A conceptual framework for achieving rice self-sufficiency in Sierra Leone

Alieu MOININA [1], **Rachid LAHLALI** [2*], **Mohammed BOULIF** [3]

[1] Department of Agriculture, Government Technical Institute Kailahun, Technical and Vocational Education and Training, Sierra Leone

[2] Department of Crop Protection, Phytopathology Unit, École Nationale d'Agriculture de Meknès, Morocco

[3] School of Agriculture, Fertilization and Environmental Sciences, Mohammed VI Polytechnic University, Ben Guerir, Morocco

[*] Corresponding author rlahlali@enameknes.ac.ma

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Abstract

Rice production in Sierra Leone is confronted with problems relating to pests, climate change and general rice production management practices. The present paper reviews the problems associated with rice production and conceptualizes a framework on possible solutions to achieving rice self-sufficiency in Sierra Leone. It further focuses on the research concerning the contributions of agronomic and pest management practices towards boosting rice production. This review has helped inventory the key pests (insect pests, diseases, and weeds) that affect rice production in Sierra Leone. It revealed that among diverse varieties of rice, the new varieties adapt to fertilizer use. There is little information and knowledge about pesticide use to control rice pests. Furthermore, the country's stagnant dependence on imported rice accentuates the problem of achieving rice self-sufficiency. We recommend a conceptual framework to achieve self-sufficiency in rice. Also, there is a need to carry out a rice pest survey in order to provide information about the biodiversity in the rice ecologies.

Keywords: Rice production, Integrated Pest Management, rice self-sufficiency, Sierra Leone

INTRODUCTION

Rice crop (*Oryza sativa* L.) is undeniably the main staple food crop in Sierra Leone. With high annual consumption per capita (104 kg) and dependence on imported rice, the country is among the leading consumers in Africa. The crop sub-sector with the staple food rice dominating contributes about 75 percent of agricultural gross domestic product (GDP) (NRDS, 2009). The data from Sierra Leone's Ministry of Agriculture and Forestry show a deficit is more than half of the country's demand in rice. In 2018, the demand was 1.6 million tonnes and the local production accounted for 700,000 tonnes (Demaree-Saddler, 2020). Fofana *et al.* (2014) estimated that Sierra Leone requires production of three million metric tonnes of paddy in order to achieve full self-sufficiency.

However, diverse factors such as diseases, pests, low soil fertility, low-yielding local varieties, and poor extension services are limiting rice productivity. There has been a drastic reduction in grain yield over the years. One of the major causes of such reduction is the lack of good pest management strategies. Rice grain yield in the 1990s was about 5 t/ha owing to the application of contact fungicides in the rice field of the mangrove swamp ecology (Fomba and Singh, 1990). Today, most smallholder farmers are faced with drastic yield losses. In addition, postharvest losses due to poor crop management, inappropriate storage, and marketing facilities are remarkable (NRDS, 2009). Consequently, AfDB (2020) estimated that Sierra Leone spends over US$200 million on imported rice, despite its good agro-climatic conditions for the cultivation of the crop. Such a paradoxical situation could be reverted if rice production and productivity are enhanced and value added on it.

Rice production in Sierra Leone is predominantly subsistent with the agricultural practices undertaken by farm families. This farming practice comprises 104 workdays per acre, of which 84 man-days from family labour (Njoku, 1971) and the rest is from hired labour. This could be a cooperative society.

Rice production in Sierra Leone

Rice ecologies in Sierra Leone

Seventy-four percent of the land area of the country, covering 5.4 million hectares, is suitable rice cultivation. Rice lands cover some 180,000 ha and annual production is about 200,000 tons. Sierra Leoneans consume an estimated 530,000 tons of rice annually. In all the ecologies, rain-fed rice farming is predominant, especially in the upland. Moreover, direct seeding is typical to upland rice. Most rice is produced in upland systems, which account for 80% of the total national rice area (Figure 1). Inland valley swamp systems are the second major ecosystem, covering another 12% and less than 5% of the inland valley swamp rice area has been developed (MAFFS, 2018).

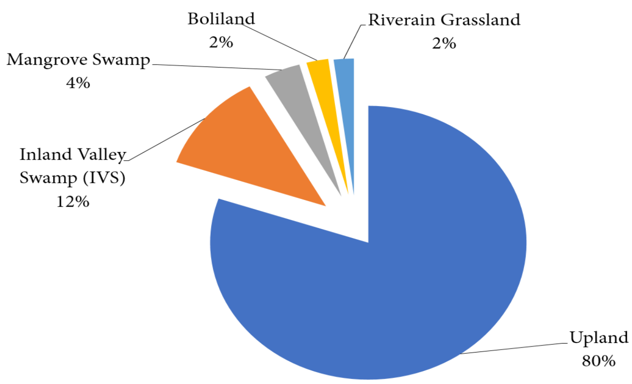

Figure 1: Agro-ecologies in Sierra Leone (MAFFS, 2018)

With typical hydromorphic soils (ultisols and oxisols) (Chakanda *et al.,* 2013) which require a high amount of water to support rice cultivation, the lowlands are differentiated in four ecosystems: inland valley swamps (630,000 ha), mangrove swamps (200,000 ha), bolilands (120,000 ha) and riverine grasslands (110,000 ha) (MAFFS, 2018). The inland valley swamp is dispersed in the districts whereas the lowland ecologies are along the hinterland of the country. In lowland ecology, both direct-seeding and transplanting are possible and the latter is a more common practice. Recently, the government has intervened and is committed to implementing projects in mechanical rice cultivation in the riverain grasslands at Gbundap and Torma Bum, and the bolilands (flooded lands during the rainy season) in the Bombali and Tonkolili Districts.

Economic impact of rice

The rice sector in Sierra Leone accounts for 75% of agricultural gross domestic product (GDP). Being not only the staple food, but the crop also creates self-employment of over 70 % of crop growers in the country. Rice cultivation is predominantly practiced with the informal employment of family labour and the use of rudimentary tools across the agro-ecologies. Annual per capita consumption of rice (104 kg) in Sierra Leone is amongst the highest in sub-Saharan Africa (NRDS, 2009).

According to Spencer and Fornah (2014), the estimated the cost of production per ton of paddy rice ranges from US$ 206.00 to US$ 458.00 per metric ton. However, the cost is dependent upon the system of rice production. Thus, the insufficient level of rice cultivation in Sierra Leone is a complex problem. This has led to the widening supply and demand for the crop within the country. Consequently, the government spends huge money on the importation of milled rice that would have been otherwise cultivated domestically at a cheaper cost (Conteh *et al.,* 2014).

Another obstacle to the low demand for locally-produced rice in the market is the presence of impurities. Because of poor postharvest handling. Local rice in Sierra Leone could be contaminated with stones and rice weevils. Also, almost all the people in the capital city which hosts about 70% of the total population of the country prefer eating imported rice, since it is free from stones and other impurities (Conteh *et al.*, 2012). In favourable conditions, rice weevils and other insect pests of store rice will reproduce in the stored grains and this will decrease the market value of the grains (Kamara *et al.*, 2014).

The production and consumption of local rice remain the crucial strategies to enhance rice self-sufficiency, stimulate economic growth and thus improve the livelihoods of rice farmers (Bah, 2013). The rice self-sufficiency ratio (SSR) is expressed as (rice production x 100 / (rice production + rice imports)) (Faostat, 2015) for the countries with no rice exports. Precisely, when the ratio of rice production to rice consumption is greater or equal to one, its self-sufficiency is attained (van Oort *et al.,* 2015). According to figure 2, Sierra Leone attained an SSR of 91 in 2004 despite the undulating increase in milled rice imports and milled rice production. Between 2000 and 2019, the quantity of milled rice produced was always greater than that of milled rice imported. The average yield of rice in the country never reached 2 t/ha despite the increase in the cultivated area during this period. To boost rice production and productivity, AfDB (2020) approved the US$11 million Agribusiness and Rice Value Chain Support Project in Sierra Leone. In 2018, the country needed to produce roughly three million metric tonnes of paddy to achieve full self-sufficiency (Fofana *et al.*, 2014). This estimate is proportional to the population growth rate.

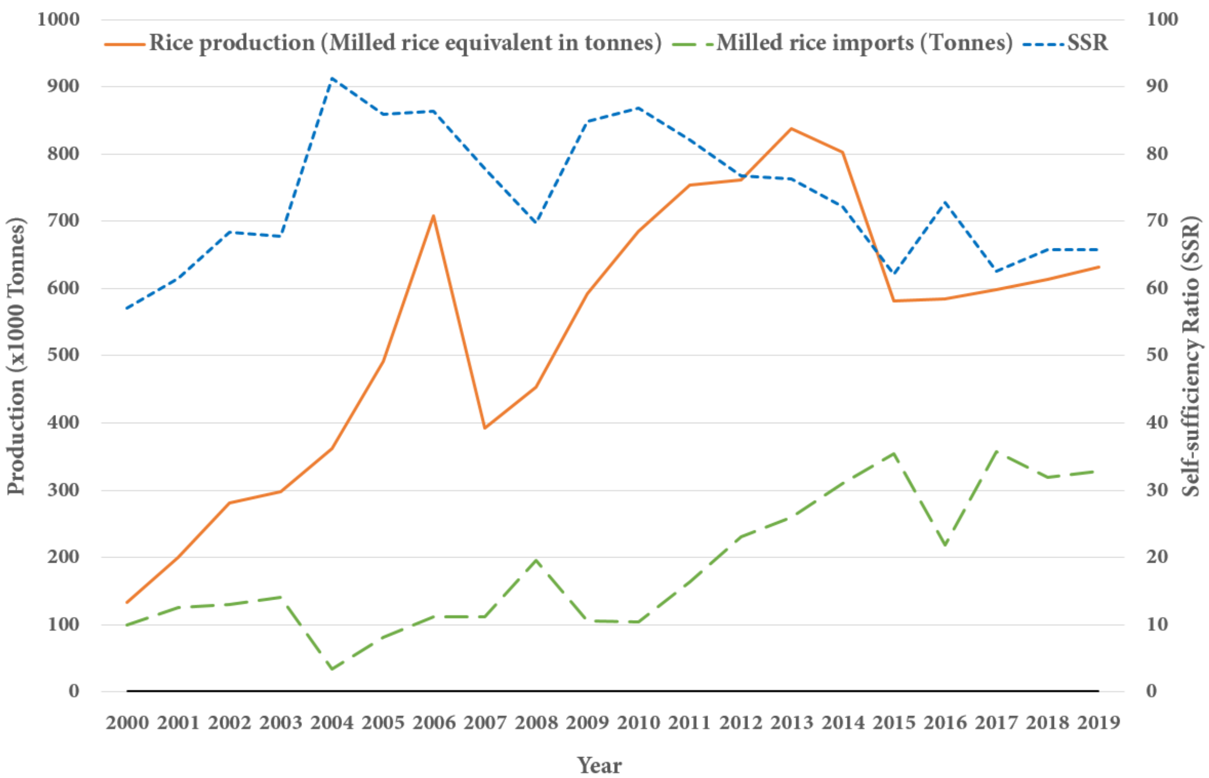

Figure 2: Rice self-sufficiency ratio of Sierra Leone from 2000 to 2019 (FAOSTAT, 2020)

Diversity of rice varieties in Sierra Leone

The local rice varieties are more common than exotic ones in the country. Confusedly, most of these varieties are not distinctly identified. A local variety can be called with different names across the regions in the country. Many of the rice varieties cultivated can be recognized as landraces, and the systematic identification of these varieties by specific names is a very important aspect of variety management in local farming systems. Several varieties that have been dispersed through farmers' exchange mechanisms have specific names, which sometimes remain unchanged across regions. It has remained unclear whether these varieties maintain their genetic identity, whether the genetic variation is influenced by dispersal patterns, or whether the names linked to specific phenotypes can be used to assess the available rice genetic diversity in a particular region (Chakanda *et al.*, 2013). Most of the local varieties have poor quality and vigour. As a result, there is a need for credible research on the exhaustive collection of rice seeds and their respective genetic information (Kamara, 2015).

Through the dissemination of agricultural inputs, there have been reports about the presence of improved varieties. Most of the improved varieties are adaptable to lowland ecologies. The New Africa Rice (NERICA) varieties are improved and most often considered. Farmers perceive NERICAs to be better in terms of yield, early maturity, taste, aroma, and tillering ability especially with fertilizer application (Kamara, 2009). There have been field trials different varieties and some are adaptable (NRDS, 2009). Conversely, Singh *et al.* (2000) explained that several varieties widely grown by farmers are susceptible to diseases.

Table 1 shows the list of rice cultivars commonly grown in Sierra Leone.

Even though some farmers have access to new varieties of rice, there has been little research to show how these varieties adapt to local conditions (Spencer and Fornah, 2014). According to (Kamara, 2009), NERICA varieties are no better than traditional varieties with respect to drought and disease resistance, threshability, weed competitiveness, and grain resistance to damage. Moreover, local varieties are, to a large extent, superior to improved varieties in the sub-optimal conditions facing most farmers (Okry *et al.,* 2007). There is no well documented in the local context, making it difficult for the extension services to convey well-founded messages to the farmers, and to have a clear understanding of farmers' constraints when these new varieties are introduced in the farming system.

Key agronomic and phytosanitary problems affecting rice production in Sierra Leone

Cultural practices

Rice cultivation is very tedious because of the labour force required. According to Chenoune *et al.* (2016), subsistence rice farming is the dominant agricultural practice undertaken by 90% of farm families. Crude tools (cutlass, knife, hoe and sickle) are most often available and used in farming operations. Such system hinders large-scale farming. Furthermore, the widespread use of unimproved varieties, limited use of fertilizers, coupled with poor cultural practices adversely affects rice production.

In the upland rice farming, shifting cultivation is the main farming practice. Mixed cropping (rice, cassava, maize, sweet potato, groundnut, soya bean, cocoa, coffee, oil palm, ginger, etc.) is the commonest cropping pattern although there are significant differences depending on the land type and the region (MAFFS, 2018). Nonetheless, rice monoculture is quite common in the lowland ecologies where mechanised farming is possible and applicable. Ngegba (2016) highlighted physical, technical, economic, and social factors that are responsible for the poor rate of adoption of agricultural innovations in developing Sierra Leone.

Low soil fertility and irrigation facility

Most researchers have reported on the poor fertility of the soil for rice production and little fertilizer use in the rice ecosystems. The upland rice ecology is highly leached with low fertility status, suitable for a variety of food and cash crops (MAFFS, 2018). Another crucial problem of upland rice ecology is the heterogeneity of the farms because of the differences in soils, fallow periods, and subsidiary crops intercropped with rice or

Table 1: Rice varieties most commonly cultivated in Sierra Leone

Rice variety				Reference
CP 4, (ROK3 [e], ROK 4, ROK 5 [ce], ROK 8 [c], ROK 9, ROK 10, ROK 11, ROK 14 [e], ROK 16 [e], ROK18, ROK 21, ROK 22, ROK 23, ROK24 [f], ROK25, ROK29, ROK30) [a]				(Gborie *et al.*, 2016; Harding *et al.,* 2012)
WAR 25-14-1-2 WAR 25-16-4-1 WAR 25-22-2-1 WAR 27-4-3-1	WAR 30-18-4-2 WAR 36-40-1-2 WAR 39-36-1-2 WAR 39-50-2-2	IRAT 13 IRAT 109 IRAT 132 IRAT 138 IRAT 144	ITA 116 ITA 117 ITA 162	(Fomba, 1988)
(CCA, Kuatic Kundir) [d] (Suakoko 8, Mahsuri, WAR 1 ADNY 11, WAR 77) [e]				(Singh *et al.*, 2000)
NIL 2, NIL 16, NIL 54, NIL 130, NERICA-L 19				(Taylor and Jalloh, 2017)
(Pa Kiamp, Pa Limba, Culma, Butter cup [f], Pa Chaim [f], Pa Biaka, Pa Koroma, Pa Kandeh, Gissi 27, LAC 23, Angkata Pa Kpenyei (Red) 191, Pa Miniku 33, Nyowai) [b]				(B. O. Kamara, 2015; Fomba, 1988)

[a] ROK selection lines maturity period is between 120- 150 days after seeding, [b] Some of the local varieties, [c] Varieties susceptible to rice yellow mottle virus (RYMV) (Fomba, 1988), [d] Varieties susceptible to rice blast, [e] varieties resistant to rice blast (Singh et al., 2000), [e] Near Iso-lines are resistant to RYMV (DR & Jalloh, 2017), [f] Over 90% vigour at tillering stage after germination (B. O. Kamara, 2015)

grown in each area (Njoku and Karr, 1973). The upland rice farms are rain-fed farms situated on laterite and/ or alluvium soils. Taylor, *et al.* (2012) emphasized that the soil fertility status in lowland and mangrove swamp is low with nitrogen and phosphorus being the major nutrient deficiencies. Spencer and Fornah (2014) further explained that improved varieties perform best with fertilizers and suggested the application rate of 100 kg/ ha of NPK 15-15-15.

Rice cultivation in Sierra Leone is dependent on rainfall. Little research has been carried out on irrigated rice farming in the country. Evidently, this is one of the constraints toward achieving rice self-sufficiency. The development of inland valley swamps for irrigated rice production has encountered many problems including serious technical ones in Sierra Leone. The technological requirements for appropriate development of swamps differ because of variations of hydrological conditions even within the same agro-ecological zone.

Rice pests

There is no exhaustive official data on rice pests and their management in Sierra Leone. This affects greatly agricultural production and even the implementation of some agricultural projects (MAFFS, 2018). Moinina *et al*.(2018) reviewed that pests and diseases have negative impacts on rice yield. By quantification, yield losses due to all kinds of pests in rice production range from up to 20% to at least 30% of the attainable (un-injured) yield (Oerke, 2006). The yield loss range could be represented as from 1.2 to 2.2 t/ha in Asia (Serge Savary *et al.*, 2000). Both incidence and severity of pests varied considerably across different climatic zones and rice agro-ecosystems.

Even though animal pests cause about 25% yield loss (Oerke, 2006), the control of insect pests is not reckoned with in Sierra Leone especially the subsistent farmers who account for over 90% of rice growers. However, it is worth knowing these pests before considering a suitable control method. Thirteen insects were classified as major pests. Among the insects listed in table 2, gall midge, *Orseolia oryzivora,* has been widely reported (Shamie *et al.*, 2012a) and its found in all the rice ecologies in the country. Nwilene *et al.* (2002) reported that there have been no resistant rice cultivars against *O. oryzivora. Diopsis longicornis* is considered the key pest of rice (Igbinosa *et al.,* 2007). According to Kamara *et al.* (2014), *Sitophilus oryzae* (L.) is one of the most important insect pests infesting stored food grains. There have been reports on invasive insect pests damaging rice crops in Sierra Leone. According to data from the Ministry of

Table 2: Key rice pests and pesticide use

Key rice pest		Pesticide used	Reference
INSECT			
Diptera			
Cecidomyiidae	African gall midge (*Orseolla oryzivora* H &G)		
Diopsidae	Stalk-eyed fly (*Diopsis longicornis* Macquart)		
Lepidoptera			
Noctuidae	Pink stem borer (*Sesamia calamistis* Hampson)		
	Fall armyworm [d] (*Spodoptera frugiperda* Smith)		(MAFFS, 2018; Shamie *et al.*, 2012a)
	African armyworm (*Spodoptera exempta* Walker)	*Insecticide* [a]	
Pyralidae	White rice borer (*Maliarpha separatella* Rag)	Chlopyrifos	
Ephydridae	African rice borer moth *(Chilo zacconius* Blesz)	Furadan	
	Leaf folder *(Marasmia trapezalls* Guenée)	Malathion	
Hemiptera		Furadan	
Aleyrodidae	Whitefly (*Aleurocybotus indicus D*&S)		
Pentatomidae	Grain-sucking bugs (*Asparvia armigera* Fab)		
	Green stink bug *(Nezara viridula* L)		
Delphacidae	Brown plant hopper (*Nilaparvata maeander* Fennah)		
Coleoptera			
Coccinellidae	Epilachna beetle (*Epilachna similis* Thunb)		
	Rice weevil [e] (*Sitophilus oryzae* L.)		
Isoptera			
Termitidae	Termite (*Macrotermes spp.*)		
FUNGAL DISEASE		*Fungicide* [b]	
	Rice blast (*Pyricularia oryzae* Cavara)	Cupric hydroxide	
	Brown spot (Helminthosporium oryzae Breda de Haan)	Benomyl 50 w.p	(Fomba, 1984; Fomba and Singh, 1990; Fomba and Taylor, 1994)
	Leaf smut of rice *(Entyloma oryzae* H. & P.)	Kocide	
	Sheath blotch (*Pyrenochaeta oryzae* Shirai ex Miyake)	Tricyclazole	
	Narrow brown leaf spot (*Cercospora oryzae* Miyake)		
VIRAL DISEASE	Rice yellow mottle virus	NA	(Fomba, 1990)
WEEDS		*Herbicide* [c]	
Sedges *Cyperus rotundus), Mimosa pudica* and *Imperata cylindrical. Oryza longistaminata*, (*Imperata cylindrica (L.) P. Beauv.*), (*Panicum repens L.*), Echinochloa crus-galli and *Paspalum vaginatum*		Oxadiazon Propanil 2,4-D Butachlor	(Shamie *et al.*, 2012b)

[a] Insecticides used to control rice insect pests (Sankoh, Whittle, Semple, Jones, & Sweetman, 2016), [b] Fungicides reported to control fungal diseases (Fomba & Singh, 1990), [c] Reports on the herbicide (Harding, Taylor, et al., 2012; Sankoh et al., 2016), [d] Invasive pest (MAFFS, 2018), [e] Major insect pest of stored rice grain (J. S. Kamara et al., 2014)

Agriculture, Forestry and Food Security (MAFFS, 2018), the fall armyworm (*Spodoptera frugiperda)* was officially confirmed attacking rice and other crops in Sierra Leone in 2017.

Farmers hardly consider diseases as a menace to rice production due to the inability to diagnose them (Adesina *et al.,* 1994). However, researchers have reported the presence of fungal and viral diseases in Sierra Leone. The survey report of Awoderv *et al.* (1991) indicates that there have been no confirmation on bacterial diseases in the review. Yield loss due to rice blast is 80% in Sierra Leone (Muck, 2015). Fomba and Singh (1990) quantified grain yield loss due to rice brown spot (*Helminthosporium oryzae* Breda da Haan) to a rough figure of 23% in the mangrove ecosystem.

Weeds are also major phytosanitary problems facing rice production. When uncontrolled, yield losses due to weeds range from 28 to 74% in transplanted lowland rice, 28 to 89% in direct-seeded lowland rice and 48 to 100% in upland ecosystems (Rodenburg and Johnson, 2009). According to Naylor (1996), yield loss due weed infestation is contingent upon the weed species present. In Sierra Leone weeds several weed species affect rice cultivation. Only few superficial inventory has be done on weeds in Sierra Leone. On the report from Shamie *et al.* (2012b), the key weeds species found in rice ecologies in the country are sedges (*Cyperus rotundus), Mimosa pudica* and *Imperata cylindrical.* Fomba (1984) recorded the presence of some weed species in the rice field *Oryza longistaminata*, (*Imperata cylindrica* (L.) P. Beauv.), *Panicum repens* L. and *Paspalum vaginatum*.

Vertebrate pests are the most important pests that most Sierra Leonean rice farmers reckon with when selecting a rice ecology and its location. These pests are rodents, birds and some fishes in the mangrove ecologies. Rodent and bird species are considered the most abundant in tropical rice ecologies. There are several vertebrate pests that attack rice crop depending on the ecologies. There destruction is hardly quantified. Without any control measure the yield loss is indisputably 100 per cent. Dispersed and small-scale farms are more vulnerable to vertebrate pest attacks. Rodents feed on all parts of rice crops where birds mainly target the grains. As emphasized by (Becker and Diallo, 1992), birds attack rice crop at different growth stages especially during sowing, milk stage and maturity stages. Frightening, fencing, trap setting and hunting are the most common techniques used to manage vertebrate pests (Garriga *et al.,* 2018).

Little knowledge on agrochemical input use

The access of rice farmers to agrochemical inputs is less than five percent (NRDS, 2009). This is one of the challenges that has also hindered a boon to rice self-sufficiency. Fundamentally, agrochemical input use is more applicable when production is mechanised. Sankoh *et al.* (2016) reported that the most agricultural extension agents have little knowledge in pesticide use and the farmers are prone to such vulnerability with grave consequences to them and the environment. Most farmers have very little knowledge about the safe handling of pesticides as 71% of them have never received any form of training on these harmful substances (Sankoh *et al.,* 2016).

However, many pesticides have been reported to be in use by rice farmers in Sierra Leone (Table 2). 60% of the pesticides used enter illegally into the country. Pesticide use, though not in large quantities is a big problem in the country, especially where pesticides are brought without due consideration to their effects on human health and the environment, and labels are written in unknown languages, and pesticide operators and farmers as well have no foreknowledge of the various pesticides they use (MAFFS, 2018). Contact fungicides used in sample plots did not only control brown spot disease but also increased rice yield (Fomba and Singh, 1990).

Haefele *et al.* (2000) elucidated that improved fertilizer management qualitatively increases grain yield. The volume used depends on the purchasing power of the farmers and the size of the farm. Due to ineffective knowledge on rational fertilizer use, most farmers apply fertilizer whenever it is accessible without considering the dose. Such injudicious use of synthetic agrochemical inputs will result in environmental degradation and the deterioration in the quality of the natural environment (NRDS, 2009).

Conceptual model of achieving rice self-sufficiency in Sierra Leone

Best government policies

One of the crucial ways of achieving food security and food self-sufficiency in rice is through the enactment of stringent Government policies (Emodi and Madukwe, 2008) that prioritise the value addition to the local rice. These policies will favour boosting production and productivity thereby making it available, accessible and affordable to the entire population. Sierra Leone's high dependence on imported rice has been increasing since after the rebel war. The agricultural policies hinder food security.

Sierra Leone can easily revamp rice production and productivity with harmonious accords in public-private partnerships. Elsewhere, Diagne *et al.* (2013) identified the institutional constraints as one of the major obstacles in achieving rice self-sufficiency. The rice value chain comprises mainly subsistent farmers at the production level in Sierra Leone. Empowering these farmers through practical training on rice production, assess to inputs and adopting agribusiness will not only increase their incomes but only motivate them in such practice (Figure 3).

According to the MAFFS (2018), there is no plant protection policy to direct the delivery of crop protection services in the country. Although some of the respondents are aware of the benefits of Integrated Pest Management (IPM), it is not operational as a national policy for crop protection in Sierra Leone. The understaffing of requisite expertise in crop protection is a big challenge. Furthermore, there is no pesticide laboratory nor is there equipment for testing of pesticides for their purity and efficacy. With the lack of legislative instruments, the importation of pesticides is very much disorganized and difficult to enforce (MAFFS, 2018). The production and consumption of local rice remain the crucial strategies to enhance rice self-sufficiency, stimulate economic growth and thus improve the livelihoods of rice farmers (Bah, 2013).

Suitable input use

In the case of varieties of rice seeds, Gborie *et al.* (2016) mentioned that farmers' adoption depends on evidential extension services, training, access to credits, and personal experience in rice farming.

The existence of diverse rice-growing ecologies in Sierra Leone calls for suitable rice cultivars that could adapt to an available ecology. The knowledge on the choice of varieties of each rice ecosystem is vital (Gborie *et al.*, 2016). Therefore, certified improved varieties distributed in the country must have specifications on rice ecologies. Moreover, field trials should be conducted to validate credible and relevant data which could thereafter be disseminated to the farmers. Resistant varieties to pests and disease, and water stress are highly required even though their resistance fades with time (Singh *et al.*, 2000). The insect pest situation will probably change as the use of modern inputs increases, based on experience in Asia (Alam, 1992). Rational fertilizer recommendations are required through research evidence.

Suitable use of irrigation water in lowland ecology is crucial in ensuring the optimum growth of rice. During its growth cycle, the root system should remain submerged in water. To do this in a gravitational irrigation system, refill the field with water four from the emergence to the milking stage. The first emptying takes place after emergence and the filling of 2 to 3 cm is necessary after two days (Moinina *et al.*, 2018).

Adoption of best agronomic and pest management practices

Sustainable rice production is only possible if pest management strategies are set. According to Savary *et al.* (2012), modern pest management underpins agricultural sustainability, thereby achieving food security and self-sufficiency. In Sierra Leone, rice farmers could locally identify the weed and vertebrate pests that attack their crops. More difficulty lies in the little knowledge and negligence of diseases and insect pests. Pest management is only done when a farmer is able to identify the pest(s) that are damaging their crops. Moreover, the quantification of damage and the economic impact on production should be justifiable.

There is little information about pest management in rice. The yield remains relatively low while the consumption per capita is high with the growing population. Yield losses due to pests should be estimated in order to establish well-adapted pest management tactics (Savary *et al.*, 2000). In addition perceptions of Sierra Leonean

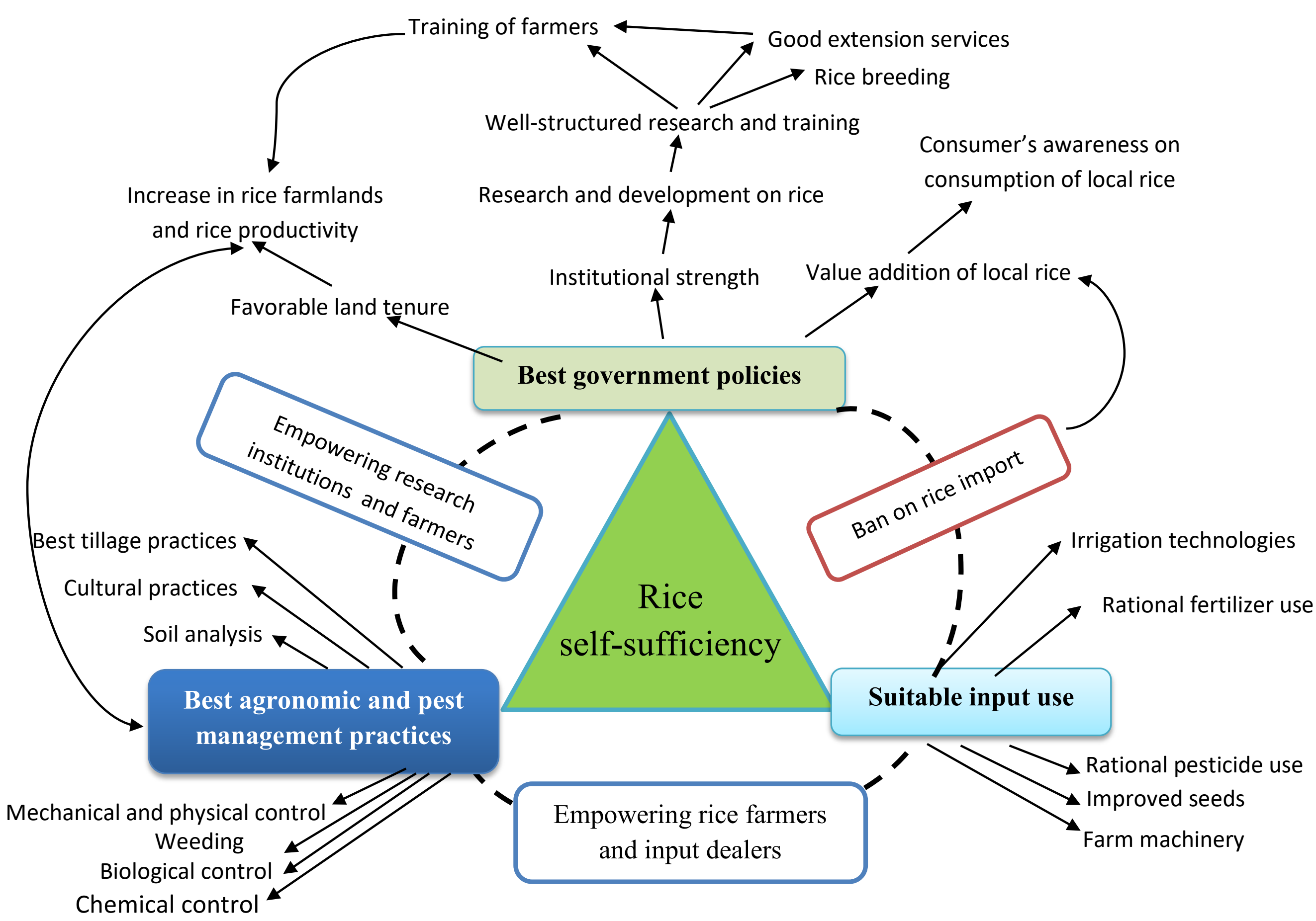

Figure 3: Conceptual framework on rice self-sufficiency in Sierra Leone (Authors' viewpoint, 2020)

farmers in terms of rice pests and their management practices are rarely documented. According to Adesina *et al.* (1994), such problems are common among West African farmers.

Preliminary information on the soil in rice production will facilitate the need for fertilizer use. Such information is primordial in crop production. Soil preparation, especially soil levelling is very paramount in lowland rice gowning ecologies. This practice will guarantee uniform water distribution with appropriate irrigation techniques (Moinina *et al.,* 2018).

CONCLUSION AND RECOMMENDATION

The holistic approach of the thorough combination of government policies, access to all inputs, and integrated rice management will help achieve rice self-sufficiency. Service delivery for production (research and modern inputs etc.) is weak. The lack of a comprehensive agricultural database and an early warning information system poses difficulties for forecasting climatic conditions, pest and disease threats.

The smallholder farmers in Sierra Leone are generally resourced poor with only the hoe, axe, and cutlass as the main implements while labour is mainly supplied by family members thereby severely limiting their scale of production. On the other hand, the widespread use of unimproved varieties, irrational use of fertilizer, coupled with unimproved cultural practices are the current challenges for a sustainable future boost in rice production.

We recommend an adoption of conceptual framework to achieve self-sufficiency in rice. Also, there is a need to carry out rice pest survey in order to provide information about the biodiversity in the rice ecologies. On-farm training of rice farmers and substantial yields from the demonstration farms will help boost rice productivity.

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