A.

The second business model (Model B) is medium rice mills with milling capacity of 2.5-3.0 tons of paddy/hour. Based on recent quotations and selling prices of storage facilities, parboiling machines, dryers and rice milling machines from Vietnamese, Indian or South Korean suppliers; and recent selling prices of electricity generators in Nigeria markets; total investment cost of medium rice mills of Model B is about ₦ 481,726,740. Processing flow of the Model B is shown in Fig. 15.2.



**A rice processing flow of medium rice mills
of 2.5-3.0 tons of paddy/hour**

Machines belonging to sections of parboiling and drying should be imported from India. The other equipment in the milling section could be imported from Vietnam, Thailand or India. Importing prices of the machines and equipment are also estimated in the table below.

General information of initial investment cost	Unit	Quantity
+ 2 electricity generators of 100 KVA & 150 KVA	NGN	3,500,000
+ 2 paddy pre-cleaning machines of 1.5 tons/hour (2*1.5 tons/hour) & 1 de-stoner	NGN	5,000,000
+ 2 parboiling systems of 15 tons/batch (8-10 hrs), (2*15 tons/batch) including soaking tanks (8-9hrs/batch), steaming tanks (15-18 mins) & a paddy husk boiler (India)	NGN	40,000,000
+ 2 column dryers of 25 tons/batch with a paddy husk furnace (2*25tons/batch (15hrs/batch))(India)	NGN	270,000,000
+ 3 storage facilities of 500 tons (L*W*H = 60*5*3.5 (m)) = 1,500 tons	NGN	60,000,000
+ 1 de-stoner + 2 husking machines	NGN	3,537,400
+ 1 un-husked paddy separator	NGN	2,660,100
+ 2 whitening machines	NGN	6,345,600
+ 1 de-stoner	NGN	918,600
+ 2 polishing machines	NGN	4,119,000
+ 1 rotary shifter	NGN	1,277,400



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+ 3 length graders	NGN	2,279,700
+ 1 color sorter	NGN	8,460,000
+ 1 temporary storage	NGN	1,189,800
+ 1 shutter scale	NGN	1,256,400
+ Other supporting equipment of the milling line	NGN	41,975,100
+ Sea transportation & Installation for milling machines	NGN	29,207,640
Total investment cost of the medium rice mill of 2.5-3.0 tons/hour	NGN	481,726,740

(Notes: The figures of the general information of initial investment cost were from recent quotations and selling prices of storage facilities, parboiling machines, dryers and rice milling machines from Vietnamese, Indian or South Korean suppliers; and recent selling prices of electricity generators in Nigeria markets).

With a similar processing flow and the same technology; machines or equipment in the processing line of Model B could be replaced with those of higher capacities or be added together with minor modifications in order to increase the total milling capacity of the rice mill up to 4-6 tons of paddy/hour.

Financial analyses showed that excepting the worst situation of scenario no. 5, NPVs of all the other scenarios are positive. Under these conditions, the rice mill could generate good profit for the investors. According to the analysis, profit generated from the rice mill are varying from ₦ 2,418.08/ton of paddy to ₦ 149,573.02/ton of paddy; and from ₦ 8,705,102.09/year to ₦ 1,076,925, 763.10/year. Under unfavorable conditions of a high bank interest rate of 22%/year and a low selling price of the parboiled milled rice of only ₦ 200/kg, if the rice mill stores raw paddy within 5 months for milling at least 150 days/year, it can pay back to the investment within 5-6 years. Medium rice mills should consider for applying the business model (Model B) to their rice mills. The two rice mills should replace husking and whitening machines with new ones to reduce broken rate of the parboiled milled rice. The two rice mills should also buy more necessary machines to put into the processing line, and integrate machines together for improving quality of the parboiled milled rice; and reducing the labor cost and the processing cost.

New rice mills should invest enough warehouses with equipment or facilities which can control better quality of the paddy during storage. The warehouses should be installed in integration with mechanical dryers and pre-cleaners in order to be sure that raw paddy will be dried up to appropriate MC (14%wb) and cleaned up perfectly before storage for processing afterwards. Besides, to reduce the processing cost and to minimize environmental impacts, the new rice mills should also buy boilers, soaking and steaming equipment and mechanical dryers which use paddy husk as a main energy source for their operation.

To improve quality of the parboiled milled rice and to increase operation efficiency of rice mills in Nigeria, the CARI project should organize training courses on rice quality, post-harvest technology of rice and rice milling technology and machinery for technicians and technical managers of rice



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mills. Besides, managers of rice mills should also be trained on rice milling management. Moreover, seminars on technical and business management with field visits to good rice mills should also be organized frequently so that rice mills can come and share their knowledge and experiences together. From these events, good business models would be up-scaled in the rice producing regions.

To develop sustainably the rice production and the rice milling industry in Nigeria, the government should strengthen and develop gradually the irrigation systems and the national electricity network. These are essential conditions to expand rice growing areas, to ensure rice yield and rice productivity, and to increase operation efficiency of the rice mills in the country.