Smallholder Agricultural Productivity Enhancement and Commercialization (SAPEC) Project

PACKAGES AND SUPPORT THE DISSEMINATION OF TECHNOLOGIES FOR RICE PRODUCTION IN LIBERIA

Final Report

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1.0 INTRODUCTION

1.1 Background

Rice is among the important cereals produced in sub- Sahara Africa and primary staple food of Liberians representing 50% of adult calorie intake. Despite the involvement of approximate 404,000 farm families in rice production, the country still relies heavily on rice importation to meet the local demands (USAID, 2009).

2.0 IMPLEMENTATION OF DEMONSTRATION PLOTS IN PROJECT COUNTIES

Breeder seeds of 14 improved and climate change resilient rice varieties (7 upland and 7lowland) were used to establish demonstration plots in 6 project counties. Notably among them are: NERICA 4, ARICA5, NERICA8 NERICA14, NERICA12, NERICA18 and ARICA 4 (Upland), ARICA2, NERICA L-19, NERICAL-20, Orylux 6, WITA 9 and IR841 (Lowland).

Two of the varieties (LAC 23 and Suakoko 8) are known to be late maturing duration varieties (140 to 160 days) and have become age long varieties with the Liberia farmers. However, with the current trend of the climate change, it is not always possible for them to complete their cycle before the end of the rainy season. Their continuous cultivation may pose a serious risk to farmers in the nearest future. However, other varieties are early maturing (80 to 100 days) having the possibility of being grown two times in one rainy season under low altitude conditions.

The demonstration plots were established and monitored jointly with project focal points and farmers. During each monitoring visit, training was given to farmers on the field. Fertilizer application was done together with farmers and importance of fertilizer application and weed management were also explained. Pests and other problems identified were shown to farmers and possible control measures proposed.

3.0 FARMERS' FIELD DAYS AND VARIETAL SELECTION

Well attended field days by 580 participants (377 females and 203 males) were conducted at CARI station and 6 project counties for formal evaluation of the introduced rice varieties. During the field days, farmers were given the opportunity to make their choice among the rice varieties in the demonstration plots and gave reasons for their choice. The participating farmers were educated on the activities expected of them during the exercise and instructed to be fully

independent of their choice. Three cards with the inscriptions of **"My 1st variety"** (written in red colour), **"My 2nd variety"** (written in blue colour) and **"My 3rd variety"** (written in black colour) were given to each participant to go round the field and make their choice. After that, they were asked to drop their cards in the corresponding labelled baskets specially placed at the plots of their selected varieties. Cards in the labelled baskets of each variety were sorted, counted and recorded against each variety.

Results of the farmer's selection of their best rice variety during the field day exercise indicated the following order of preference: The farmers ranked the upland rice varieties in the following order: NERICA 4 (1st), NERICA 8 (2nd) and NERICA 14 (3rd) while the lowland varieties were ranked as follow: NERICA L 19 (1st), ORYLUX 6 (2nd) and NERICA L 20 (3rd).

A post evaluation survey was conducted using questionnaires to find out the reasons for their choice. Among the reasons for their choice of rice varieties include high plant height, a high number of panicles, high tillering capacity, weed tolerance and grain size. These reasons were based on their field observations at various demonstration plots during the field days. They, however, indicated that their final choice would be based on the palatability exercise scheduled for a later date**.**

All the demonstration plots established at the project counties and CARI station were harvested and seeds processed and secured for the following cropping season. Relevant agronomic data were collected and collated for the generation of passport data (Appendices 1&2). The mean yields of improved climate change resilient upland rice varieties ranged from 2.4 – 4.8 tons/ha while the yield for improved lowland varieties was within the range of 3.1 – 3.5 tons/ha. The mean yield of LAC 23 (popular upland variety) was 2.6 tons/ha while that of SUAKOKO 8 (popular lowland variety) was 3.6 tons/ha.

4.0 PRODUCTION OF TECHNOLOGY DISSEMINATION TOOLS

Five flyers (27,000 copies) carrying information for closing farmers' knowledge gap on various aspects (land preparation, nursery bed preparation, weed management, transplanting and fertilizer application) of rice production were produced and distributed to farmers in all the project counties. Another flyer on "Quality Rice Seeds Production has been designed but could not be printed due to budget constraints. A poster on field days activities carrying information on selected varieties produced for display at special events such as "World Food Day" and the like.

5.0 SENSORY EVALUATION OF FOURTEEN RICE VARIETIES IN PROJECT COUNTIES

Sensory evaluation is a scientific discipline used to evoke, measure, analyze and interpret those responses to products that are perceived by the senses of sight, smell (aroma or scent), touch, taste and hearing (Stone and Sidel, 1993). There are three methods of sensory evaluation namely: Discrimination tests, Descriptive analysis and Affective/Hedonic tests.

A total of 14 rice varieties (7 upland and 7 lowlands) were used in the sensory evaluation tests conducted in the project counties where the demonstration plots were established and field days conducted. The upland varieties included NERICA 4, ARICA 5, NERICA 8 NERICA 14, NERICA 12, NERICA 18 and ARICA 4 while the lowland varieties were ARICA 2, NERICA L-19, NERICA L-20, Orylux 6, WITA 9, Suakoko 8 and IR841. The main objective of the test was to determine farmers' preferences and acceptability of the rice varieties introduced to them during the field days.

5.1 Materials and Methods

The hedonic test method was used to evaluate the quality attributes of 14 rice varieties (7 upland and 7 lowlands) as determining factors for farmers' choice of preferred varieties. A sensory panel of 10 farmers was selected in each of the project counties where they assessed the 14 cooked rice varieties. The trained panelists used a hedonic scale to rank the attributes (***aroma, color, texture, taste, consistency and overall acceptability***) of each rice variety on the basis of five criterions 1 = Dislike Very much, 2 = Dislike, 3 = Neither Like nor Dislike, 4 = Like and 5 = Like Very Much. A multiple responses analysis for the 14 varieties was run, and the variety with higher mean scores on any of the quality attributes indicate that such variety was liked by the farmers based on that particular attribute.

5.2 Sample Preparation and Presentation

A litre of water was poured into a pot and allowed to boil. Half a kilogram of each of the rice varieties was added to boiling water. The amount of water absorbed by rice and cooking time was observed and recorded. All the 14 rice varieties were subjected to the same boiling operations. No salt or any other cooking ingredients was added to any of the rice varieties to prevent external flavour enhancement and bias among the panelists. The boiled rice samples were served in already coded plates with numbers corresponding to the rice varieties. The plates were placed in separate locations with a reasonable distance from one another to ensure that panelists do not share responses. A cup of water to act as neutralising agent was placed beside each of the rice plates. The panelists used the water to rinse their mouth thoroughly between tasting different samples.

The panelists were assisted by trained enumerators to score their responses on a structured questionnaire that contains a brief definition of the sensory parameters. The evaluation exercises were conducted from 10-11 a.m. to ensure that the panelists were not very hungry or too satisfied because their taste buds are likely to be affected by both factors.

5.3 Statistical Analysis

The Statistical Analysis System (SAS) software package was used for data analysis. One-way ANOVA was employed to compare data sets with Duncan's Multiple Range Test (DMRT) giving significant difference ($P<0.05$) among means. The average sensory assessment for all the 14 rice varieties is shown in Tables 1 and 2.

5.4 Results

5.4.1 Upland Varieties

With regards to criteria for selection, farmers ranked the following upland rice varieties in the following order of likeness with the overall acceptability of NERICA 14 (4.22) > NERICA 18 (4.00) > LAC 23 (3.83) > ARICA 4 (3.67) > NERICA 8 (3.53) > NERICA 4 > NERICA 12 (2.75). All the quality attributes (***aroma, colour, texture, taste, consistency and overall acceptability***) fell within the likeness range for NERICA 14, NERICA 18, LAC 23 and ARICA 4 (Table 1). However, there was no significant difference among the sensory attributes selected for the likeness of NERICA 14, NERICA 18 and LAC 23 by the farmers (Table 1). It may be due to the similar colours which both

NERICA 14 and NERICA 18 shared with the cooked LAC 23 (tagged "country rice") which most of the farmers were familiar with and liked.

It is interesting to note that NERICA 18 and LAC 23 were not among the preferred first three varieties selected during the field day selection exercise. LAC 23 was not selected during the field selection exercise probably because it is a late maturing variety and failed to display all the observable rice traits which the farmers used to select and rank the early maturing varieties as at that time. It confirms the earlier assertion by the farmers during the field day exercise that their final selection of the preferred varieties would be based on palatability test.

Table 1. Sensory assessment of seven upland rice varieties by farmers in the project counties

Rice Variety	Mean score and standard deviation (*parentheses*) of quality attributes					
	Aroma	***Color***	***Texture***	***Taste***	***Consistency***	***Overall Acceptability***
NERICA 8	3.75 (1.45) $^{b c}$	3.85 (1.34) $^{a b}$	3.70 (1.38) $^{a b}$	3.63 (1.44) $^{b c}$	3.53 (1.50) ^{b}	3.33 (1.54) ^{c}
ARICA 4	3.75 (1.45) $^{b c}$	4.17 (1.06) $^{a b}$	3.85 (1.34) $^{a b}$	3.65 (1.42) $^{b c}$	3.78 (1.49) ^{ab}	3.67 (1.36) ^{b}
NERICA 14	4.43 (1.12) ^{a}	4.45 (1.11) ^{a}	4.23 (1.23) ^{a}	4.18 (1.32) ^{a}	4.23 (1.55) ^{a}	4.22 (1.26) ^{a}
NERICA 4	3.37 (1.52) $^{c d}$	4.18 (4.18) $^{a b}$	3.48 (1.60) ^{b}	3.42 (1.57) ^{c}	3.55 (1.43) ^{b}	3.32 (1.50) ^{c}
NERICA 18	4.22 (1.24) $^{a b}$	4.20 (1.29) $^{a b}$	4.13 (1.37) ^{a}	4.05 (1.35) $^{a b}$	4.12 (1.30) ^{a}	4.00 (1.40) ^{ab}
LAC 23	3.82 (1.55) $^{b c}$	4.28 (1.21) $^{a b}$	3.87 (1.46) $^{a b}$	3.85 (1.55) $^{a b}$	4.13 (1.23) ^{a}	3.83 (1.49) ^{ab}
NERICA 12	3.13 (1.52) ^{d}	3.12 (1.54) ^{c}	2.93 (1.56) ^{c}	2.90 (1.47) ^{d}	2.90 (1.46) ^{c}	2.75 (1.41) ^{d}

Means followed by the same letter in the same column are not different (P<0.05). Figures in parentheses are Standard Deviations.

5.4.2 Lowland varieties

Results of the overall sensory acceptability of 7 lowland rice varieties were ranked by the farmers in the following order of likeness: IR 841(4.30) > ORYLUX 6 (3.58) > NERICA L 20 (3.53) > WITA 9 (3.27) > NERICA TG 19 (3.15) > ARICA 2 (3.13) > SUAKOKO 8 (2.68). The first three varieties; IR 841(4.30), ORYLUX 6 (3.58) and NERICA L 20 (3.53) have their mean scores of the quality attributes (***aroma, colour, texture, taste, consistency and overall acceptability***) fell within the

range of likeness by farmers (Table 2). Only NERICA L 20 was not among the first three varieties selected during the field day exercises. IR 841 (4.30) was the most preferred lowland rice variety by farmers and was significantly different ($p < 0.05$) from other varieties regarding farmers' assessment of the quality attributes.

Table 2. Sensory assessment of seven lowland rice varieties by farmers in the project counties

Rice Variety	Mean score and standard deviation (*parentheses*) of quality attributes					
	Aroma	***Colour***	***Texture***	***Taste***	***Consistency***	***Overall Acceptability***
NERICA TG 19	3.42 (1.6) [c]	3.70 (1.39) [c]	3.15 (1.56) [cd]	3.20 (1.51) [bc]	3.42 (1.43) [bc]	3.15 (1.49) [bc]
ARICA 2	3.37 (1.58) [c]	3.78 (1.38) [b c]	3.22 (1.57) [bcd]	3.20 (1.59) [bc]	3.37 (1.59) [bc]	3.13 (1.60) [bc]
IR841	4.38(1.17) [a]	4.33 (1.08) [a]	4.32 (1.14) [a]	4.30 (1.28) [a]	4.35 (1.10) [a]	4.30 (1.20) [a]
SUAKOKO 8	2.83 (1.63) [d]	3.65 (1.54) [c]	2.75 (1.48) [d]	2.75 (1.53) [c]	3.07 (1.56)c	2.68 (1.46) [c]
NERICA L 20	4.12 (1.29) [a b]	4.25 (1.13) [a b]	3.45 (1.65) [bc]	3.53 (1.40) [b]	3.62 (1.52) [b]	3.53 (1.55) [b]
ORYLUX 6	3.65 (1.56) [bc]	3.62 (1.51) [c]	3.72 (1.47) [b]	3.65 (1.60) [b]	3.75 (1.57) [b]	3.58 (1.57) [b]
WITA 9	3.68 (1.58) [bc]	3.88(1.38) [a b c]	3.33 (1.48) [bc]	3.37 (1.57) [b]	3.65 (1.48) [b]	3.27 (1.58) [b]

Means followed by the same letter in the same column are not different ($P<0.05$). Figures in parentheses are Standard Deviations.

6.0 Conclusion

From the preceding, it is clear that farmers' access to improved rice varieties is very low and as a result, there is a need for developing an appropriate strategy to make the seeds available to farmers. Community-based Seed multiplication Scheme (CBSS) approach should be employed in the production of the selected and preferred rice varieties.

REFERENCES

Reynolds, C. and Field, M. (2009). Global Food Security Response: Liberia Rice Study United Agency for International Development (USAID), pp. 34

Stone, H and Sidel, J. L. (1993). Sensory Evaluation Practices: 2nd Ed. Academic Press: San Diego

ANNEX 1 ACTIVITIES IN PICTURES

Figure 1: Distribution of flyers to farmers during the World Food Day event

Figure 2: Upland Demonstration plot

Figure 3: Lowland Demonstration plot

Figure 4: Field day participants at lowland demonstration plot CARI station

Figure 5: Field day participants at upland demonstration plot Margibi

Figure 6: Field day participants selecting their best rice varieties

Figure 7: Sensory evaluation panelists in Cape Mount County receiving instructions before the exercise

Figure 8: Sensory evaluation test participants in Margibi County getting ready for the exercise

Figure 9: Participants at the sensory evaluation test conducted in Grand Gedeh County

Figure 10: Participants being assisted in recording their scores on sensory parameters in Margibi County

Figure 21: A participant responding to questions on sensory parameters in Cape Mount County

Figure 12: A poster carrying information on Field day exercise and selected rice varieties

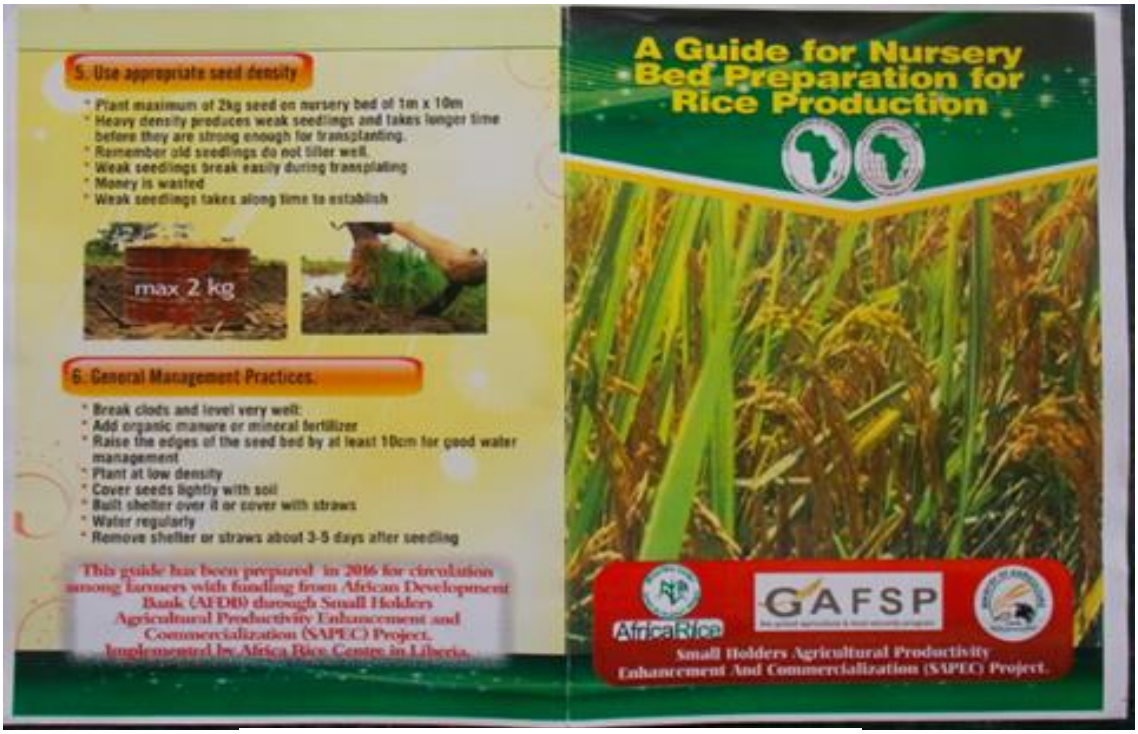


Figure 13: Flyer on Nursery bed preparation

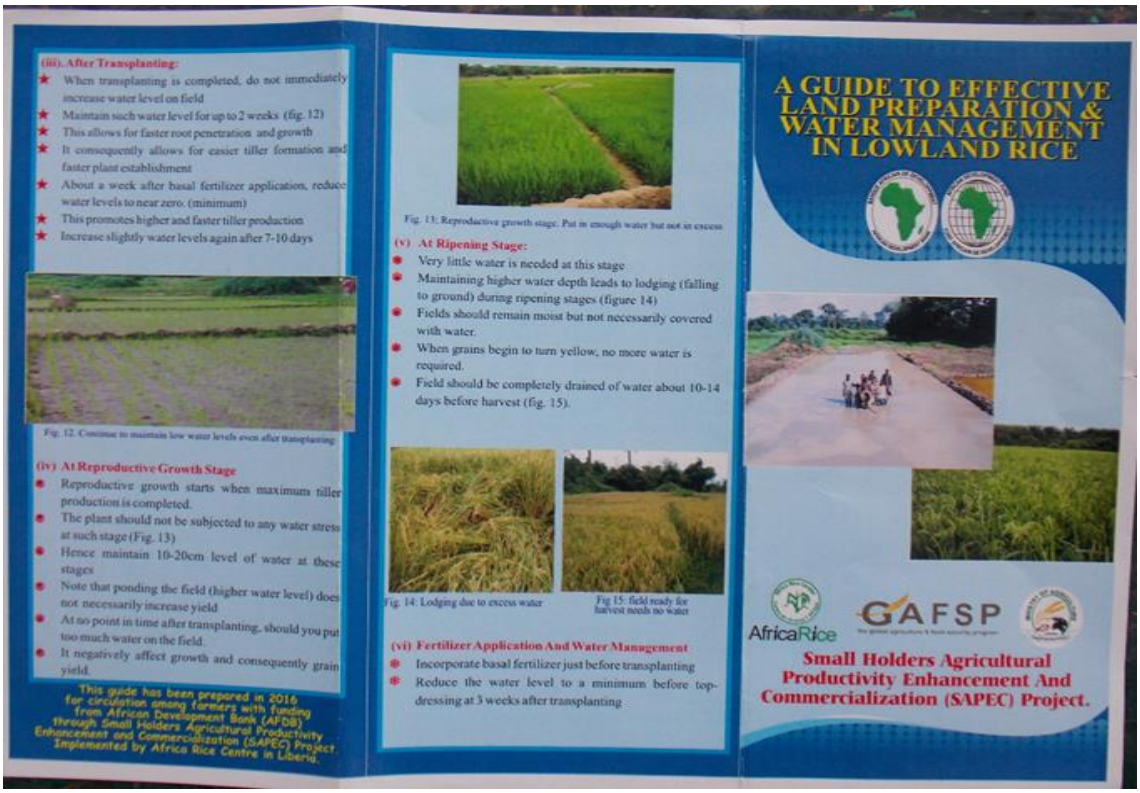


Figure 14: Flyer on Effective Land Preparation & Water Management

Figure 15: Flyer on Good practices in Seedling transplanting

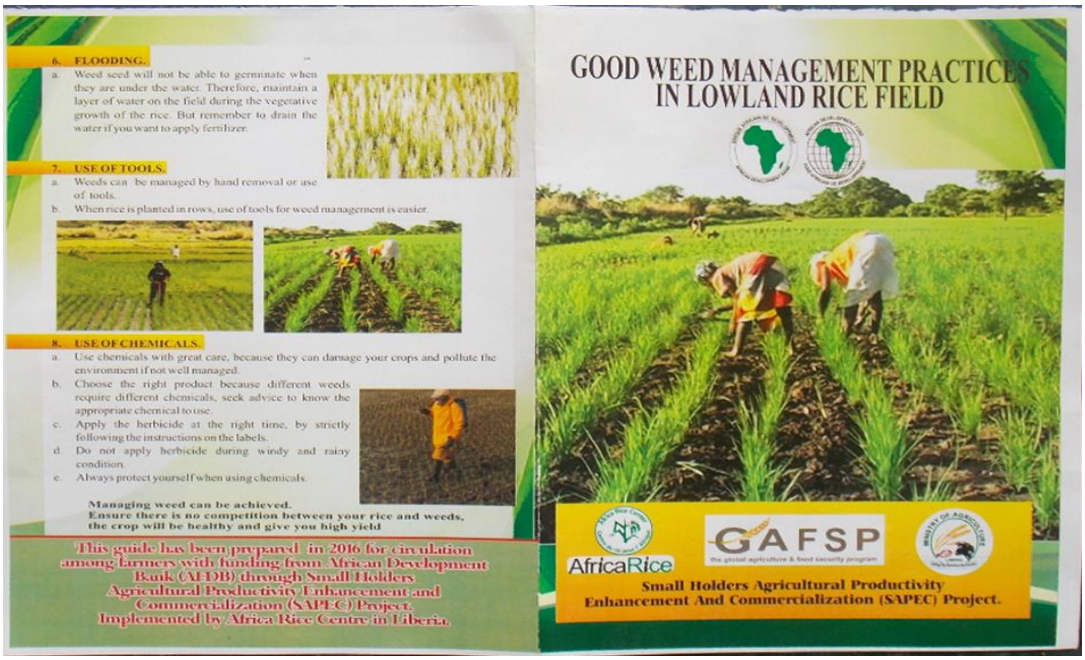


Figure 16: Flyer on Good Weed Management Practices

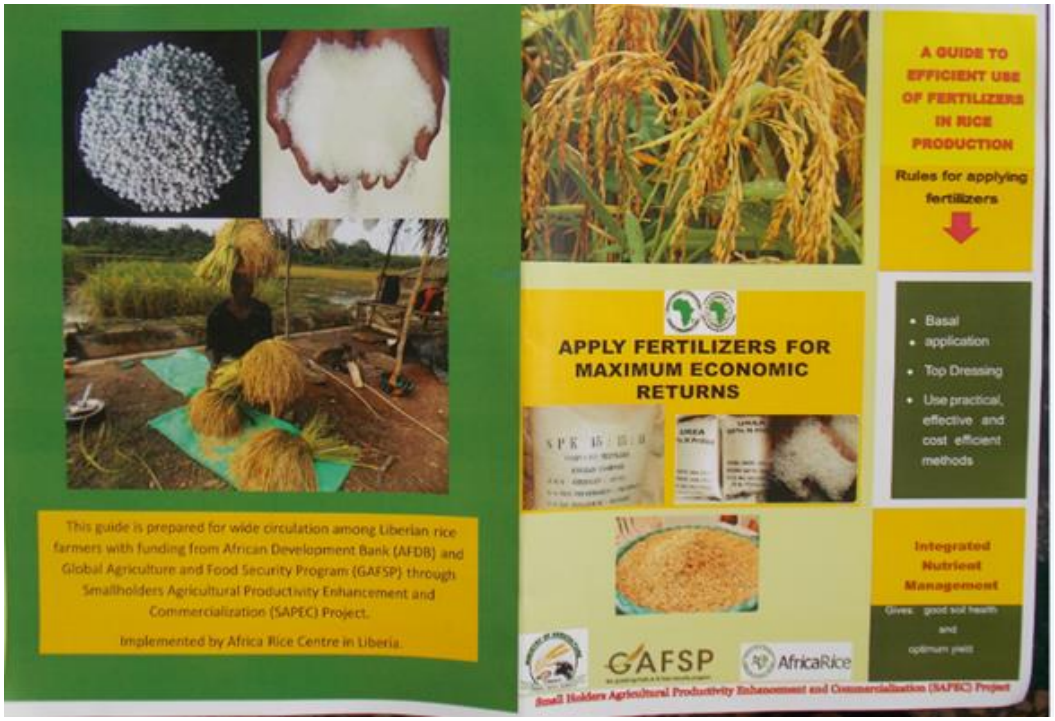


Figure 17: Flyer on Fertilizer Application in rice Production

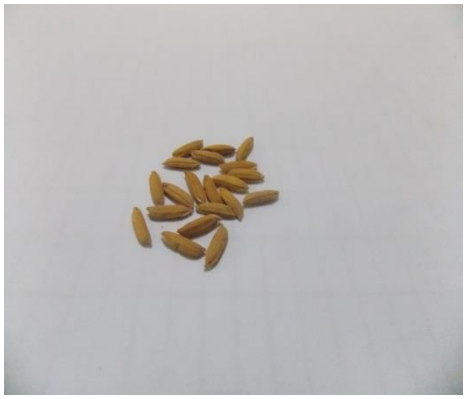
Figure 18: Flyer on Quality Rice Seeds Production

APPENDIX 1 PASSPORT DATA (Upland Varieties)

AfricaRice

Passport data

ARICA 4



AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **100-105 days**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **120 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

NERICA 4

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **95-100 days**

Actual yield: **3,410**

Resistance to leaf blast: **Medium**

Resistance insect: **Good**

Resistance to lodging: **Good**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: 120 cm

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis color: **White**

Apex color: **None**

AfricaRice

Passport data

NERICA 14

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **94 days**

Actual yield: **3,140 kg/ha.**

Resistance to leaf blast: **Medium**

Resistance insect: **Good**

Resistance to lodging: **Resistant**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **110 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis color: **Reddish**

Apex color: **Brown**

AfricaRice

Passport data

LAC 23 (white)

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **140-155 days**

Actual yield: **2,900 kg/ha**

Resistance to leaf blast: **resistant**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **164 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Awned**

Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

NERICA 12

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **90-100 days**

Actual yield: **4,040 kg/ha.**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **115 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis color: **Whitish**

Apex color: **None**

AfricaRice

Passport data

NERICA 18

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **90-100 days**

Actual yield: **3,490 kg/ha**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **130 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis color: **Red**

Apex color: **None**

AfricaRice

Passport data

NERICA 8

AGRONOMIC CHARACTERISTICS

Ecology: **Upland Rice**

Maturity: **75-85 days**

Actual yield: **3,510 kg/ha**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **100 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis color: **White**

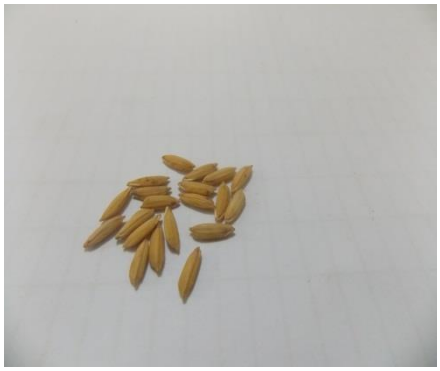
Apex color: **Light brown**

APPENDIX 2 PASSPORT DATA (Lowland Varieties)

AfricaRice

Passport data

NERICA –L19



AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **115-120 days**

Actual yield: **4,080 kg/ha**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Good**

Resistance to Iron toxicity: **Tolerant**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **132 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

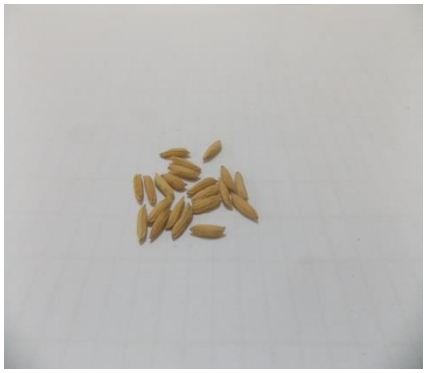
Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

ARICA 2



AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **115-120 days**

Actual yield: **4,360 kg/ha**

Resistance to leaf blast: **Resistant**

Resistance insect: **Good**

Resistance to lodging: **Good**

Resistance to Iron toxicity: **Good**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **106 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

IR 841

AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **115-118 m days**

Actual yield: **4,750 kg/ha**

Resistance to leaf blast: **Good**

Resistance insect: **Good**

Resistance to lodging: **Resistant**

Resistance to Iron toxicity: **Moderate**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **93 cm**

Tillering: **Good**

Panicle Grain

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

Aroma: **Perfume**

AfricaRice

Passport data

SUAKOKO 8

AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **135-140 days**

Actual: **1,230 kg/ha**

Resistance to leaf blast: **Resistant**

Resistance insect: **Good**

Resistance to lodging: **Moderate**

Resistance to Iron toxicity: **Tolerant**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **155 cm**

Tillering: **Moderate**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

NERICA -L20

AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **120-125 days**

Actual yield: **3,970 kg/ha**

Resistance to leaf blast: **Medium**

Resistance insect: **Good**

Resistance to lodging: **Good**

Resistance to Iron toxicity: **Good**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **110 cm**

Tillering: **Good**

Panicle

Exsertion: **Medium**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

AfricaRice

Passport data

ORYLUX 6

AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **90-100 days**

Actual yield: **2,380 kg/ha**

Resistance to leaf blast: **Medium**

Resistance insect: **Good**

Resistance to lodging: **Good**

Resistance to Iron toxicity: **Good**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **96 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: **Absent**

Caryopsis: **White**

Apex color: **None**

Aroma: **Perfume**

Passport data

WITA 9

AGRONOMIC CHARACTERISTICS

Ecology: **Lowland Rice**

Maturity: **115-120 days**

Actual yield: **4,380 kg/ha**

Resistance to leaf blast: **Medium**

Resistance insect: **Good**

Resistance to lodging: **Resistant**

Resistance to Iron toxicity: **Medium**

MORPHOLOGICAL CHARACTERISTICS

Plant

Height: **97 cm**

Tillering: **Good**

Panicle

Exsertion: **Good**

Grain

Awning: Absent

Caryopsis: White

Apex color: None