Managing the challenges in optimizing wetland management via sawah rice production: Abeokuta experience

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Abstract

Most developing countries particularly Sub-Sahara Africa in general have never been able to produce sufficient food to meeting the teaming population in spite of the abundance inland valleys which have great potential to be optimized without investment on expensive irrigation systems. Inland valleys show considerable potential for intensification and sustainable land use. The potential impact of this valley is related to the presence of water and total areas covered for the production of many food crops. However, they are only marginally utilized. New sawah rice production technology was established in Abeokuta 2010 and repeated in 2011 as demonstration plot in the University of Agriculture, Abeokuta, Nigeria to showcase the inherent potential and sustainable agricultural practice to the farmers in Ogun State, Nigeria. This paper therefore highlighted the natural abundance of the highly productive resources, yield potential, robustness, resilience and sustainable sawah rice based production technology that could be adopted by small scale farmers in Nigeria. It also emphasized the harrowing experiences during natural disaster (such as flood) and the associated problems such as weed infestation, diseases infections, rodents damage, more usage of fertilizer because the beneficial effect of sawah were hindered, lack of funding, poor post harvest facilities and poor marketing structures. The role of government policies in stabilizing agricultural produce, such as importation, subsidies and price support as it affects peasant farmers were discussed. Sawah rice technology has the potential of enhancing sustainability of inland valley if well managed and free from natural disaster.

Introduction

Tarnocai (1979) defined wetland as land having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to the wet environment. Such flooded areas are generally considered to be more robust and resilient to land use pressure than the fragile uplands (Becker and Diallo, 1992; Gopal *et al*., 2000; Dixon and Wood, 2003).

They are characterized by fine-textured soils (Abergel, 1993), are islands of biodiversity (Gawler, 2002), providers of clean water and air (Dixon, 2002) and potentially highly productive sites for agriculture (Becker and Johnson, 2001; FAO 2003). They are valuable for agriculture and are important to international biodiversity as breeding grounds for migratory birds (World Bank, 2006).

Tropical Asia, with about 1/13 of the world's land area, has more than 1/3 of the potentially arable lowlands (FFTC, 2007). This, perhaps, point to the fact why Asia is leading in rice production. Wetlands in Sub-Saharan Africa are estimated to cover 228 million ha (FAO, 1998; Bergkamp, 2000). There is a preponderance of inland valleys in West Africa, where valley bottoms and hydromorphic fringes are estimated to occupy 22-52 million ha of land (Windmeijer and Andriesse, 1993). In rural West Africa, less than 10% of an estimated 55 million ha of wetlands are being used for agriculture (Thenkabail *et al*., 1995) suggesting that wetlands are grossly underutilized for food crop production as opposed to the Asia continent.

The estimated 3 million ha of the fertile soils of the fadama in Nigeria with residual moisture in the dry-season, offers attractive opportunities for the arable farmers to grow off-season high value crops (World Bank 2001; Adigbo and Adigbo, 2011) but this resource has not been fully exploited. The underutilization of inland valley in Nigeria has also been reported by FAOSTAT, 2008 as saying that Nigeria, as a nation, has the inland valley resource and management potential to produce enough rice to meet local and as well as for exportation. This under utilization has ironically ranked Nigeria as the second largest importer of rice in the World after Philippine (Africa Rice Center 2008a). However, in West Africa, Nigeria is the leading producer of rice in the in West Africa sub region (Africa Rice Center (WARDA), 2008b) but the quantity produced is far below consumption.

The utility of inland valley was further improved by increasing the crop intensification from two to three crops per year (Adigbo *et al*., 2007 Adigbo *et al*., 2010) without supplemental irrigation but the sustainability and judicious fertilizer utilization were not as efficient in rainfed system.

Therefore, effective management of inland valleys via friendly ecological technology such as sawah rice based production system to enhance the sustainability of inland valley could become a laudable option to closing the gap between production and consumption. This paper therefore highlighted the yield potential, robustness, resilience and sustainable sawah rice based production technology that could be adopted by small scale farmers in Nigeria. It also emphasized the harrowing experiences during natural disaster (such as flood) and the associated problems such as weed infestation, diseases infections, rodents damage, more usage of fertilizer because the beneficial effect of sawah were hindered, lack of funding, poor post harvest facilities, poor marketing structures and government policies on importation, price support and subsidies were discussed.

Robustness and resilience

The flooding of wetland soils alters both pH and the redox potential of the soil influences the availability of other nutrients as well. The pH of both acid and alkaline soil tends to converge on a pH of 7 when they are flooded. In the process of anaerobiosis in paddy soils, iron phosphate tends to be reduced, with a release of some of the P in available forms. Moreover, reduction of iron oxides releases some of the occluded P into the soil. The reduction of paddy soils under submerged conditions is accompanied by an elevation in soil pH. The rise in pH enhances the solubility of iron phosphate and aluminum phosphate, by a factor of 10 times per unit rise in pH.

Here is another mechanism to raise the availability of P in paddy soils (Redman and Patrick, 1965; FFTC, 2007). The availability of major ions such as potassium, magnesium, sulphur and several trace nutrients such as iron and manganese is also affected by hydrologic conditions in the wetlands (Mohanty and Dash, 1982; FFTC, 2007). Paddy fields in the lowlands receive new sediments deposited from run-off that carries eroded topsoil down from the uplands, thus perpetuating soil fertility and productivity.

In upland farming, crop rotation is a necessity to avoid a decline in yield due to diseases and pests that arise from a monoculture situation (soil sickness). In paddy fields, on the other hand, rice can be grown year after year without any clear sign of yield decline, over a considerable length of time. The alternation from aerobic to anaerobic conditions in a yearly cycle of rice farming is the best measure to remove the causes of soil sickness. No pathogens or soil-borne animals can survive such a drastic change in the redox environment.

Yield potentials of inland valley (rainfed lowland) compared to others ecologies
Rice Ecologies and their Potentials

The yield of rice in inland valleys is generally much higher than on the uplands (IITA, 1980; 1988). There is enough residual soil moisture or shallow ground water table for crops other than rice in dry season (Raunet, 1984). The average yields of the world's rice-growing areas are 4.9, 2.3, 1.5 and 1.2 t/ha for irrigated, rainfed lowland, flood prone and upland, respectively while the average yield of West Africa's rice-growing area are 5.0, 2.1, 1.3 and 1.0 for irrigated, rainfed lowland, flood prone and upland, respectively (Anon, 1993). The cost of irrigation equipment is, however, prohibiting for resource-poor farmers to acquire for rice production in Nigeria. Therefore, the rainfed lowland rice in the available inland valley that gives relatively higher yield of rice as compared to the upland can be taken advantage of, at no extra cost.

Out of the total land area of 1,642000 ha devoted to rice cultivation in Nigeria, 1, 5, 16, 30 and 48% is grown to mangrove swamp, deep water rice, irrigated lowland, rainfed upland and rainfed lowland, respectively. In West Africa, however, of the total land area of 4,011,000 ha devoted to cultivation of rice, 4, 9, 12, 44 and 31% is planted to mangrove swamp, deep water, irrigated lowland, rainfed upland and rainfed lowland Lançon and Erenstein (2002). To increase the production of rice in West Africa, therefore is the need to re-allocate more of inland valley which is more productive than dissipating our energy and scare resource on the upland.

More importantly, the adoption of simple technology such as sawah that will enhance the productivity of inland valley should also be accepted if the gap between consumption and production must be closed in West Africa. Asia continent is leading in rice production in the world, perhaps because, they choice the right combination of ecology and technology. The time has come for farmers in Sub-Sahara Africa to relocate rice production in the upland to more productive lowland ecology in combination with sawah rice production technology.

Sustainable sawah rice production systems

The concept and term sawah refers to man-made improved rice growing environment with demarcated, bunded, puddled and leveled rice field with water inlets and outlets using power tiller for weed and water control in the inland valley which can be springs or pumps (Wakatsuki *et al*., 2005). The Sawah system of rice production ensures proper management of the rice environment leading to efficient and higher rice grains production with higher returns is a better option to current systems (Wakatsuki, 2005). It is one of the most efficient systems that will ensure adequate production to meet the ever increasing demand and save the country from the use of scare foreign exchange resources for its importation (Buri *et al*., 2007).

The project is embarking on the process of mass adoption for the whole country with its attendant challenges of procurement of power tillers used in land preparation. The sawah project focuses on three important keys: (1) enhances soil and water management which is important for sustainable rice production; (2) the package significantly increases rice yield and (3) the dissemination of the Sawah technology through a participatory learning approach enhances rapid adoption among rice farmer.

It is well-known that weeds can be controlled by means of efficient water control. But it is not well evaluated that the nitrogen fixation by soil microbes under a submerged sawah systems could reach 20 – 100 kg/ha/year in Japan and 20 – 200 kg/ha/year in the tropics depending on the level of soil fertility and water management (Kyuma 2003, Hirose and Wakatsuki 2002). This amount is comparable to the nitrogen fixed by leguminous plants. Under submerged condition, because of reduction of ferric iron to ferrous iron, phosphorous availability is increased and acid pH is neutralized, hence micro-nutrients availability is also increased (Kyuma, 2003). There are other benefits of sawah systems. The eutrophication mechanisms are not only encouraging the growth of rice plant but also encourage the growth of various algae that increase the nitrogen fixation. The quantitative evaluation of nitrogen fixation in sawah systems including the role of algae will be also important future research topics.

Under nitrate rich submerged water conditions, sawah systems encourage denitrification. Easily decomposable organic matter becomes substrate of various denitrifyers. Purification of the nitrate polluted water is another function of sawah system (Kyuma, 2003).

Experiences in Abeokuta sawah rice

Sawah field was introduced and established in Abeokuta, Nigeria in 2010 and repeated in 2011 cropping season. The performance of Abeokuta sawah was rated the best in Nigeria by sawah team in 2010 cropping season (Plates 1-6). However, the story was not palatable because of the damaged caused by flood coupled with non-release of approved fund in 2011 cropping. The resultant harrowing problems such as weeds, rodent, birds' damage etc were not palatable experience compared to 2010 cropping season (Plates 7-15).

Success story of sawah rice field in 2010

Plate 1: Sand filling bags to control water in sawah rice field after transplanting.

Plate 2: Sand filled bags used to divert water into sawah field.


Plate 3: The sawah field 2 two weeks after transplanting and water introduction

Plate 4: Rice farmers’ field day in 2010

Plate 5: Farmers admiring the sawah field

Plate 6: Prof. Waktsuki, Prof. Lagoke (Deputy Vice-Chancellor, UNAAB) Engineer Segun Ademiluyi and farmers during sawah field day

Sawah rice field experience in 2011

The rainfall pattern in Nigeria in 2011 was an aberration from the normal. The rains did not come when it should and when it came; it was torrential coupled with destructive flood. The central drainage canal was washed away or seriously weakened that mending was difficult because of the sandy nature of the soil (loamy sand). So much money and time were invested in managing the damaged caused by the floods. In mending the canal, the story was better experienced than to be told. Natural disasters (such as flood in our own case) with the associated problems (such as weeds, grass cutters, more usage of fertilizer and perhaps low yield) are inevitable all over the world. But prompt release of approved money could have further alleviated the challenging scenario.

Nationwide problems such as poor post harvest facilities, poor marketing structures and the role of government policies in stabilizing agricultural produce, such as importation, subsidies and price support have actually aggravated the situation. The pictures (Plates 7-15) below presented the flood incident and the repairs carried out. Our inability to effectively control water given the sandy nature of the soil resulted in weed, rodent infestation and higher rate of fertilizer application.


Plate 7: Flood top view


Plate 8: A day after the torrential rainfall


Plate 9: Commencement of repairs


Plate 10: Leakages here and there 8 weeks after repairs of central darinage canal


Plate 11: Weakened bunds with leakages after repairs


Plate 12: Leakages in the mended bunds

Plate 13: When bund repair with sand bags and soil failed, another bund inside each sawah unit was done but leakages persist.

Problems arising from leakages

Weeds: Failure to supply water to uniformly cover the sawah units, created aerobic situation which allow serious weed infestation. It is well-known that weeds can be controlled by means of water control. This could have been achieved by eliminating air (i.e. inundation of sawah with water) which is one of the conditions for germination (air, water and temperature). However, because water control was inadequate to the sawah field consequently aerobic condition was created giving room for all the conditions necessary for weed seeds to germination. Consequently, weed became serious problems which resulted in weeding sawah field three times as opposed to one weeding in 2010 cropping season without flood (Plates 14a and 14b).

Plate 14a:Weedy sawah plot Plate 14b: Weedy and rodent damage sawah plot

Grass cutter: Normally, when sawah fields are inundated, rodents find water logging condition uncomfortable hence they avoid the field. But because sawah field was dry, the invasion of grass cutter was very apparent and significant in spite of the facts that hunters were invited to prevent this damage (Pictures 14 b and 15).

Plate 15: Rodent damage

More usage of fertilizer: Usually, when the sawah field is well managed with good water control, the benefit derivable from the various N-fixing sources such as bacterial, blue-green algae, geological fertilization etc and the availability of phosphorus are hindered. Consequently, more fertilizer was be used to obtain the minimum grain yield of 4 t ha^{-1} rather than augmenting the various benefits of sawah.

Lack of funding

In fairness to sawah team leader, he promptly approved fund for Abeokuta in response to our call for financial help to ameliorate the damaged caused by the flood but the release of fund was not effected up till the moment of writing this paper. The lack of fund to effectively control water further aggravated the problems of rodent, bird and weed damages. It must be noted that withholding money met for sawah field operation led to debt due to labourers.

Poor post harvest facilities and poor marketing structures. In the face of these problems, we decided to invest in processing the previously harvested paddy but the quality of the milled rice was not attractable enough to consumers. In order words, the locally milled rice could not stand the competition with the imported polished rice in the market. Arising from poor processing facilities coupled with poor marketing structure, the poor quality milled rice was given out at a giveaway price below market price and against our wish.

The role of government policies in stabilizing agricultural produce, such as importation, subsidies and price support further aggravated issues. The low command price of our last year processed rice could be link to government policy in the sense that there was virtually no price support for agricultural produce in Nigeria. Heavy importation of polished rice into Nigeria is a good deterrent to peasant farmer who has the courage to grow rice. The issue of subsidies if it existed does not benefit the peasant farmers for whom it was meant. In a way the global problem within the country also affected those of us who dare to produce rice and mill locally. If Nigeria could import one million tonnes of rice, valued at seven hundred million US dollar (US$700m) or about one hundred and six billion naira (₦106 billion) from the Peoples Republic of Thailand every year (Sams, 2010), then importation policy would not encourage local production and processing of rice.

Conclusion

Naturally abound inland valley in west Africa are high potential resources, robust, resilience to meet our food sufficiency if well managed as the Asia continent. Sawah technology if well managed and free from natural disaster has the potential to enhance the sustainable use of inland valley compared to rainfed inland valley or upland ecologies adopted in West Africa. Viable and implementable government policies should be in place to cushion the farmers' suffering. Prompt release of fund or the availability of power tiller in the case of resource poor farmer is very important for sawah to meeting it target goals convincingly if farmers are to adopt it.

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