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THE INFLUENCE OF AGRICULTURAL RESEARCH ON SEED HARMONIZATION POLICIES BY WAAPP IN THE KAOLACK REGION - SENEGAL

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Abstract: *The purpose of this study was to establish the role of agricultural research on seed harmonization policies by the West Africa Agricultural Productivity Program (WAAPP). The study applied descriptive survey design and phenomenology research designs to assess the harmonization of seed policies and West Africa agricultural productivity program. The study targeted 13,786 beneficiaries from Kaolack region from which a sample size of 377 both beneficiaries and professionals participated in the study. The study used purposive and random sampling techniques to select sample size. To establish ways in which WAAPP supports innovation and research in seed harmonization, results showed that 310(86.1%) of the respondents stated that the program had supported research through carrying out research on new seed varieties, 286(79.4%) of the respondents indicated the support was through Provision of laboratories for tests, as per the findings, 148(41.1%) of the study respondents indicated millet as their farm product which had increased productivity the most after using resilient seeds. It was concluded that, research and innovation were vital in improving agricultural productivity in West Africa. The study recommended the creation of a board comprising agricultural experts as well law practitioners who should adopt proper laws that can lubricate proper running of agricultural system for a sustained growth in agricultural productivity. Secondly the study suggests extension of cooperation and support to legal institutions to strengthen the harmonization of seed policies for a regulated agricultural system. Efficient mechanism for the obligatory prompt payment of quotas by WAAPP member states should prevent project delay thereby accelerate the process to food security. Finally the study recommends more attention to local farmers and traditional seeds for durable increase in agricultural productivity.*

Key words: *Research, innovation, Agricultural productivity, seed harmonization policies, West African Seed Program*

1.1 Study background

Reference to Jorgensen (2002), agriculture contributes a small fraction to the United States economy and employs approximately 2% of the labor force. According to ECG (2011) agricultural production is relatively lower in African countries compared their counterparts in Asia and Latin America. For instance, AfDB-IFAD (2010) posits that, African farmers harvest two metric tons of grains in comparison to Indian farmers who gets double, a Chinese farmer harvest four times more, and an American farmer reaps five times more. Dethier and Effenberger, (2011) note that agricultural productivity growth can be an effective tool for ameliorating poverty in developing nations. Africa's work force invest more in agriculture to other parts of the world like India, China and the United States. Meanwhile agricultural harvest is lower in Africa to other parts of the world.

According to Barrios, Ouattara and Strobl (2008), agriculture remains to be the leading driver of the economic growth for countries in Sub-Saharan Africa. However, providing food for the ever-rising population in the continent of Africa remains a critical challenge for most of the nations in the continent (Owusu, Abdulai & Abdul-Rahman, 2010). In Ethiopia, most people live in the rural areas. According to MOFED (2012), the agricultural contribution to GDP stands at 41%. Dialo & Hazel further opine that agriculture spurs growth of 1% per annum increase in Ethiopia's per capital GDP, thus aiding in poverty reduction at 1.7% yearly. To enhance this, the Ethiopian government has developed strategies such as Agricultural Development Led Industrialization (ADLI) program that is a cornerstone and a leading economic policy in this nation. According to MoFED (2002), this is a long-term plan aimed at enhancing agricultural productivity. The Ethiopian government therefore comes out strongly as a supporter of agricultural activities by allocating 16% of its national budget to this sector (Davis et. al, 2010). Ethiopia seeks to enhance its agricultural productivity through institutions to lead the country in agricultural productivity with the use of policies.

According to Ouma et. al (2002), agriculture plays this benevolent role in spurring the economy of Kenya in a more sustainable manner. Further, success in Kenya's agriculture depends on improvement of agricultural technologies so that the same could trickle down to the farmers (IFPRI, 2002). The problem of food insecurity worsened by inability to expand land under maize production and lack of sufficiency and quality. Karugia et al (2004) observed that, the average yield of maize has stagnated at 1.7 tons per hectare, a level representing less than a third of the optimal yield on farms. There are programs like the Kenya Agricultural Productivity Program (KAPP) that seeks to improve on agricultural productivity. The East Africa Community (EAC) has not been idle about the deficiency in agricultural productivity in the region because East African Agricultural Productivity Program (EAAPP) created to promote agricultural research to boost agricultural productivity. Kenya's President made food security one of four key pillars to his manifesto to his reelection in 2017 yet sustainable agricultural productivity and food security is still a challenge.

World Bank (2008) posits that, agriculture employs approximately 60% of its labor force in Cameroon and injects 30% of the income in the nation's GDP. Further Agriculture has become an important tool in alleviating poverty in the country. According to ACDIC (2008), family farms play an important role in development of agriculture. In Cameroon, they supply nearly 95% of the food products such as cocoyam, sweet potato, maize, and retain about 80% of their production for on-farm consumption. However, family farms have always witnessed low productivity due to high

cost insufficient and low quality planting seeds (Mugisha & Diiro 2010). Other challenges include poor organization of actors, biotic constraints (diseases and pests), road infrastructure-related constraints (dilapidated rural roads and obsolescent and inadequate means of transportation) and production-related challenges. Cameroon introduced seed improvement programs that are in good pace. However, positive impacts of such programs impacts at macro level compared to micro level, as far performance of farmers is concerned (Oehmke & Crawford 1993). Encouraged by the results of WAAPP, Cameroon and a few other countries have since sought to join the program in order to improve agriculture and economic growth in their respective countries. The West and Central African Council for Agricultural Research and Development (CORAF) were in Cameroon recently to support the country in setting up an ambitious new agriculture program. Titled, the West African Agriculture Transformation Program (WAATP), this intervention seeks to scale up the use of new technologies and varieties to transform agriculture in West and Central Africa (WAAPP web 11 October 2017).

West Africa initiated significant agricultural programs to bolster agricultural growth. Special focus placed on harmonizing seed policies in order to boost productivity. One such program is West African Agricultural Productivity Program (WAAPP). WAAPP is a multi-annual program taking some steps to institutionalize, modernize, and organize the agricultural sector of its participating states in order to foster agricultural productivity in West Africa. Harmonization of agricultural policies amongst its member states is one of the main objectives of WAAPP. WAAPP is currently involved in the harmonization of seed policies in West Africa. Countries such as Burkina Faso, Côte d'Ivoire, and Nigeria, Benin, Gambia, Guinea, Liberia, Niger, Sierra Leone, and Togo, Mauritania, Cape-Verde, and Guinea Bissau are benefiting from the initiation of this program. Gisselquist (2001) asserts harmonization of seed policies enhances conformation to the stipulated international standards with an aim of promoting competitive modern seed industry.

The West Africa Agricultural Productivity Program (WAAPP) created in 2008, is a multinational, multi-phase and multi-year project. WAAPP which was created in response to agricultural productivity challenges that is an agricultural policy of Regional Economic Communities (REC) to implement the pillar IV (New Partnership for Africa's Development (NEPAD) & Comprehensive Africa Agriculture Development Program (CAADP), 2002, 1.8.4. Pillar No 4) of CAADP. WAAPP is one of five programs carried out by CORAF. WAAPP is organized around four components; (1) Enabling conditions for regional cooperation in improved technologies generation and dissemination, (2) Establishment of National Centres of Specialization (Ncos) which could evolve to Regional Centers of Excellence (RCoE). (3) Funding of demand-driven technology generation and adoption, (4) Coordination, Management, Monitoring and evaluation. Each of these components have sub-components. This study is focused on component one. One of the objectives of this component is harmonizing and strengthening agricultural policies. It aims at improving cooperation among member states in the adoption of improved technologies as well its diffusion. It strives to re-enforce seed systems, mechanisms and institutional procedures for regional integration of markets.

Rickert-Gilbert et al (2013) postulate that, in Senegal agriculture constitutes of 40% of labor force. Most of these farmers live in the rural areas. Senegal's agricultural productivity is serious affected by the recent unfavorable climate change. "I have seeded 50 acres of peanuts and 40 acres of millet three times since the month of May. I was not successful in yielding one single acre," says Talla Ndiaye, a local farmer from the village of Nguick. Climate-smart seeds identifies in the country as one of many remedies to the predicaments of the country's agricultural productivity. To be

classified as climate-smart, a crop variety must meet at least one of two criteria - early maturity and/or tolerance to extreme weather conditions such as drought, flooding, or frost. The length of the variety release process is the duration between the application for release of a variety to the time the variety is released by the relevant authority. In Senegal, it currently takes an average of 36 months to release a variety in Senegal (Mabaya, Diack, Ndiaye and Mainza, December 2017).

The ripples of WAAPP program is largely felt in the nation of Senegal. The government of Senegal through WAAPP Senegal invested $7,180,000.00 (Seven Million One Hundred and Eighty Unites Sates Dollars) principally in agricultural research and development, infrastructure and equipment from 2008 to 2016 (Les Réalisations au Sénégal-CORAF, December 2018). However, areas like Kaolack are yet to feel the seed harmonization program aimed at enhancing agricultural productivity. Rampant poverty is witnessed in this region, and whatever farmers produce is not sufficient to feed the people. Climate change is a great obstacle to agricultural activities. Could it be that farmers get insufficient supplies and quality seeds? It is against this background that the study seeks to unearth this phenomenon.

1.2 Statement of the problem

Agriculture is the backbone of the African economy. Africa is experiencing a faster growing population to agricultural productivity to sustain such population. According to the World Bank Report of 2017, agriculture employs more than half of Africa's total labor force. A majority of the population is involved in farming on subsistence basis while commercial and large-scale farming is common. Food security, poverty alleviation, economic growth and employment are still a pipedream in Africa. It is a regrettable fact that many people in the continent have lost their lives due to hunger. A good number of factors account for the low agricultural productivity in Africa. Amongst others, is poor research and innovation amongst African states in this era of regionalization and globalization in an attempt to foster the harmonization of agricultural policies for agricultural productivity in West Africa, ECOWAS through its technical branch CORAF is enacting the WAAPP program established in 2008. Few studies have in the past examined research and innovation influence on the harmonization of seed policies in the West African region for productivity. It is against this backdrop that this research seeks to study the role of research and innovation in the West Africa Agricultural Productivity Program: a case study of Kaolack region, Senegal.

1.3 Study Objectives

The major objective of this study was to ascertain the influence of agricultural research on seed harmonization policies by WAAPP in the Kaolack Region of Senegal

1.4 Justification of the study

Several studies exist on the role of research and innovation in the harmonization of agricultural policies in West Africa, yet none has been in Kaolack region. Research and innovation is a contemporary subject in the agricultural milieu. Proper policies on seeds also help to cushion the masses from immediate suffering especially from poverty and starvation due to poor seeds. The study is relevant in finding out the challenges seed programs faces in its quest to enhance agricultural productivity. This study is relevant since it will make vital recommendations that will be important in making critical decision on how to establish innovative agricultural practices that

can increase productivity. The study is relevant as it feeds the minds of agriculture researchers to the area of harmonization of seed policies. The study is relevant as it searches through catalyst and stimulants to agricultural productivity that stands the chance of providing much needed sustainable agricultural prosperity. Huge human force investment for time immemorial in agricultural activities in Africa to boost productivity yet food insecurity, unemployment and hunger prevails.

1.5 Conceptual framework

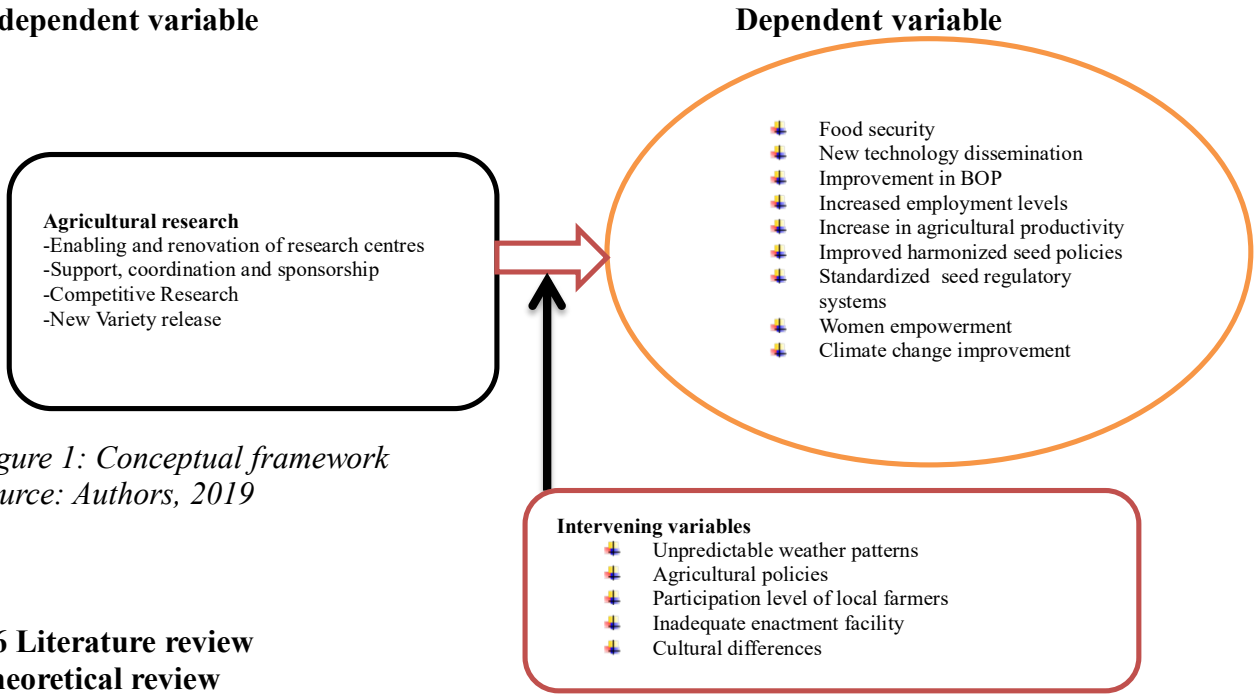

Figure 1: Conceptual framework
Source: Authors, 2019

1.6 Literature review

Theoretical review

The high pay off input model

The theory stipulates that the key to transforming a traditional agricultural sector into a productive source of economic growth is an investment designed to make modern, high pay off inputs available to farmers in developing countries. According to Ruttan (1960), peasants considered as rational in traditional agricultural system, efficient in resource allocators. As a result, they remained poor because in most poor countries there are only limited technical and economic opportunities to which they could respond. Ruttan further classifies the new high pay-off inputs in three categories; a) the capacity of public and private sector research institutions to produce new technical knowledge, b) the capacity of industrial sector to develop, produce and market new technical inputs and lastly c) the capacity of farmers to acquire new knowledge and use new inputs effectively.

High pay off input model has been accepted and translated into economic doctrine due to the studies reporting high rates of returns on public investment in agricultural research. Through its knowledge, the theory led to the success of efforts to develop new high productivity grain varieties in Mexico in the beginning of 1950s that led to a new high yielded wheat varieties and new high yielded rice variety in Philippines in the 1960s.The theory is relevant to this study because it clearly addresses the research objectives underscored focusing on how WAAPP harmonizes seed policies

in order to create high pay off input through coming up with climate friendly and pest resistant seeds varieties to improve agricultural productivity in West Africa that impacts particular places like Kaolack Senegal. The high pay off input model is relevant to this study as it touches the aspect of capacity building by Ruttan. WAAPP builds capacity in Senegal to enhance agricultural productivity that spreads all the way to kaolack, Senegal. Ruttan classification involves research and knowledge dissemination as relevant to economic growth. It is in the same light that WAAPP engages in educating farmers and agricultural research specialist for which the later creates new technologies like new seeds varieties that is made available to the hands of farmers which aims to boost agricultural productivity. WAAPP as well financially supports various agricultural research activities and institutions, which foster proper seed policies thereby boosting agricultural productivity. As such represents its investment in high pay off activities of agricultural research for a prosperous, sustainable agricultural productivity as the high pay off reward.

However, the theory remains incomplete as a theory of agricultural development since the mechanism by which resources allocated among education, research and other alternative public and private sector economic activity are not fully incorporated into the model. More so, the model does not treat investment in research as the source of new high pay off techniques.

Empirical review

Agricultural research and seed harmonization policies

World population will increase from 6.9 billion in 2010 to 9.3 billion people in 2050; and agriculture will play a fundamental role in meeting the world's growing demand for food, feed and fiber. In order to feed the world population in 2050, agricultural production will have to almost double, and most of the incremental output will have to come from increases in yields (FAO, 2009). High-quality seed is a pre-requisite to achieve maximum outputs and good returns for farmers. In many countries, crop production and seed trade are also important sources of rural employment and foreign income. In 2011, the commercial world seed market was valued at US$ 42 billion, and the value of internationally traded seed was estimated at US$ 8.2 billion in 2010 (ISF, 2011). Research plays a significant part in agricultural productivity. It ensures that the right seeds are acquired which are capable of withstanding severe weather conditions in order to enhance food productivity. *Sassenrath et al* (2008) posit that in order for productivity to increase, there is need for manipulation of seeds. Seeds that fulfill the quality requirements have positive results on the productivity of farms. Li, Liu and Deng (2010) in their study on the role of innovation on food productivity noted that, areas that had improved seed varieties posted, a 30% increase in agricultural output. Kugbei (2011) in his study in Afghanistan found out that, production of wheat had an increase of 33% from improved seeds compared to those who used local seeds.

There are many organizations, research institutions and bodies engaged in seeds regionally and globally. Africa's Regional Economic Communities is engaged in providing comprehensive framework for the development of the seed sector. The Forum for Agricultural Research in Africa (FARA), which is connected to the Africa Union(AU), coordinating platform for agricultural research and development in Africa and includes regional organizations like ECOWAS, East Africa Community(EAC) and Southern African Development Community (SADC) active in the seed sector. The Association for Strengthening Agricultural Research in Eastern and Central Africa

(ASARECA), the West and Central African Council for Agricultural Research and Development (CORAF), International bodies, conventions, and treaties dealing with the regulation of seed trade also directly influence seed regulation at the regional and national levels. The scope of these bodies' work and range of measures vary from access and delivery of quality seeds to covering the interests of farmers, breeders, companies, markets and consumers in the area of seeds.

A study conducted by International Food Research Institute (2002) on food productivity in Kenya demonstrates that 30% of maize produced in the country comprises of local variety. This views the hybrids as expensive and required specialized agronomic care that is out of reach of most poor farmers. Studies conducted by various scholars such as *Mureithi et al* (2000), Mulugeta (2001) and Ransom et al. (2003) demonstrates that, most farmers have rejected innovative ideas and new technology in order to enhance food productivity in this region. According to Cheryll et al (2000), farmers prefer to adopt technologies with relatively low risks as compared to their traditional alternatives. For instance, they would rather stick to familiar variety of seeds rather embracing new technology and innovations.

As adjudged by the Republic of Kenya (2010), agriculture injects 26% of the gross domestic product (GDP) one on one and 25% indirectly into the Kenyan economy. The agricultural industry is also responsible for 65% of the overall exports and accounts for 18 percent of direct employment in this nation. It also boasts of 70% of informal jobs in rural areas. This trend is highly attributed to innovations and adoption of improved inputs such as fertilizer, hybrid seed, and safe use of pesticides. However, the investment in research and new technology remains low. *Moyo et al* (2007) opine that, huge potentials still exist among the farmers to increase agricultural productivity by adopting new farming methods. It also stresses the need to increase investment in agricultural development in order to bolster income and create employment, enhance food security and stimulate overall economic growth

Alemu et al (2008) opine that, improved seeds cause a remarkable improvement in agricultural productivity and yields for small-scale farmers in Ethiopia if combined with modern science and innovations. Low agriculture productivity characterises most countries in Eastern and Central Africa (ECA), which remain food insecure despite the availability of new and improved technologies. Seed is one of the most important inputs in agricultural production that determines the quantity and quality of output. Until recently, the unfavourable seed policies, regulations and procedures that existed in the region known to hamper access to quality seed. ECA countries had different laws, policies and regulations governing the seed industry and seed trade, resulting in restricted movement of seed across borders and a smaller market, which was not attractive for investment in the seed industry. Efforts to develop harmonized seed standards, regulations and procedures, and to promote their adoption, have been ongoing since 1999 through the former Eastern and Central Africa Programme for Agricultural Policy Analysis (ECAPAPA) and the Policy Analysis and Advocacy Programme (PAAP) of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). The areas covered by these agreements include variety testing, release and registration procedures, plant variety protection, seed certification, phytosanitary requirements, and import and export documentation. Although harmonised East African seed standards, regulations and procedures (HESSREP) were agreed upon and published in 2002 (ECAPAPA, 2002), their implementation has been slow, with individual member countries not completely adapting them to their national systems. To address

these bottlenecks, PAAP has been working with partners in the region to spearhead initiatives for fast-tracking the adoption and implementation of HESSREP. A 2013 initiative involved working with key stakeholders in five pilot countries (Burundi, Kenya, South Sudan, Tanzania and Uganda) to undertake an audit of the level of implementation in each country, identify challenges for adoption and implementation, draw road maps for implementation and enhance adoption (Judith, February 2015).

Awotide (2011) further notes that farmers in Nigeria notes that poverty reduction witnessed among farmers who were supplied with improved rice seeds in good time. *Li et al* (2010) add that farmers are more concerned with characteristics of seeds rather than the price. This implies that innovation and research is central in improving seeds that are critical in enhancing agricultural productivity. In Nigeria, numerous separate entities received funding for agricultural research, 140 agencies in Nigeria that fosters agricultural research were beneficiaries (ASTI, Status Report, December 2017). This mandate emanated from the May 2014 World Bank Support Mission, when WAAPP-Nigeria was advised to collaborate with other major programs in the country, to propagate notion of Innovation Platforms as a vehicle for Integrated Agricultural Research for Development (IAR4D). The major programs identified for the collaboration include (i) the FGN/IFAD Rural Financial Institution Building Programme (RUFIN); (ii) the World Bank-funded FADAMA III AF; (iii) the World Bank-funded Commercial Agriculture Development Programme (CADP); and the FGN/IFAD-funded Value Chain Development Programme (VCDP). Two other programs approached WAAPP for collaboration (WAAPP-Nigeria Report, December 2016). The collaboration was achieved for which huge success was recorded that surpassed the indicator threshold for success.

National Centre of Specialization aims at strengthening the National Agricultural Research Systems (NARS) to contribute technology development, dissemination and adoption to boost agricultural productivity increases in Nigeria's top commodity sub-sectors that aligns with the region's top priorities, as identified by Central Africa Counsel for Agricultural Research (CORAF). An early activity in the project was to identify promising commodity-based agricultural technologies that have potential for scaling out, both within the country in which they originated and in other WAAPP partner countries. 'Technologies' are defined as: technologies, innovations and management practices. Eleven new technologies including procedural practices within the regional mandate (aquaculture) generated and disseminated (WAAPP-Nigeria Report, December 2016).

A mandate emanated from the May 2014 World Bank Support Mission, when WAAPP-Nigeria received advise to collaborate with other major programs in the country, to propagate notion of Innovation Platforms as a vehicle for Integrated Agricultural Research for Development (IAR4D). The major programs identified for the collaboration include (i) the FGN/IFAD Rural Financial Institution Building Programs (RUFIN); (ii) the World Bank-funded FADAMA III AF; (iii) the World Bank-funded Commercial Agriculture Development Programs (CADP); and the FGN/IFAD-funded Value Chain Development Programs (VCDP). Other programs approached WAAPP for collaboration (WAAPP-Nigeria Report, December 2016). The collaboration was achieved for which huge success was recorded that surpassed the indicator threshold for success.

WAAPP program has continued to grow in the areas of research and innovation in order to improve

food production in the countries where the program is undertaken. According to World Bank (2008), agriculture plays a significant role in Ghana's economy and observes that, growth in the sector could speed up both greater general economic growth and poverty reduction. Ghana Statistical Service (2000) further demonstrates that, the increase of agricultural productivity in Ghana has directly influenced programs on poverty reduction. Statistics indicate that poverty levels among export and food crop farmers have dropped from 49.6% and 51.8% in 1991/92 to 19.4% and 45% respectively in 1998/99. This accounts for 62% improvement in the general economic activities of export farmers. This partly has contributed to the general reduction of rural poverty in Ghana, by a whopping 27% between 1991/92 and 1998/99. This increase owed to research and innovation of variety of seeds used by farmers.

The 2nd phase of the WAAPP Program for the last five years been collaborating with the following institutions/Agencies to execute its planned activities. The CSIR under WAAPP 2A has Crop Research Institute (CRI), Animal Research Institute (ARI), Food Research Institute (FRI) and Savanna Agricultural Research Institute (SARI) implementing research activities under the program (WAAPP-Ghana Annual Report, 2017).

Despite agriculture playing key role in Senegal economy, the country is susceptible to destructive natural forces such as declining rainfall, desertification as well as pests. Agricultural Problems in Senegal as a country that heavily relies on agriculture are severe since it is also a semi-arid country with rainfall varying from year to year. Groundnut takes up 42% of all cultivated land providing an income of more than one million people (Senegalese research authorities, 1999). In the past few years, WAAPP Senegal has been at the forefront funding research and development efforts to revitalize the sector and achieve economic growth, stimulate employment and achieve food and nutrition security. Through regional center of excellence on dry cereal research, WAAPP, funded adaptive research in critical cereals such as millet sorghum, fonio and associated crops such as groundnuts cowpea etc.

Through the support of WAAPP, the National Agriculture Research Center (CNRA) generated resilient groundnuts varieties that would adapt in the current climate. The existing groundnut varieties have about twenty to fifty years old. As a result, they could not produce the expected yield under the new climatic conditions. According to Dr Issa Faye (2009), the new varieties are highly yielded, disease resistant, and pest free. He further notes that compared to the old varieties, significant difference traced in the maturity of the pods per plant, the weight of the seed and the grain size.

Kaolack is one of the chosen centers for WAAPP; however, few documentation about seed harmonization. In Kaolack, majority of the population are involved in groundnuts farming. Experts projects that these new varieties will considerably improve production. According to WAAPP Senegal (2018), dissemination of new multipurpose groundnuts, varieties with both high seed yield potential 2.5 to 3 ton per hectar and medium to long cycle of 80 to120 days are more resistant to disease. Though approval and validation process are already over, the seeds are pending supplies to all the farmers. The projection by 2020 is that the new varieties will be in the hands of all farmers (Dr. Faye, 2017).

In Senegal, the function estimates of rice and maize in Senegal River valley demonstrates the

possibility to reach self-sufficiency of rice (Seoul National University, 2017). Nonetheless, its fulfillment requires many accompanying measures in rice and maize production (Neven and Demont (2010). Furthermore, policy makers should provide a larger incentives in terms of producer price to encourage farmers to increase their outputs thereby face smaller risks of having non-sold outputs. In Senegal, policy measures are in need to prevent farmers from dumping their products under severe social and economic pressure such as children schooling and loan payment. Gert-Jan Stads and Louis Sène (2011) argues that Barriers of agricultural production development cannot be tackled without addressing closely related issues such as the structural and social economic problems that Senegal face. Such challenges involve all the actors who are directly and non-directly linked to agricultural sector activities. Since the rural areas like Kaolack performs a crucial role in the process of achieving food self-sufficiency in Senegal, agricultural policies on land reform, direct subsidies should be in line with the realities of the rural environments like Kaolack.

1.7 Design and methodology

The study applied descriptive survey design and phenomenology research designs to assess the harmonization of seed policies and West Africa agricultural productivity program. The study targeted 13,786 beneficiaries from Kaolack region from which a sample size of 377 both beneficiaries and professionals participated in the study. The study used purposive and random sampling techniques to select sample size.

1.8 Findings and discussion

Research instrument response rate. Response rates provide valuable insight into the accuracy and quality of data collected. It could also refer to the number of people who completed the survey divided by the number of people who make up the total sample group (Fluid Surveys University, 2014).

Table 1: The response rate

Category	No. released	No. collected	Return rate
Farmers(beneficiaries)	389	360	92.5
Implementation agents	10	9	90.0
Government representatives	10	8	80.0

Field data, 2019

The study targeted a sample of 409 participants. The total number of farmers (beneficiaries) targeted being 389 while the key informants (project implementation agents and government representatives) were 20. As table 1 reveals, 360 (92.5%) of the beneficiaries returned their questionnaires while 29 did not. Of 10 implementation agents, 9 (90%) completed and returned the questionnaires. 10 government representatives participated for which 8(80%) of the government representatives participated in the study interview. Richardson (2005) stated that the Australian vice-Chancellors' Committee and Graduate Careers Council of Australia (2001) regarded an overall institutional response rate for an academic research questionnaire of at least 70% to be both desirable and achievable. Thus, the process of data collection of this study achieved the desired responses as recommended by the Australian vice-Chancellor's Committee.

Demographic information

Demographic information helps the researcher understand the characteristics of respondents and that information determines the respondents' capacities to participate in the study. Respondents were asked to state their gender. Results were summarized and presented in figure 2.

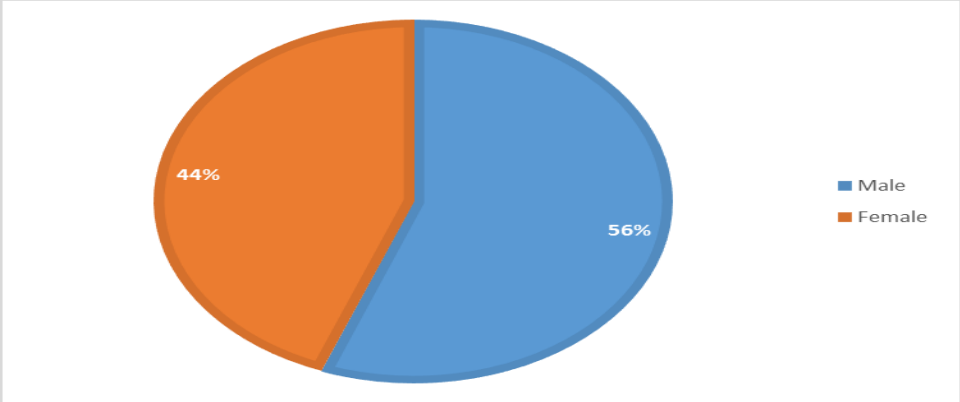

Figure 2: Gender
Field data, 2019

Findings in figure 2 revealed that 201(55.8%) of the study participants were males while the rest 159(44.2%) were females. However, 55.8% for males and 44.2% for females was deemed a good representation since the gender representation variable was not a great determinant of the study findings.

The age of the study participants was investigated, collected data was analysed and presented in table 2 below.

Table 2: Age

Age bracket	Frequency	Percent
Below 20 years	33	9.2
20 – 29 years	82	22.8
30 - 39 years	90	25.0
40- 49 years	101	28.0
50 years and above	54	15.0
Total	**360**	**100.0**

Field data, 2020

Findings in table 2 show that 101(28%) of those who participated in the study were aged between 40-49 years, 90(25%) were aged 30-39 years, 82(22.8%) were aged 20-29 years, 54(15%) were aged 50 years and above while only 33(9.2%) were below 20 years. This shows that a majority of those who participated in the study 90.8% were above 20 years of age. The researcher understood that the respondents were mature enough to participate in the study.

Further, the researcher sought to establish the respondents' education level, this was to ascertain respondents' ability to understand the variables of the study. Responses were presented in figure 3 below

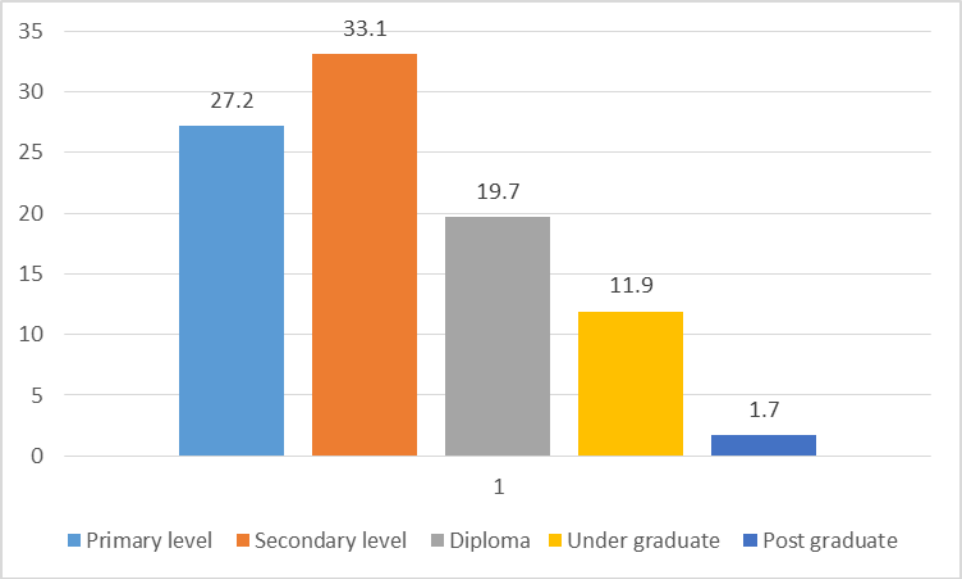

Figure 3: Education level
Field data, 2019

As displayed in figure 3, the highest number of the study participants 119(33.1%) had secondary level education, 98(27.2%) had primary level education, 71(19.7%) had diploma, undergraduates were 43(11.9%) while rest were post graduate 6(1.7%). The results indicate that a majority of those who are involved in farming in Kaolack region either primary or secondary level education while a few had tertiary education. The researcher assumed that the respondents were literate enough to intelligently respond to the questions.

The researcher sought to determine the type of crop farming practiced by the study respondents. Collected data was analyzed and presented in table 3.

Table 3: Type of crop farming practised

Types	Frequency	Percent
Rain fed farming	299	83.1
Irrigation farming	25	6.9
Both rain fed and irrigation	25	6.9

Field data, 2019

Results displayed in table 3 shows that a majority 299(83.1%) of the respondents are dependent on rain fed agriculture while irrigation farming is practiced by 25(6.9%). Another 25(6.9%) of the respondents reported to be practicing both irrigation and rain fed at same time. This implies that majority of the respondents practice rain fed farming with very few with chances of practicing irrigation. This further indicated that any delay or low rainfall could affect many of the farmers in the Kaolack region.

Respondents were asked to indicate rainfall density received in their area. Findings were summarized and presented in table 4 below.

Table 4: Rainfall density

Rainfall density	Frequency	Percent

Low rainfalls	176	48.9
Moderate rainfalls	67	18.6
High rainfalls	39	10.8
Both low and moderate	47	13.1
Both moderate and high	18	5.0
Total	**347**	**96.4**

Field data, 2019

Results in table 4 shows that 176(48.9%) of the respondents said that rainfall received in the area was low rainfall, 67(18.6%) said it was moderate rainfall, 39(10.8%) said the area rainfall was high rainfall, 47(13.1%) said it was both low and moderate while 18(5%) said the rainfall was both moderate and high. This implies that the amount of rainfall likely to be received in Kaolack region was most likely to be low. Furthermore this shows that Kaolack region is a drought prone area with irregular rainfall. As shown in the results, the researcher assumed that production in Kaolack is subject to drought, pests, and diseases which due to low/poor rainfall.

Respondents were asked to state their vulnerability levels in case of rainfall failure. Findings were presented in table 5 below.

Table 5: level of vulnerability when there is no rain

Vulnerability level	Frequency	Percent
Extremely vulnerable	204	56.7
Vulnerable	98	27.2
Less vulnerable	23	6.3
Not vulnerable	2	0.6
Don't know	14	3.9
Total	**341**	**94.7**

Field data, 2019

Findings displayed in table 5 shows that most of the respondents 204(56.7%) would be extremely vulnerable incase rainfall misses, 98(27.2%) said they would be vulnerable, 23 (6.3%) said they would be less vulnerable only 2(0.6%) would not be vulnerable incase rainfall fails in a season. This implies that rainfall is a key factor in the economy of the study participants and incase of failure/low rainfall, it negatively affected the lives of the farmers and majority would be vulnerable. The research assumes that most of the farmers are only able to produce low farm yield which can sustain them for few months as they wait for the next raining season and incase of any rainfall failure majority would suffer.

The researcher sought to determine respondents' farmland sizes. Gathered data was summarized and presented in figure 4 below.

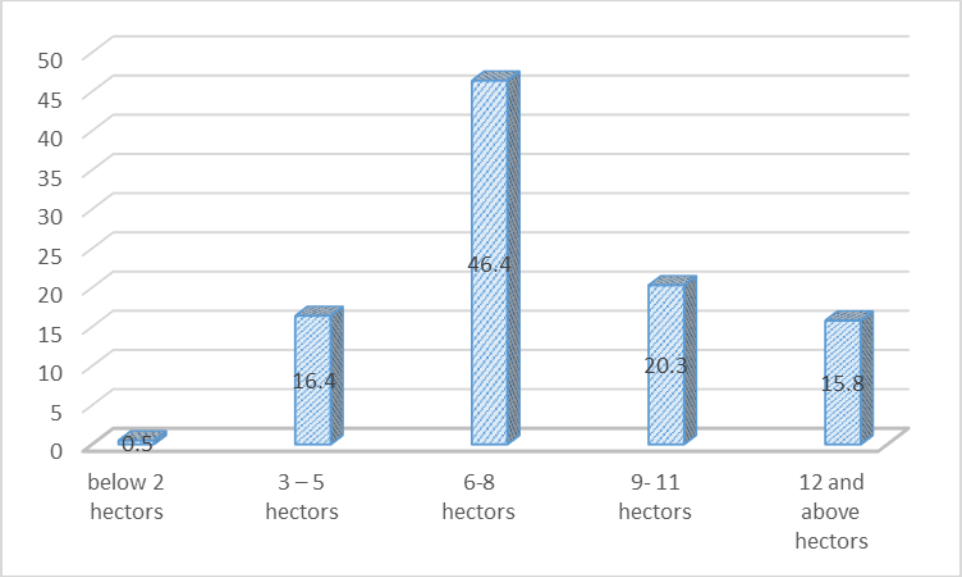

Figure 4: Size of cultivate land
Field data, 2019

Findings in figure 4 revealed that 167(46.4%) of the respondents had 6-8 hectares of cultivated land, 73(20.3%) had 9-11 hectares, 59(16.4%) and 3 – 5 hectares, 57(15.8%) had 12 and above hectares while 2(0.5%) had 2 hectares and below. This implies that majority of the respondents 82.5% have six hectares and above of cultivated land. Therefore, the researcher assumes that there is adequate cultivated land for farming among majority of farmers in Kaolack region and therefore land was not amongst major challenges facing the famers.

Agricultural research By WAAPP

This study sought to establish ways in which WAAPP supports innovation and research in seed harmonization. The researcher sought to understand how the program supported agricultural innovation and research. Respondents were asked to state ways in which WAAPP supports agricultural innovation and research. Responses were presented in table 4.10.

Table 6: Ways in which WAAPP supports research and innovation

Responses	Frequency	Percent
Carrying out seed research on new seed varieties	310	86.1
Adoption and dissemination of seed varieties	189	52.5
Adoption & marketing of new seed technology and innovation	207	57.5

Field data, 2019

Results in table 6 showed that 310(86.1%) of the respondents stated that the program had supported research and innovation through carrying out research on new seed varieties. 189(52.5%) stated through adoption and dissemination of seed varieties, while 207(57.5%) said through adoption and marketing of new seed technology and innovation. The researcher assumes that to a great extend the program has taken measures to support research and innovation in agricultural sector.

Moreover, the researcher sought to determine how the program had also facilitated innovation and research. As respondents reports, 286(79.4%) of the respondents indicated through provision of laboratories for tests, 236(65.6%) talked of provision of seeds analysis certification, while the rest 178(49.4%) indicted provision of trainings to different stake holders.

They were asked to state which of them to state the crops that had increased productivity after using the new seed varieties. Responses are in table 7.

Table 7: Crops whose productivity increased due to new seed varieties

Crop	Frequency	Percent
Millet	148	41.1
Rice	81	22.5
Maize	120	33.3
Ground nuts	57	15.8
Corn	71	19.7
Sorghum	118	32.8
Sugar cane	0	0
Cotton	67	18.6
Peanuts	55	15.7

Field data, 2019

According to the findings, 148(41.1%) of the study respondents indicated millet as their farm product with increased productivity after using harmonized seeds, 120(3.3%) indicated maize, 118(32.8%) indicated sorghum, 81(22.5%) indicated rice, 71(19.7%) indicated corn 67(18.6%) indicated cotton while 55(15.7%) indicated peanuts. This implies that the harmonization of seeds had created positive impacts to farmers by increasing their farm productivity.

Different farmers have different tests and preferences when choosing the variety of seeds to plant. The researcher sought to understand some of the farmers concerns when buying seeds. According to the findings, a majority of the respondents (81%) were concerned about the price of seeds. It was found that farmers are likely to buy low priced seeds than the expensive ones. 70% were also concerned by the characteristics of the seeds. Seeds which are resilient characteristics were most preferred. 30% could also pointed to the manufacturers. Respondents argued that some companies have better and genuine varieties while others had fake ones. Lastly, only 19% said they are also concerned with the country where the variety comes from. Respondents said they believed that some countries had better varieties than others due to better technology. One of the respondent R5 noted the following:

Mostly, you have to consider the price, this is because some prices are just too high for others to afford, if the prices are low, it will even make me to buy very high quantity due to economy of scale. In addition, the characteristics of the seeds are very important, this involved the quality of the seed, its resilient level and even its productivity (Respondent R5, 30th January, 2020)

Results discussion

Concerning ways in which WAAPP supports research and innovation, 86.1% of the respondents stated that the program had supported research and innovation through carrying out research on new seed varieties. In agreement, Li, Liu and Deng (2010) found that innovation on seed varieties increased food productivity. Secondly 52.5% stated that it supported through adoption and

dissemination of seed varieties. Another study by Cheryll et al (2000) established farmers prefers adoption of technologies with relatively low risks so as to promote supply of varieties of seeds. Thirdly 57.5% said through adoption and marketing of new seed technology and innovation. In support, *Sassenrath et al* (2008) posit that for improved productivity there is need for manipulation of seeds by use of research and innovation

Moreover, on how the program had facilitated research, it was found that 79.4% of the respondents indicated through provision of laboratories for tests. As asserted by OECD (2012), seed varietal certification is enhanced by carrying out relevant tests through laboratory standards, such as minimum germination, minimum analytical purity and seed health. Further, 65.6% talked of provision of seeds analysis certification as supported by OECD Seed Schemes (December 2012) while 49.4% indicted provision of trainings to different stake holders. In uniformity, FAO (2009) reports that imparting knowledge on farmers that through seminars, workshop and other agricultural related trainings promotes production of high yields.

Regarding the farmers concerns when buying seeds, 81% were concerned about the price of seeds. Meanwhile, 70% were concerned by seed characteristics. The manufacturers of the seeds was also considered as reported by 30.0%. Lastly, only 19% said they are also concerned with the country where the variety comes from. Conversely, according to OECD (2012), seed certification standards can be determined by factors such as local agro-climatic conditions, genetic characteristics, seed varietal certification among others. In agreement with the descriptive statistics, the multiple regression results found that increased agricultural researches and innovation promotes seed harmonization policies in Senegal.

1.9 Conclusion

The objective of this study sought to establish ways in which WAAPP supports innovation and research in seed harmonization. The researcher sought to understand how the program supported agricultural innovation and research in the harmonization program. Respondents were also asked to state ways in which WAAPP supports agricultural innovation and research. The respondents stated that the program had supported research and innovation through carrying out research on new seed varieties. The researcher assumes that to a great extend the program has taken measures to support research and innovation in agricultural sector. Regarding agricultural research and innovation, the study found out that increased use of agricultural research and innovation lead to improved seed harmonization policies in Senegal.

1.10 Recommendations

The orthodox seeds are portrayed as irrelevant and given little or no attention immediately a researched new variety is discovered and gazette. This study opines the protection of orthodox seeds as they could, are and still remain useful. Orthodox seeds have spent ages as evidence of their harmless nature to mankind. New variety seeds need time to interact with the environment to confirm they don't develop into a hazard. Analogy being the orthodox could come back to be useful in an event that the new seed variety doesn't meetup with the expectations. Secondly some orthodox seeds serve as cultural representation to some societies and should be protected and given more attention. Again, orthodox seeds are vital as they could serve as bench mark for new seed

varieties today and in the future not leaving out the fact that they increase the choices of farmers. Therefore, this study suggest the creation of seed archive to help in ongoing agricultural research as well in the future. This study is of the opinion orthodox seeds are important today and in the future to serve in the stride the WAAPP program is making towards a sustainable agricultural productive West Africa.

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