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EFFECTS OF SAWAH TECHNOLOGY ON THE GROWTH AND YIELD PERFORMANCE OF NERICA RICE VARIETIES IN THE SOUTH-EAST NIGERIA

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Abstract
Field experiment research was conducted to determine the effects of Sawah Technology on NERICA rice production from April to December 2020 during the rainy season at two different locations, namely, Ishieke and Imeoha Nkerefi in Ebonyi State and Enugu State respectively, both in the south-east of Nigeria. Six NERICA rice varieties: Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19 were used for the study on two Sawah fields and two non-Sawah fields measured 0.3ha each. Research data, namely: height, width, panicle length, grain number, and grain weight were collected starting from nursery to maturity of the rice. The study revealed that Sipi692033 has the highest yield of 5 tons/ha under Sawah Technology condition. The findings of the study show that the panicle length, grain number per panicle, weight of 1000 grains, and yield (ton/ha) were higher by 55.56 %, 50.00 %, 39.41 %, and 87.50 % respectively in the Sawah field relative to the non-Sawah field. The study concludes that Sawah technology enhances rice yield by at least 50 per cent.

Keywords: Growth, NERICA rice, Sawah technology, Yield performance.

1.0 INTRODUCTION

Rice is in high demand now as a result of population growth and its importance as sources of energy and other minerals. Rice is the most stable crop, and it feeds the majority of the world's population [1, 2]. Rice, according to [3] is not only a source of calories but also a source of revenue for rice farmers and job prospects for the unemployed youth. Rice could also be one of the cheapest technologies for small-scale farmers to improve productivity of crops in flooded and swampy environments through diverse land and water management systems, according to [4 - 6].

However, growth, yield, quality, and cultivation method of rice, on the other hand, are all factors to consider by rice farmers in other to have a bumper harvest. Rice yields are insufficient to meet the country's significant population growth, resulting in food shortages. According to [7], decreased rice output is linked to bug and pest infestations. Rice productivity is influenced by the environment, farming method, cultural practices, and biotic and abiotic factors [8]. No wonder, in the study of [9], rice yield can be improved through irrigation, fertilization, disease and insect controls. Lack of technology for rice production is one of the reasons that restrict rice production in some developing nations like Nigeria [10]. Rice yields in Nigeria and Ethiopia were reported to be 5.4 tons/ha and 6 tons/ha, respectively [5].

Meanwhile, in 1991, Africa Rice began a breeding programme for upland rice ecosystems, which resulted in the introduction of New Rice for Africa (NERICA) cultivars [11]. In 1994, [12 – 13] achieved the first agronomic performance in the African ecological zone that boosted rice diversifications. West African Rice Development Association (WARDA) later overcome the limitation by selecting seven upland rice varieties named NERICA, after previous attempts to crossbreed Oryza sativa with Oryza glaberrima failed due to sterility barriers [11, 14]. It was claimed in 2006 that the population of approved NERICA contained roughly eighty-eight cultivars and constituted one of Africa's major rice ecologies [11].

The NERICA varieties are the first large-scale crossbreeding success of the two cultivated species: Oryza sativa, often known as 'Asian rice,' and Oryza glaberrima, known as 'African rice,' which is exclusively found in Africa. It is a hybrid of rice developed by the Africa Rice Center (AfricaRice) to increase African cultivars' development and productivity. Oryza glaberrima has excellent adaptability to any environment, while Oryza sativa has a high yielding capability [15]. NERICA rice varieties were created with the primary goal of increasing rice productivity, producing high yields with minimal input in stress-affected ecosystems, increasing rice farmer income, and reducing food insecurity among poor rice farmers who hardly use correct farm input, which they claim they cannot afford [6, 16, 17]. This could be achieved by quality seed and creating a good rice environment, which Sawah technology is the achievable tool.

Precisely, Sawah refers to a levelled, bonded, and puddled paddy rice field with an inlet and outlets for water control. As a superior option or alternative to the current system, the Sawah rice production system assures correct water management of the rice environment, resulting in efficient and greater rice grain production with higher returns [8]. It is one of the most efficient systems for ensuring adequate production to fulfil ever-increasing demand while also preventing the country from wasting finite foreign exchange resources on imports [18, 19]. Bunding, ploughing, levelling, and smoothening of rice fields with inlet and outlet for irrigation and drainage are all part of the Sawah-based technology for rice production. It is very essential for Sawah system to be done in the lowland due to the weathering operation that takes place in the upland which washes down the nutrients to the lowland. [20] stated some of the achievement of Sawah technology, which includes improving rice mechanization in Nigeria, adoption of indigenous technologies in Fadama areas, an extension of rice cultivated areas and increase in quantity and quality of paddy rice. Sawah technology eases most of the operations in paddy rice production. The skills that make up the technology known as Sawah are site selection, Sawah system design, marking/ delineation, structural development, agronomic practices and finally water management as presented in Figure 1. The tillage operation in Sawah based technology includes ploughing, harrowing, puddling, levelling and smoothening which is best done using a single axle tractor called power tiller. The application of the power tiller for land development in Sawah based technology is important for rice field tillage operations.

Despite the efficacy of Sawah technology in rice production, it is influenced by some factors like soil type, topography, and climate. Consequently, the investigation of the performance of the technology needs to be carried out at different agricultural locations and regions. Observations from available literature indicate insufficient data on Sawah technology applications in South-East Nigeria. Therefore, the thrust of this paper is to determine the effects of Sawah Technology on the growth and yield performance of NERICA rice varieties in the South-East of Nigeria.

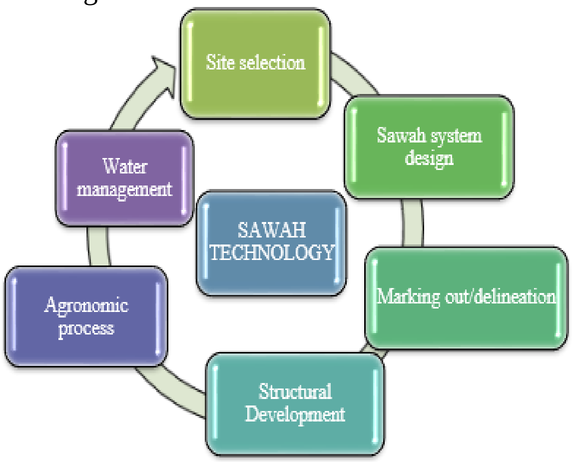


Figure 1: Flow chart of skill in Sawah technology for rice production

2.0 MATERIALS AND METHOD

The study was conducted in Nigeria from April to December 2020. Field experiments were carried out during rainy season in two different locations Ishieke in Ebonyi local government area of Ebonyi State (N 06° 22.704, E008 02.501’) and the second location at Imeoha Nkerefi, Nkanu East local government area of Enugu State (N 06° 04.991, E007 42.072’) all in the south-east of Nigeria. Six NERICA rice varieties: Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19 were used for the study. Two acrisol Sawah fields measuring 0.3 ha each was designed by constructing major bond at the perimeter of the rice field while peripheral bonding was done to get six basins. Land preparation was done in stages starting from mapping, clearing, ploughing, harrowing, flooding and puddling. Another area close to each of the Sawah fields was prepared using the conventional method of planting rice. Conventional method in this context is the old method of producing rice without the application of sawah technology, which does not involve proper water management, puddling, levelling and flooding. Rice nursery was established according to the six varieties and transplanted to both Sawah field and non-Sawah field. Data were collected starting from nursery to maturity of rice in the both Sawah and non-Sawah field. Descriptive statistics were used to analyze the panicle length, grain number per panicle, 1000 grain weight and tons per hectare.

Table 1 presented the six varieties of NERICA rice used in the study. The varieties were selected because of easy availability and accessibility. Some of the varieties have only old name without NERICA names such as FARO 44 and FARO 52. The two varieties that have no suffix (NERICA) like others. These six varieties are easily available in south-east of Nigeria.

Table 1: NERICA Rice varieties used for the study

S/N	Variety	Old Name	NERICA Name
1	FARO 44	Sipi692033	No name
2	FARO 52	WITA 4	No name
3	FARO 61	NERICA 34	NERICA 34
4	FARO 55	NERICA 1	NERICA 1
5	FARO 58	NERICA 7	NERICA 7
6	FARO 60	NERICA 19	NERICA 19

Table 2: Growth rate of the selected varieties at nursery stage

S/N	Variety	Old Name	Seedling Height (mm)
1	FARO 44	Sipi 692033	320
2	FARO 52	WITA 4	340
3	FARO 61	NERICA 34	320
4	FARO 55	NERICA 1	280
5	FARO 58	NERICA 7	300
6	FARO 60	NERICA 19	320

3.0 RESULTS AND DISCUSSION

Table 2 presents the height of seedlings in the nursery. The six varieties used in the study have almost the same rate of growth. The growth of Sipi 692033, NERICA 34 and NERICA 19 is 320 mm at 28 days old. The least growth is NERICA 1 while WITA 4 has the highest growth of 340 mm at the nursery stage, it is in line with the study of [22].

3.1 EFFECT OF SAWAH TECHNOLOGY ON THE GROWTH OF SIX NERICA RICE VARIETIES FROM TRANSPLANTING STAGE TO FLOWERING STAGE

Figures 2 to 7 presented the height, width and tiller number of the six NERICA varieties in both sawah and non-sawah fields, collected on weekly bases which took six weeks except FARO 52 (WITA 4) which took eight weeks (56 days). It was analyzed based on the two locations in accordance with Sawah and Non-Sawah field.

3.1.1 Effect of Sawah Technology on Sipi693033 Growth

Figure 2a and b represent FARO 44 (Sipi693033) growth performance in Ishieke and Nkerefi locations respectively for the Sawah and non-Sawah rice fields. In Ishieke Sawah field, the initial height and width after transplanting were 32 cm and 0.3 cm respectively, and the height at flowering stage (42 days) was 100 cm and 1.3 cm respectively; whereas in the non-Sawah fields, the height increased from 32 cm to 80 cm from the transplanting stage to the flowering stage, making a difference of 20 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 0.9 cm from the transplanting stage to the flowering stage, making a difference of 0.4 cm in favour of the Sawah field.

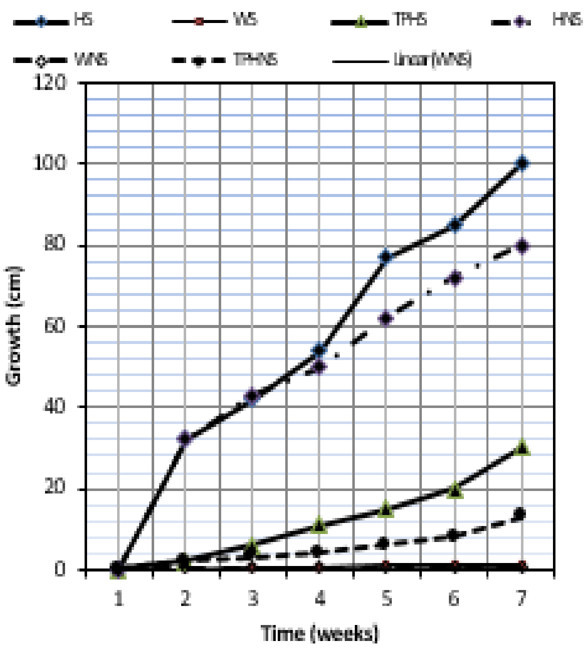


Figure 2a: Sipi693033 at Ishieke Field

In the Nkerefi Sawah field, the initial height and width after transplanting were 30 cm and 0.2 cm respectively, and the height at the flowering stage (42days) was 82 cm and 1.4 cm respectively; whereas in the non-Sawah fields, the height increased from 30 cm to 72 cm from the transplanting stage to the flowering stage, making a difference of 10 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 0.9 cm from the transplanting stage to the flowering stage, making a difference of 0.5 cm in favour of Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 17 tillers (30, 13) in favour of Sawah field from transplanting stage to flowering stage at Ishieke location, while in Nkerefi, there is a difference of 22 tillers (34, 12) in favour of the Sawah field from transplanting stage to flowering stage. The finding of the study implies that the Sawah field favours rice production compared to non-Sawah field. The findings of the study are in line with the submission of [21] that Sawah technology promotes rice production.

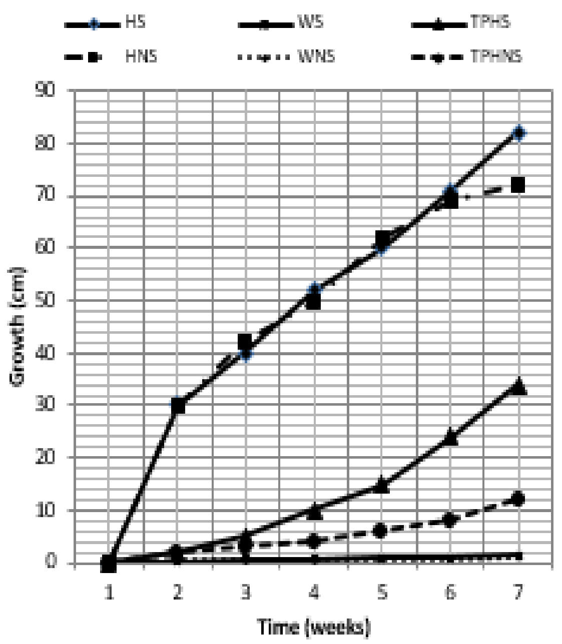


Figure 2b: Sipi693033 at Nkerefi Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

3.1.2 Effect of Sawah Technology on WITA 4 Growth

Figure 3a and b represent FARO 52 (WITA 4) growth performance at Ishieke and Nkerefi locations respectively for the Sawah and non-Sawah rice fields. In the Ishieke Sawah field, the initial height and width after transplanting were 34 cm and 0.2 cm respectively, and the height at flowering stage (42days) was 130 cm and 1.2 cm respectively; whereas in the non-Sawah fields, the height increased from 34 cm to 95 cm from the transplanting stage to the flowering stage, making a difference of 35 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 0.9 cm from the transplanting stage to the flowering stage, making a difference of 0.3 cm in favour of the Sawah field.

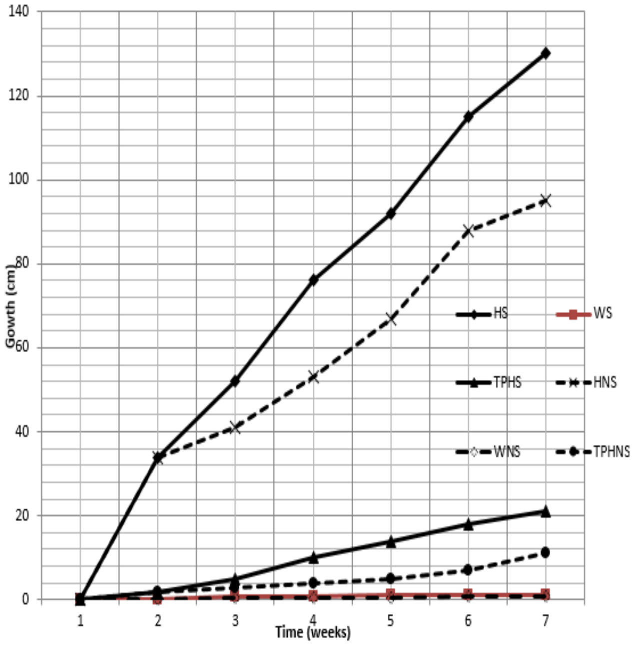


Figure 3a: WITA 4 at Ishieke Field

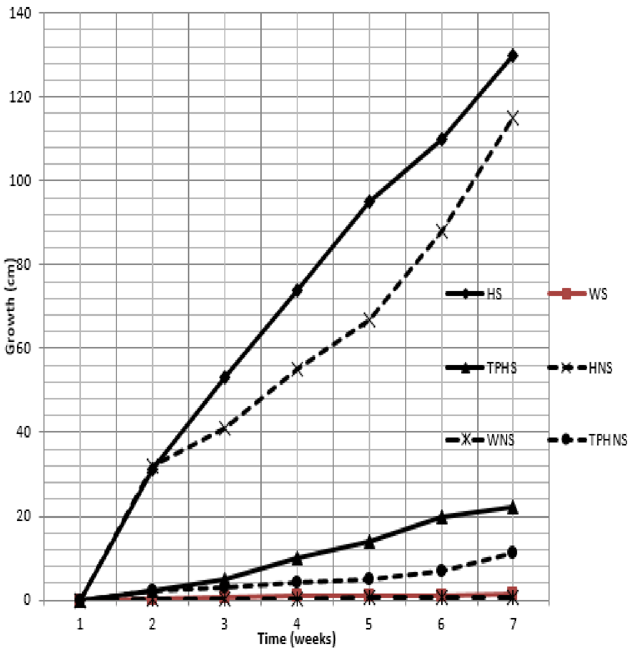


Figure 3b: WITA 4 at Nkerefi Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

In the Nkerefi Sawah field, the initial height and width after transplanting were 31 cm and 0.1 cm respectively, and the height at the flowering stage

(42days) was 130 cm and 1.1 cm respectively; whereas in the non-Sawah field, the height increased from 32 cm to 115 cm from the transplanting stage to the flowering stage, making a difference of 15 cm in favour of the Sawah field. Also, the width increased from 0.2 cm to 0.8 cm from the transplanting stage to the flowering stage, making a difference of 0.3 cm in favour of the Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 10 tillers (21, 11) in favour of the Sawah field from the transplanting stage to flowering stage at Ishieke location, while in Nkerefi, there is a difference of 11 tillers (22, 11) in favour of the Sawah field from the transplanting stage to flowering stage. The finding of the study implies that the Sawah field favours rice production compared to the non-Sawah field. The findings of the study are in line with the submission of [22] that Sawah rice eco-technology is a veritable tool to achieve green revolution.

3.1.3 Effect of Sawah Technology on NERICA 34 Growth

Figures 4a and b represent FARO 61 (NERICA 34) growth performance at Ishieke and Nkerefi locations respectively for the Sawah and non-Sawah rice fields. In the Ishieke Sawah field, the initial height and width after transplanting was 32 cm and 0.4 cm respectively, and the height at flowering stage (42days) was 90 cm and 1.4 cm respectively; whereas in the non-Sawah fields, the height increased from 32 cm to 80 cm from the transplanting stage to the flowering stage, making a difference of 10 cm in favour of the Sawah field.

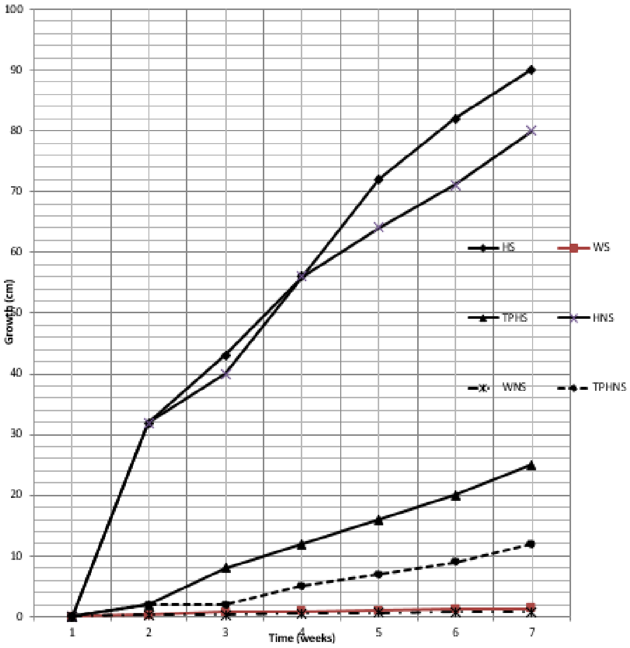


Figure 4a: NERICA 34 at Ishieke Sawah Field

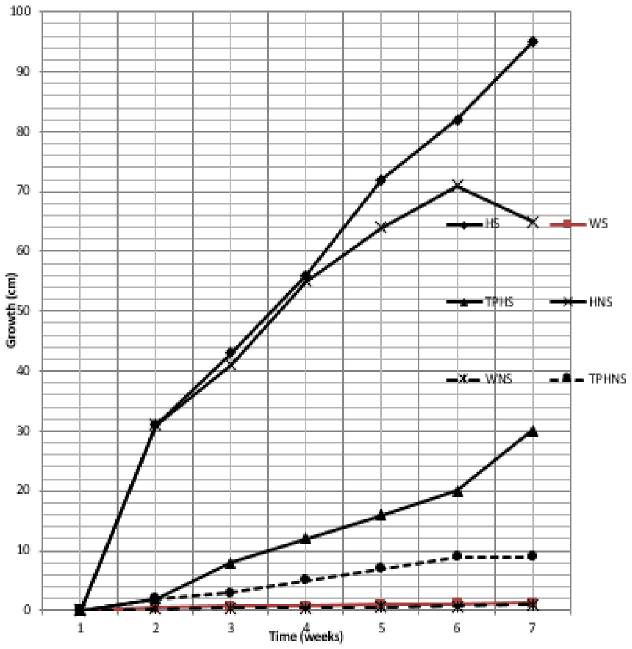


Figure 4b: NERICA 34 at Ishieke Non-Sawah Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

Also, the width increased from 0.3 cm to 0.7 cm from the transplanting stage to the flowering stage, making a difference of 0.7 cm in favour of Sawah field. In the Nkerefi Sawah field, the initial height and width after transplanting were 31 cm and 0.4 cm respectively, and the height at the flowering stage (42days) was 95 cm and 1.3 cm respectively; whereas in the non-Sawah field, the height increased from 31 cm to 65 cm from the transplanting stage to the flowering stage, making a difference of 30 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 1.0 cm from the transplanting stage to the flowering stage, making a difference of 0.3 cm in favour of the Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 13 tillers (25, 12) in favour of the Sawah field from the transplanting stage to the flowering stage at Ishieke location, while in Nkerefi, there is a difference of 21 tillers (30, 09) in favour of the Sawah field from transplanting stage to flowering stage. The finding of the study implies that the Sawah field favours rice production compared to non-Sawah field. The findings of the study are in line with the submission of [23] that Sawah technology is a great potential to boost rice production in Nigeria.

3.1.4 Effect of Sawah Technology on NERICA 1 Growth

Figure 5a and b represent FARO 55 (NERICA 1) growth performance at Ishieke and Nkerefi locations respectively for the Sawah and non-Sawah rice fields. In the Ishieke Sawah field, the initial height and width after transplanting were 28 cm and 0.3 cm respectively, and the height at flowering stage (42days) was 125 cm and 1.2 cm respectively; whereas in the non-Sawah field, the height increased from 28 cm to 90 cm from the transplanting stage to the flowering stage, making a difference of 35 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 0.8 cm from the transplanting stage to the flowering stage, making a difference of 0.4 cm in favour of the Sawah field.

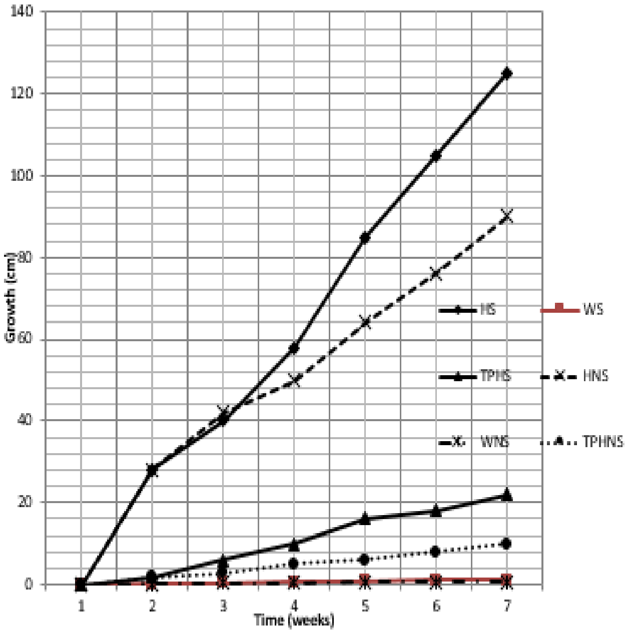


Figure 5a: NERICA 1 at Ishieke Field

In the Nkerefi Sawah field, the initial height and width after transplanting were 30 cm and 0.3 cm respectively, and the height at the flowering stage (42days) was 95 cm and 1.1 cm respectively; whereas in the non-Sawah field, the height increased from 30 cm to 80 cm from the transplanting stage to the flowering stage, making a difference of 15 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 1.0 cm from the transplanting stage to the flowering stage, making a difference of 0.1 cm in favour of the Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 12 tillers (22, 10) in favour of the Sawah field from the transplanting stage to the flowering stage at Ishieke location, while in Nkerefi, there is a difference of 6 tillers (20, 14) in favour of the Sawah field from the transplanting stage to the flowering stage. The finding of the study implies that the Sawah field favours rice production compared to the non-Sawah field. The findings of the study are in line with the submission of [24] that the Sawah technology promotes rice production.

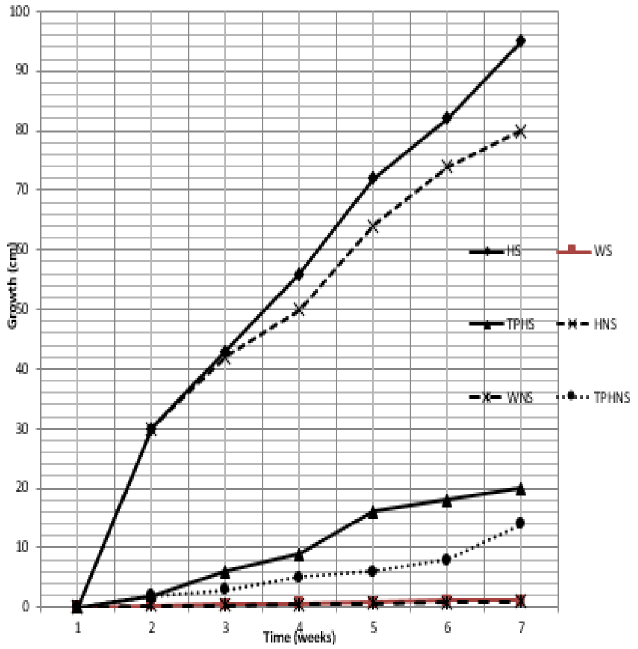


Figure 5b: NERICA 1 at Nkerefi Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

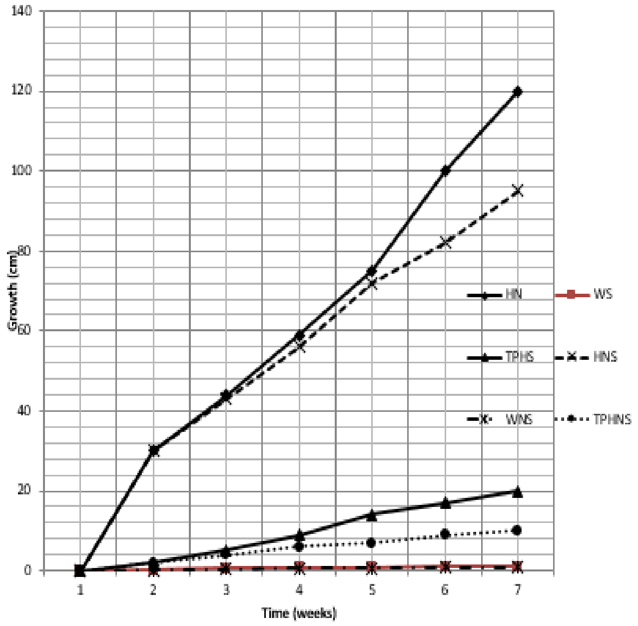


Figure 6a: NERICA 7 at Ishieke Field

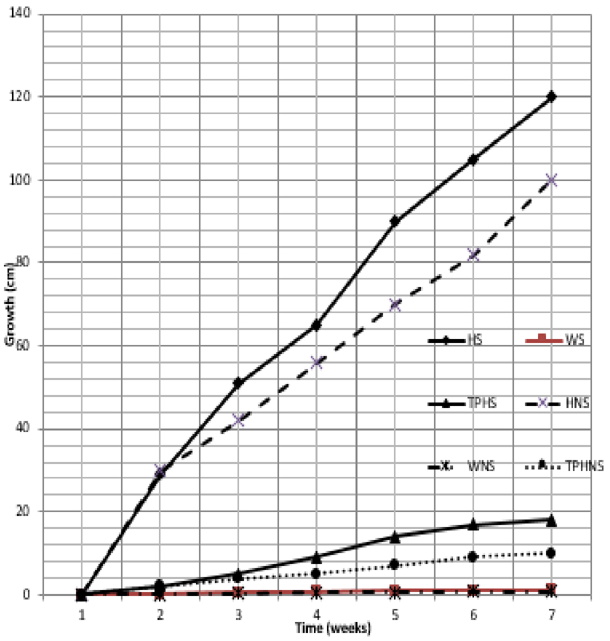


Figure 6b: NERICA 7 at Nkerefi Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

3.1.5 Effect of Sawah Technology on NERICA 7 Growth

Figure 6a and b represent FARO 58 (NERICA 7) growth performance in the Ishieke location respectively for Sawah and non-Sawah rice field. In the Ishieke Sawah field, the initial height and width after transplanting were 30 cm and 0.6 cm respectively, and the height at the flowering stage (42days) was 120 cm and 1.1 cm respectively; whereas in the non-Sawah field, the height increased from 30 cm to 95 cm from the transplanting stage to the flowering stage, making a difference of 25 cm in favour of the Sawah field. Also, the width increased from 0.2 cm to 0.9 cm from the transplanting stage to the flowering stage, making a difference of 0.2 cm in favour of the Sawah field. In the Nkerefi Sawah field, the initial height and width after transplanting was 29 cm and 0.2 cm respectively, and the height at the flowering stage (42days) was 120 cm and 1.1 cm respectively; whereas in the non-Sawah field, the height increased from 30 cm to 100 cm from the transplanting stage to the flowering stage, making a difference of 20 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 0.8 cm from the transplanting stage to the flowering stage, making a difference of 0.3 cm in favour of the Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 10 tillers (20, 10) in favour of Sawah field from transplanting stage to flowering stage at Ishieke location, while in Nkerefi, there is a difference of 8 tillers (18, 10) in favour of Sawah field from transplanting stage to flowering stage. The finding of the study implies that the Sawah field favours rice production compared to the non-Sawah field. The findings of the study are in line with the submission of [25] that Sawah technology s ecological engineering for sustainable rice production.

3.1.6 Effect of Sawah Technology on NERICA 19 growth

Figure 7a and b represent FARO 60 (NERICA 19) growth performance at Ishieke and Nkerefi locations respectively for Sawah and non-Sawah rice field. In Ishieke Sawah fields, the initial height and width after transplanting were 32 cm and 0.4 cm respectively, and the height at flowering stage (42days) was 110 cm and 1.2 cm respectively; whereas in the non-Sawah fields, the height increased from 32 cm to 93 cm from the transplanting stage to the flowering stage, making a difference of 17 cm in favour of the Sawah field. Also, the width increased from 0.3 cm to 1.0 cm from the transplanting stage to the flowering stage, making a difference of 0.2 cm in favour of Sawah field.

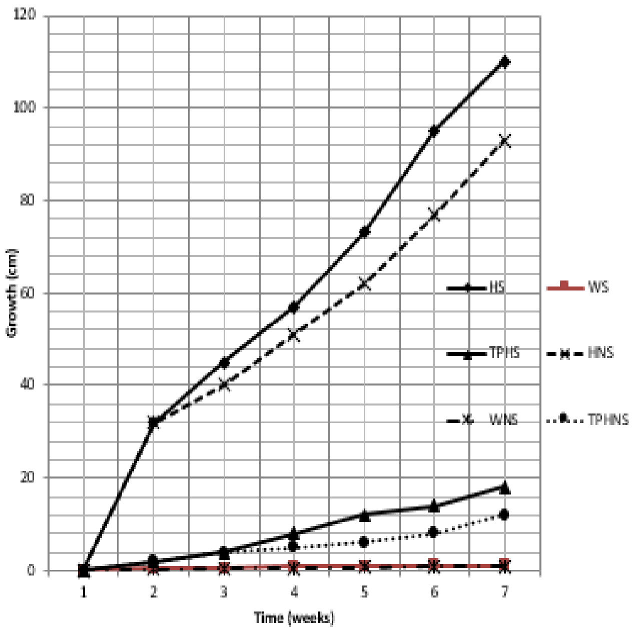


Figure 7a: NERICA 19 at Ishieke Field

In the Nkerefi Sawah field, the initial height and width after transplanting were 31 cm and 0.4 cm respectively, and the height at the flowering stage (42days) were 100 cm and 1.0 cm respectively;

whereas in the non-Sawah field, the height increased from 30 cm to 90 cm from the transplanting stage to the flowering stage, making a difference of 10 cm in favour of the Sawah field. Also, the width increased from 0.2 cm to 0.9 cm from the transplanting stage to the flowering stage, making a difference of 0.1 cm in favour of the Sawah field. For the tiller per hill parameter, analysis of the result indicates a difference of 6 tillers (18, 12) in favour of the Sawah field from the transplanting stage to the flowering stage at Ishieke location, while in Nkerefi, there is a difference of 6 tillers (16, 10) in favour of the Sawah field from the transplanting stage to the flowering stage. The finding of the study implies that the Sawah field favours rice production compared to the non-Sawah field. The result of the study is in line with the submission of [22] that the Sawah technology promotes rice production.

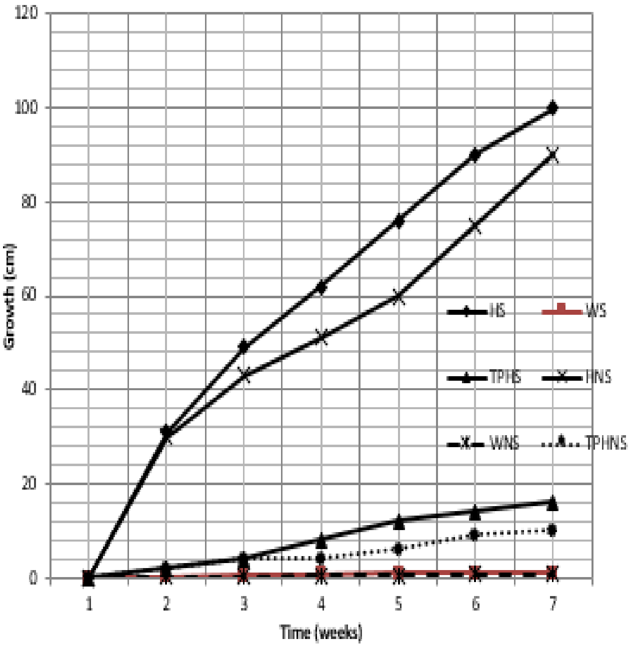


Figure 7b: NERICA 19 at Nkerefi Field

HS = Height in the Sawah field, WS = Width in the Sawah field, TPHS = Tiller per hill in the Sawah field, HNS = Height in the Non-Sawah field, WNS = Width in the Non-Sawah field and TPHNS = Tiller per hill in the Non-Sawah field.

3.2 EFFECT OF SAWAH TECHNOLOGY ON YIELD PERFORMANCE

The results of yield performance of the six varieties of NERICA rice used for the study were presented in Figure 8 to Figure 11 respectively. They are discussed bellow.

3.2.1 Panicle Length of Six NERICA Rice Varieties in Sawah and Non-Sawah at Ishieke Rice Field

Figure 8a below shows the panicle length of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has panicle length of 28 cm in the Sawah area while in the non-Sawah area it has a panicle length of 18 cm. WITA 4 has 27 cm in the Sawah and 20 cm panicle length in the non-Sawah area. NERICA 34 has 25 cm in the Sawah and 16.5 cm in the non-Sawah area. NERICA 1 has 23 cm in the Sawah and 20 cm in the non-Sawah area. NERICA 7 has 24 cm in the Sawah and 21cm in the non-Sawah area. Finally, NERICA 19 has 22 cm in the Sawah and 20 cm in the non-Sawah area. Figure 8b below shows the panicle length of the same six NERICA varieties. Sipi692033 has panicle length of 28.5 cm in the Sawah area while in the non-Sawah area it has panicle length of 16 cm. WITA 4 has 28 cm in the Sawah and 17.5 cm panicle length in the non-Sawah area. NERICA 34 has 26.4 cm in the Sawah and 17 cm in the non-Sawah area. NERICA 1 has 22 cm in the Sawah and 16 cm in the non-Sawah area. NERICA 7 has 27 cm in the Sawah and 14 cm in the non-Sawah area. Finally, NERICA 19 has 20 cm in the Sawah and 15 cm in the non-Sawah area. In all, the six varieties performed better in the Sawah area than in the non-Sawah area, more especially Sipi692033 that produces the highest panicle length in the Sawah area.

3.2.2 Grain Number per Panicle of Six NERICA Rice Varieties in Sawah and Non-Sawah at Ishieke Rice Field

Figure 9a below shows the grain number per panicle of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has a grain number per panicle of 150 in the Sawah area while in the non-Sawah area it has 100 grain number per panicle. WITA 4 has 138 in the Sawah and 93- grain number per panicle in the non-Sawah area. NERICA 34 has 136 in the Sawah and 85 in the non-Sawah area. NERICA 1 has 112 in the Sawah and 93 in the non-Sawah area. NERICA 7 has 105 in the Sawah and 94 in the non-Sawah area. Finally, NERICA 19 has 112 in the Sawah and 88 in the non-Sawah area. Figure 9b below shows the grain number per panicle of six NERICA rice varieties. Sipi692033 has grain number per panicle of 148 in the Sawah area while in the non-Sawah area it has 110-grain number per panicle. WITA 4 has 140 in the Sawah and 98-grain number per panicle in the non-Sawah area. NERICA 34 has 150 in the Sawah and 100 in the non-Sawah area. NERICA 1 has 110 in the Sawah and 87 in the non-Sawah area. NERICA 7 has 100 in the Sawah and 80 in the non-Sawah area. Finally, NERICA 19 has 113 in the Sawah and 77 in the non-Sawah area. In all, the six varieties performed better in the Sawah area than in the non-Sawah area.

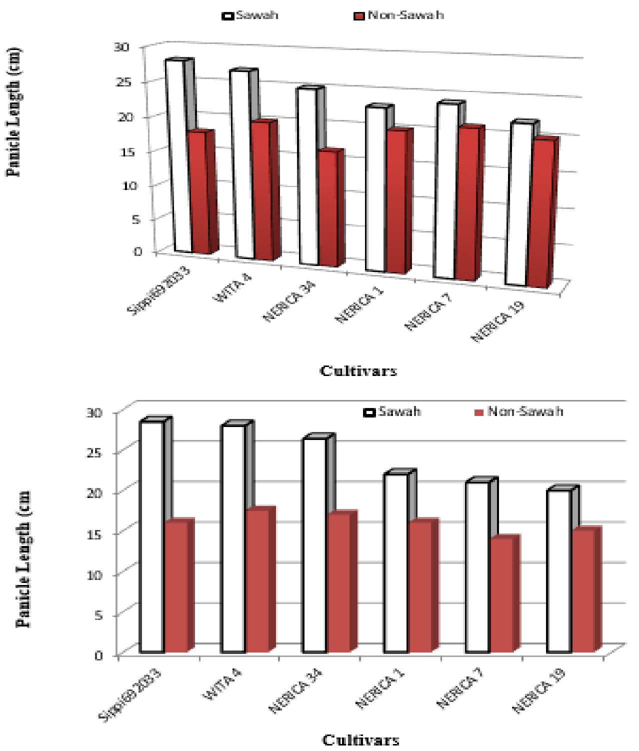
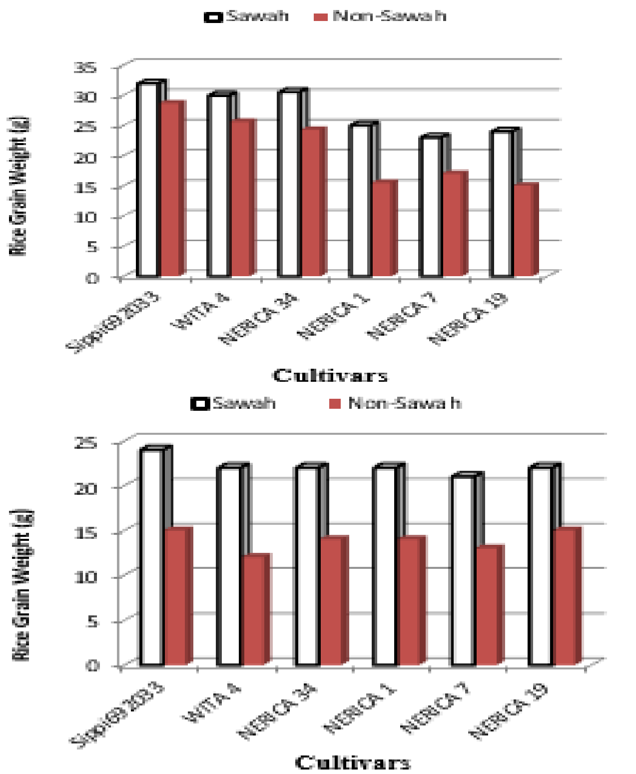


Figure 8a and b: Panicle Length of Six NERICA Rice Varieties at Ishieke and Nkerefi Sawah and Non-Sawah Rice Experimental Field



Figures 10a and b: 1000 Grain Weight of Six NERICA Rice Varieties at Ishieke and Nkerefi Sawah and Non-Sawah Rice

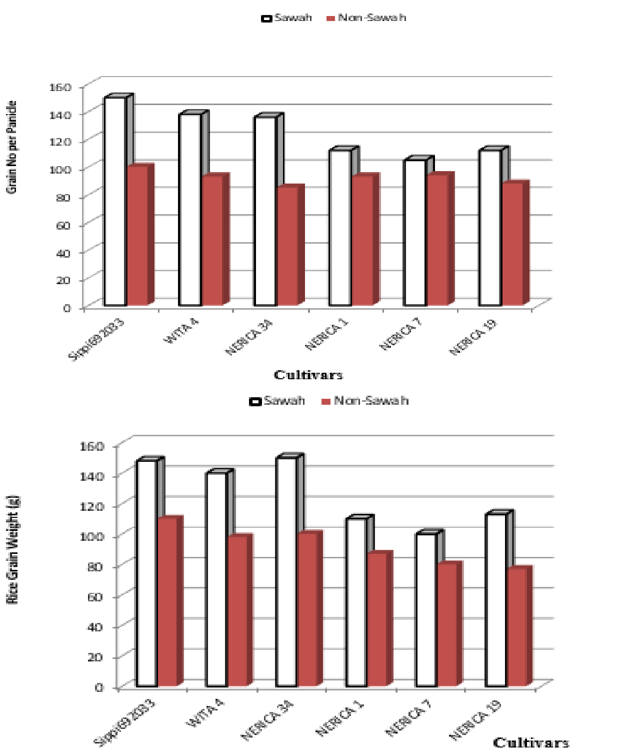
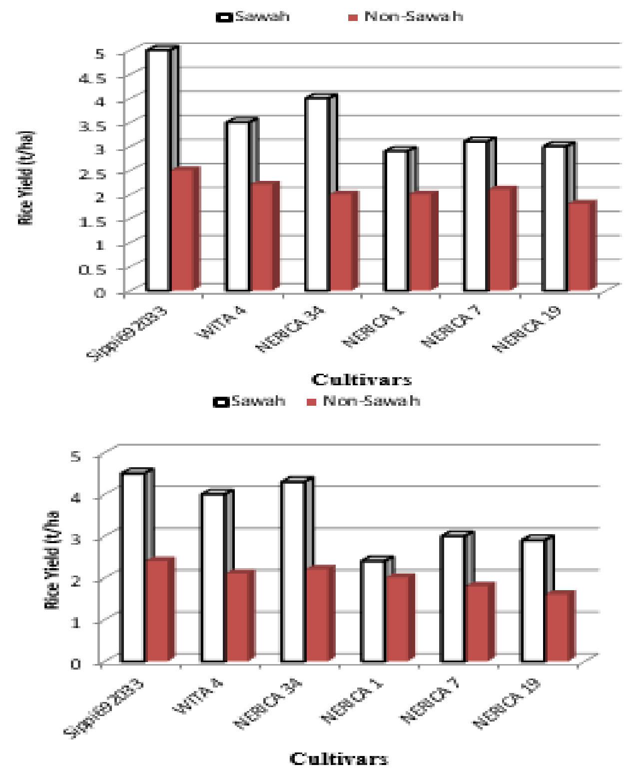


Figure 9a and b: Grain Number per Panicle of six NERICA Rice Varieties at Ishieke and Nkerefi Sawah and Non-Sawah Rice



Figures 11a and b: Yield of Six NERICA Rice Varieties at Ishieke Sawah and Non-Sawah Rice Field

3.2.3 1000 Rice Grain Weight of Six NERICA Rice Varieties in Sawah and Non-Sawah at Ishieke Rice Field

Figure 10a above shows the 1000 grain weight of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has 1000 grain weight of 31.97 g in the Sawah area while in the non-Sawah area it has a 1000 grain weight of 28.67 g. WITA 4 has 29.96 g in the Sawah and 25.61 g of 1000 grain weight in the non-Sawah area. NERICA 34 has 30.55 g in the Sawah and 24.28 g in the non-Sawah area. NERICA 1 has 25 g in the Sawah and 15.50 g in the non-Sawah area. NERICA 7 has 23.00 g in the Sawah and 17 g in the non-Sawah area. Finally, NERICA 19 has 24.00 g in the Sawah and 15.00 g in the non-Sawah area. Figure 10b below shows the 1000 grain weight of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has a 1000 grain weight of 24.00 g in the Sawah area while in the non-Sawah area it has 1000 grain weight of 15.00 g. WITA 4 has 22.00 g in the Sawah and 12.00 g of 1000 grain weight in the non-Sawah area. NERICA 34 has 22.00 g in the Sawah and 14.00 g in the non-Sawah area. NERICA 1 has 22.00 g in Sawah and 14.00 g in the non-Sawah area. NERICA 7 has 21.00 g in Sawah and 13.00 g in the non-Sawah area. Finally, NERICA 19 has 22.00 g in the Sawah and 15.00 g in the non-Sawah area. In all, the six varieties performed better in the Sawah area than in the non-Sawah area.

3.2.4 Rice Yield of Six NERICA Rice Varieties in Sawah and Non-Sawah at Ishieke Rice Field

Figure 11a above shows the yield of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has a yield of 5 tons/ha in the Sawah area while in the non-Sawah area it has a yield of 2.5 tons/ha. WITA 4 has 3.5 tons/ha in the Sawah and 2.2 tons/ha in the non-Sawah area.

NERICA 34 has 4 tons/ha in the Sawah and 2 tons/ha in the non-Sawah area. NERICA 1 has 2.9 tons/ha in the Sawah and 2 tons/ha in the non-Sawah area. NERICA 7 has 3.1 tons/ha in the Sawah and 2.1 tons/ha in the non-Sawah area. Finally, NERICA 19 has 3 tons/ha in the Sawah and 1.8 tons/ha in the non-Sawah area. Figure 11b below shows the yield of Sipi692033, WITA 4, NERICA 34, NERICA 1, NERICA 7 and NERICA 19. Sipi692033 has a yield of 4.5 tons/ha in the Sawah area while in the non-Sawah area it has a yield of 2.4 tons/ha. WITA 4 has 4 tons/ha in the Sawah and 2.1 tons/ha in the non-Sawah area. NERICA 34 has 4.3 tons/ha in the Sawah and 2.2 tons/ha in the non-Sawah area. NERICA 1 has 2.4 tons/ha in the Sawah and 2 tons/ha in the non-Sawah area. NERICA 7 has 3 tons/ha in the Sawah and 1.8 tons/ha in the non-Sawah area. Finally, NERICA 19 has 2.9 tons/ha in the Sawah and 1.6 tons/ha in the non-Sawah area. In all, the six varieties performed better in the Sawah area than in the non-Sawah area.

4.0 CONCLUSION

The following are conclusions drawn from the findings of this research.

1. FARO 55 generates the least height of seedling, while FARO 52 has the highest seedling height at the nursery stage in South-East Nigeria.
2. Sawah Technology enhances rice growth in South-East Nigeria.
3. Sawah Technology promotes NERICA panicle length yield performance.
4. The number of grains per panicle, 1000 grain weight and tons per hectare increase with the application of Sawah Technology.
5. Sipi692033 variety has the highest yield under Sawah Technology condition in South East Nigeria.
6. Sawah Technology produces 50 % rice yield above what the non-Sawah Technology field offers.

REFERENCES

[1] FARA, Fouran for Agricultural Research in Africa. (2009). Patterns of Change in Rice Production in Africa: Implications for Rice Policy Development. Ministerial Policy Brief series. Accra Ghana, http//www.fara Publicatio ns/ministerial Policy brief. Number 2.

[2] WARDA, (2007) Africa Rice trends: Overview of Recent Development in Sub-Sahara Africa Sector. Africa Rice Center Brief, Cotonou. WARDA, BENIN. pp. 8

[3] Workneh, B., Hisashi, U. and Masaaki, T. (2014). Growth Pattern and Yield of NERICA 1 and NERICA 4 Rice Varieties as a Function of Split Nitrogen Application at Tsukuba, East Japan. *Agriculture, Forestry and Fisheries.* 1(3), pp. 24-29.

[4] Seyoum, M. (1999). Rice Potential Crop for Food Security in Amhara Region. *Agri-Topia Weslett. Ethiopia Agric. Res.Org*. 14. pp. 1-2

[5] Seyoum, M., Alamerew, S. and Bautte, K. (2011). Evaluation of upland NERICA rice Genotype for Grain Yield and Yield Component along an Altitude Gradient in Southwest Ethiopia. *Journal of Agronomy* 10 (4), pp. 105 – 111.

[6] Gebrekidan, H. and Seyoum, M. (2006). Effect of mineral N and P fertilizers on yield and yield

components of flooded rice on vertisol of fogera plain Ethiopia. *Journal of Agriculture and Rural Development. Tropical and Subtropicals* 107, pp.161 –178.

[7] Ogah E. O. (2013). Evaluating the Impact of New Rice for Africa (NERICA) in the Management of Rice Stem Borers 14, pp. 58 - 72.

[8] Edu, C. N., Oduma, O., Okeke, C. G., Ehiomogue, P., Umunna, M. F. and Udensi, N. K. (2021). Effect of Milling Process and Storage Period on the Proximate Characteristics of Rice Grains. *ACTA Technica Corviniensis-Bulletin of Engineering Tome XIV. Fesicule* 3, ISSN: 2067 – 3809.

[9] Yang, W., Peng, S., Laza, R.C., Visperas, R. M., Dionisio-Sese, M. L. (2017). Grain yield and yield attributes of new plant type and hybrid rice. *Journal of Crop Science* 47, pp 1393-1400.

[10] Okeke, C. G. and Oluka, S. I. (2017). A Survey of Rice Production and Processing in south East Nigeria. *Nigerian Journal of Technology* 1(36), pp 227 – 234.

[11] Africa Rice Center, (WARDA)/FAO/SAA. (2008). NERICA: the New Rice for Africa – a Compendium. EA Somado, RG Guei and SO Keya (eds.). Cotonou, Benin: Africa Rice Center (WARDA); Rome, Italy: FAO; Tokyo, Japan: Sasakawa Africa Association, 210 pp 1 - 210.

[12] Wopereis, M. C. S., Diagne, A., Rodenbung, J., Sie, M. and Somado, E. A. (2008) "Why NERICA is Successful innovation for African Farmers. A response to Orr et al. from the Africa Rice center". Outlook on Agriculture 37(3), pp. 169 – 176.

[13] Jones, M. P., dingkuhn, M., Aluko, G. K. and Semon, M. (1997). Interspecific Oryza Sativa and Glaberrima Steud. Progenies in Upland rice improvement. Euphytica. 2, pp. 237 – 246.

[14] Dingkuhun, M., Jones, M. P., Johnson and Sow, A. (1998). Growth and yield potential and *Oryza* Sativa and O. glaberima upland rice cultivars and their Interspacific progenies. *Field Crop Research* 57, pp 57- 69.

[15] Noori, Z., Kakar, K., Fujii, T. and Biaojun J. (2017). Growth and yield characteristics of upland rice 2017 cultivar NERICA field condition. International *Journal of Agronomy and agricultural Research (IJAAR)* 5(10), pp. 59-68.

[16] Stryker D.J., (2010). Developing competitive rice value chains. Panel discussion on second Africa Rice Congress, Innovation and Partnerships to realize Africa's Rice Potential, Bamako, Mali.

[17] Atera, E. A., Onyango, J. C., Azuma, T., Asanuma, S. and Itoh, K. (2011). Field evaluation of selected NERICA rice cultivars in Western Kenya. African. *Journal of Agricultural Research* 6(1), pp. 60-66.

[18] Defoer, T., Dugue, M. J., Loosvelt, M. and Soklou, W. S. (2017). Smart-Valleys: Trainee-facilitators' Manual, pp 1 – 134.

[19] Wakatsuki, T., Buri, M. M., Bam, R., Oladele, O. I., Ademiluyi, S. Y., S.E. Obalum, S. E. and Igwe, C. A. (2018). Sawah Technology (3Paper) Principles: *Sawah* hypothesis (1) the platform for scientific technology evolution and *Sawah* hypothesis (2) the platform for sustainable intensification in watershed agroforestry (Africa SATOYAMA System) 3 & 18 July 2018 Version

[20] Kolawole, A., Oladele, O. I. and Wakatsuki, T. (2011). Profitability of different Sawah rice production models within lowlands in Nigeria. *Journal of Food Agriculture and Environment* 9(1), pp. 268 - 274.

[21] Nwite, J. C., Obalum, S. E., Igwe, C. A., Ogbodo, E. N., Keke, C. I., Essien, B. A., and Wakatsuki, T. (2012). Sawah rice System, a Technology for Sustainable Production and Soil Chemical Properties Improvement in Ebonyi State of Southeastern Nigeria. *World Journal of Agricultural Science* 8(4), 351 – 358.

[22] Oladele, O. I. and Wakatsuki T. (2010). Sawah rice eco-technology and actualization of Green Revolution in West Africa: Experience from Ghana and Nigeria. *Rice Science* 17(3), 168 – 172

[23] Ademiluyi, Y. S., Oladele, I. O. and Wakatsuki, T. (2008). Socioeconomic factors affecting Power Tiller use among Sawah Farmers in Bida Nigeria. *Journal of food Agricultural and Environment.* 6(4), 387 - 390

[24] Alarima, C. I., Adamu, C. O., Masunaya, T. and Wakatsuki, T. (2011). Constraints to Sawah Rice Production System in Nigeria. *Journal of Human Ecology* 36(2), 121 – 130.

[25] Wakatsuki T., Buri M.M., and Fashola O.O. (2005). Ecological Engineering for sustainable rice production and restoration of degraded watershed in West Africa. In: proceedings of rice research conference IRRI, pp. 336-336.