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Opportunity to Influence and Impact Policy on Mechanisation, and Infrastructure Delivery for Rice Production - **Ghana**

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Abstract

Rice is one of the most important food staples in Ghana and its consumption keeps increasing as a result of population growth, urbanization and change in consumer habits.

However, the rice sector in Ghana is seriously constrained by agricultural infrastructure deficit and poor access to appropriate agricultural machinery that continuously diminishes efficiency and productivity.

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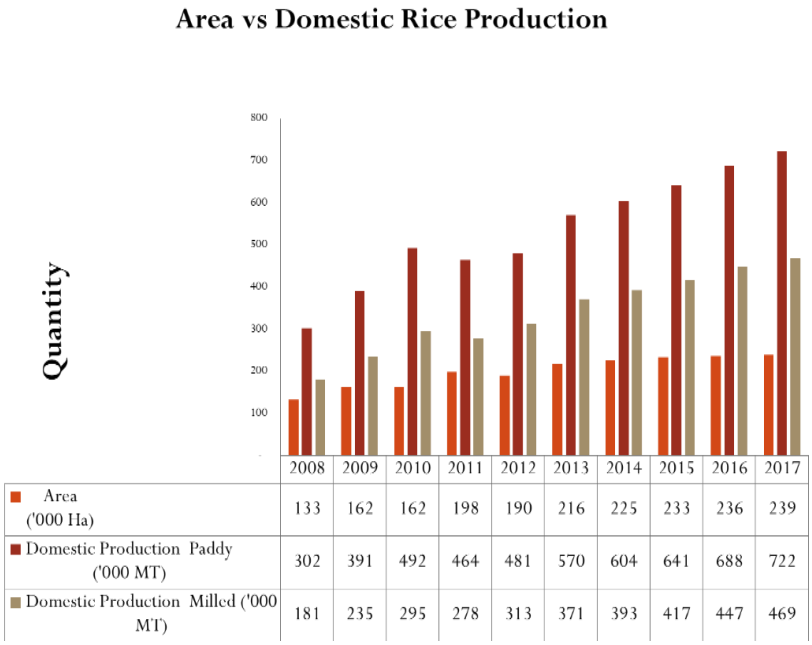
Acronyms

AAGDS	Accelerated Agricultural Growth and Development Strategy
AESD	Agricultural Engineering Services Directorate
AGRA	Alliance for Green Revolution Africa
AMSECS	Agricultural Mechanisation Services Enterprise Centres
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
CARD	Coalition for African Rice Development
CSIR	Centre for Scientific and Industrial Research
DCS	Directorate of Crops Services
DFR	Department of Feeder Roads
FASDEP	Food and Agriculture Development Policy
GIDA	Ghana Irrigation Development Authority
GPRS	Ghana Poverty Reduction Strategy
IFJ	National Agriculture Investment Plan
IVRDP	Inland Valleys Rice Development Project
JAKF	John A. Kufour Foundation
JICA	Japan International Cooperation Agency
METASIP	Medium Term Agricultural Sector Investment Plan
MMDAs	Metropolitan, Municipal and District Assemblies
MOFA	Ministry of Food and Agriculture
MTADP	Medium Term Agricultural Development Programme
NDPC	National Development Planning Commission
NRDS	National Rice Development Strategy
NRGP	Northern Rural Growth Programme
PFJ	Planting for Food and Jobs
RSSP	Rice Sector Support Project

1 Introduction

Rice is one of the most important food staples in Ghana and its consumption keeps increasing as a result of population growth, urbanization and change in consumer habits. It is a labour intensive crop and is cultivated both as a food and a cash crop.

Figure 1: Production Area against Paddy Production

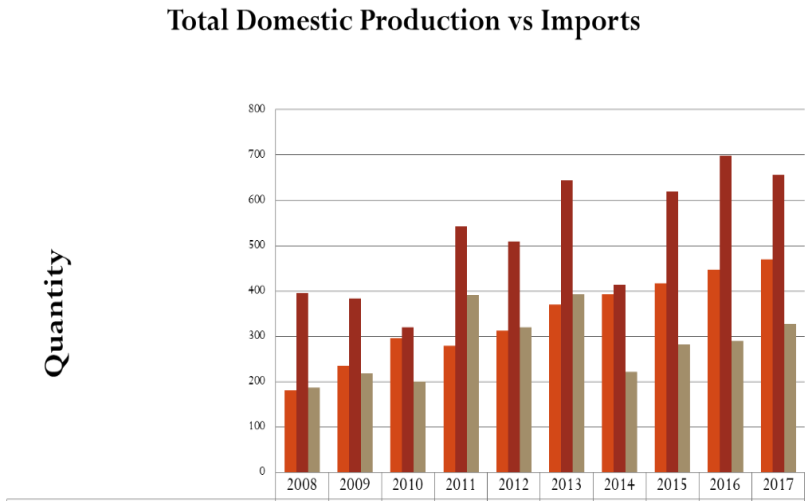


	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Area ('000 Ha)	133	162	162	198	190	216	225	233	236	239
Domestic Production Paddy ('000 MT)	302	391	492	464	481	570	604	641	688	722
Domestic Production Milled ('000 MT)	181	235	295	278	313	371	393	417	447	469

Between 2008 and 2017, paddy production was in the range of 302,000 and 722,000 MT (181,000 to 469,000 MT of milled rice) with large annual fluctuations (MOFA, 2017). The total rice consumption in 2008 amounted to about 500,000 MT (JICA, 2008), which is equivalent to per capita consumption of 26kg per annum. The annual production fluctuations are largely due to the area (ha) under rice cultivation, with marginal yield variations (t/ha).

Ghana depends largely on imported rice to make up for the deficit in domestic rice supply. On the average, annual rice import is about 500,000 MT as shown in figure 2. The self-sufficiency ratio of rice in Ghana declined from 38% in 1999 to 24% in 2006 (CIRAD, 2007) and increase to around 42% in 2017.

Figure 2: Total Rice Domestic production (milled) against Rice Import



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Domestic Production Milled ('000 MT)	181	235	295	278	313	371	393	417	447	469
Import Total Imports ('000 MT)	395	384	320	543	509	644	414	620	698	656
Import Value (US$Million)	187	219	201	391	320	392	221	282	289	328

Government policy strategies and campaigns over the years, as captured in FASDEP I, GPRS I & II, MTADP, AAGDS, IFJ and PFJ policy documents, have sought to promote rice production to address food security, poverty reduction and import substitution.

However, the rice sector in Ghana is seriously constrained by agricultural infrastructure deficit and poor access to appropriate agricultural machinery and equipment that continuously diminishes efficiency and productivity. Key infrastructure deficit of the sector includes the dearth of efficient irrigation schemes, motorable roads, modern markets, developed agricultural lands, efficient storage and warehouse facilities. The sector is largely characterized by traditional farming practices such as dependency on rain and the use of basic farming tools such as cutlass, hoe and sickle. The

dependence on erratic rainfall for agricultural activities serves to make the bad situation worse, if timely land preparation activities are not realized. The overall outcomes of these constraints have resulted in drudgery associated with rice farming coupled with low productivity and low competitiveness among imported rice.

Generally, infrastructure has the tendency to phenomenally accelerate the transformation of existing traditional and subsistence agriculture systems into modern and commercial agriculture systems. Additionally, the application of appropriate agricultural mechanization reduces the drudgery associated with traditional farming, enhances the timeliness for production, and improves yields and quality of paddy rice through precision planting, crop maintenance and harvesting thus increasing productivity. Both infrastructure and mechanization however involve huge initial capital investment outlays, long gestation periods and low rate of returns on investments, although many stakeholders although identify investments in these areas as the panacea for the maladies plaguing the sector. Poor linkages between farmers, seed producers, fertilizer dealers, millers and providers of financial and mechanization services negatively affect the adoption of improved technologies and practices among rice value chain actors.

However, it is necessary to prioritize which infrastructure and machinery require immediate attention to sustain the rice sector.

2 Background

The John A. Kufuor Foundation (JAKF) is implementing the ***Public-Private Partnership for Competitive & Inclusive Rice Value Chain Development: Planting for Food and Jobs (PFJ) – The Rice Chapter*****.** The program is commissioned by the Alliance for Green Revolution Africa (AGRA) with funding from Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ). It is implemented in Volta, Northern, Ashanti, Central, Western, Brong Ahafo and Eastern Regions of Ghana. The target group consists of 128,764 small-scale rice farmers. These regions account for more than 75% of the national rice production.

Considering the commitment of the Government of Ghana to increase the local production of rice by 30%, by 2020; reach self-sufficiency by 2025, there is a need to harness the collective skills and strengths of the various stakeholders and institutions for an efficient coordinated roll out of the program in Ghana. Therefore, the project seeks to significantly improve the livelihoods of rice farmers in selected regions by increasing the competitiveness of domestic rice supply to meet increasing regional demand through the adoption of proper production systems and linkages to markets. Six (6) consortium partners are implementing the project. They are; Intervale Ghana, Hopeline Institute, John A. Kufuor Foundation, Sparkx Farms, Volta City Farms and Directorate of Crop Services (DCS) of the Ministry of Food and Agriculture.

JAKF is responsible for the implementation of Objective IV of the project; **Strengthen continental, regional, and government multi-sectoral coordination, and mutual accountability in the agricultural sector.** One key activity for JAKF under this objective is Advocacy on infrastructure development for rice value chain. Prevailing reports have pointed out that the country's rice production can be significantly increased through expansion of infrastructure and agricultural mechanization. As such, the Foundation seeks to develop a Policy Document on the country's infrastructure and mechanization needs highlighting the required level of participation by both public and private institutions. Government of Ghana, in seeking to improve rice productivity and farmer access to markets for greater income generation is pursuing a multiplicity of outcomes aligned to the AGRA Results Framework as follows:

OBJECTIVE 1: Increased rice productivity for smallholder farmers in the selected regions

- Outcome 1. Strengthened agricultural inputs systems, technology development and supply chains
- Outcome 2. Increased adoption of agriculture productivity enhancing technologies

OBJECTIVE 2: Strengthened and expanded access to output market

- Outcome 3. Reduced post-harvest losses
- Outcome 4. Increased agricultural employment and entrepreneurship
- Outcome 5. Increased use of structured markets

OBJECTIVE 3: Increased capacity of smallholders farming households and agricultural system to better prepare for and adapt to shocks and stresses

- Outcome 6. Strengthened and expanded business development, financial and risk management services in agriculture value chain

OBJECTIVE 4: Strengthen continental, regional, and government multi-sectoral coordination, and mutual accountability in the agricultural sector

- Outcome 8. Strengthened national and regional level agriculture sector system functioning

3 Terms of Reference

The Foundation therefore engaged a consultant to develop a policy paper for infrastructure and mechanization gaps for the rice sector under the following terms of reference.

i. Conduct a needs assessment of the country's current infrastructure and machinery relevant to rice production.

ii. Engage sectoral stakeholders on how to improve infrastructure and machinery in the country.

iii. Design framework for advocacy based on outcome of needs assessment paying attention to the project indicators.

3.1 Problem Statement

The average rice yield in Ghana is around 2.2-2.5MT per hectare. The main causes of this low productivity include the following:

i. Inadequate availability of high-quality inputs, poor irrigation access and poor water management,

ii. High cost of production coupled with high post-harvest losses (estimated at 35% in the country) as there are insufficient infrastructure and technologies to maximize harvest output,

iii. Low use of adapted mechanization,

iv. Poor access to structured and profitable market due to the competition with imported rice,

v. Low access to competitive and sustainable credit for smallholder farmers and other value chain actors,

vi. Poor enabling environment that limits investments for both irrigation and post-harvest infrastructures through PPP approaches,

vii. Climate change that results in frequent natural disasters including floods, and droughts.

3.2 Objectives

The overall objective of the policy document is to identify agricultural infrastructure and machinery that are relevant to rice production, while prioritizing the ones requiring immediate attention. The policy document is to also establish lessons learnt and develop new forward-looking options on Ghana in terms of the high priority infrastructure and machinery options. The paper will also seek to inform and enrich the process of exchanges, national debates, assessments and international and regional dialogues.

Specific objectives of the assignment to be carried out in Ghana are to identify:

i. strengths and weaknesses of the present country systems,

ii. triggers for modernization of infrastructure and mechanization management,

iii. options for the development of infrastructure and mechanization service provision

iv. opportunities to leverage on existing public and private sector interventions in the sector

v. modernization approaches, practices and lessons learnt

vi. new forward-looking options for advocacy on infrastructure and mechanization modernization.

3.3 Scope

The priority needs assessment of the country's current infrastructure and machinery relevant to rice production was carried out nationwide in the major rice growing and processing districts.

The assessment covered the different ecosystems for rice production such as irrigated, lowlands/hydromorphic and upland fields to identify the strength and weakness of the sector as well as triggers for modernizing infrastructure and mechanization service provision. Sectoral stakeholders within the rice growing districts and regions such as input dealers and service providers, producers, processors, aggregators, wholesalers, retailers, etc were engaged to identify opportunities to leverage on existing public and private sector interventions in the sector.

4 Approach & Methodology

Desk study and data collection started with a thorough desk study and research, compiling and analysing all relevant documents and reports on agricultural infrastructure and mechanization for rice production in Ghana and globally. The consultants used available, reliable and appropriate sources of information as well as quantitative and qualitative methods to conduct the analysis. Lessons learnt on past government mechanization interventions targeting rice production such as Japanese Kennedy Round 2 (2KR project), Agricultural Mechanisation Services Enterprise Centers (AMSECs) werecompiled and analyzed. A SWOT analysis was adopted to identify the strengths and weaknesses of the current agricultural infrastructure and machinery environment of the entire rice value chain including input dealers and service providers.

Field visits and interviews: This phase was dedicated to meetings and interviews with all relevant stakeholders' active in Ghana and locally. Among others, consultations was held with the Ministry of Food and Agriculture, the Ghana Irrigation Development Authority, the Ministry of Energy and the Energy Commission, the Feeder Roads Authority, concerned district authorities, representatives of private sector (including financial sector) and others. Field visits to some of the rice producing districts was carried out to validate the desk review processes, update the understanding of the consultants on the current status of infrastructure and mechanization needs as well as finalize the report. This was undertaken through participatory approach with key stakeholders such as small-scale farmers and millers. Outcome of these results was analyzed using weighted variables to prioritize strategy interventions.

Synthesis and report writing: The consultants presented preliminary findings in a draft report which was subjected to review by the JAK to provide comments for refining the report. Based on these comments the consultants prepared a final report.

Baseline information collected: The report included information on the items presented below. However, these did not limit scope of work for the consultants. The information below should not be looked at with any priority order.

Table 1: Infrastructure and Mechanisation in Rice production Districts (RpDs)

Sector	Infrastructure and Mechanisation in Rice production Districts (RpDs)
General information	– Economic and social overview in each Rice Producing District (RpD) (unemployment, sectors of activity, etc.) – Population overview in each (RpD) (population,) – Geographical overview in each (RpD) (size, river basins, river descriptions, forest, natural parks)
Agriculture/Rice related information	– Main type of crops and livestock farmed in each (RpD) – Rice area under cultivation & potential, yields, etc – Type of rice cultivation ecology (Rainfed/Irrigation, Lowland, Upland, Paddy) – Current use of agricultural / arable land (scale, quality) in each (RpD) – Identified potential of agricultural / arable land (scale, quality) in each (RpD) should the right additional investment be made – Numbers of farmers and agro businesses (number and broad classification) in each (RpD)

Sector	Infrastructure and Mechanisation in Rice production Districts (RpDs)
Infrastructure and Water related information	– Presence of existing irrigation infrastructures and water use (surface, efficiency, quality, management mode) in each (RpD) – Evaluated potential of existing irrigation infrastructures in each (RpD)
Farm Mechanization and Processing related information	– Level of use of farm machinery and equipment – Number and type of farm machinery and equipment available (hoe, cutlass, animal/bullock ploughing, power tiller, tractor plough/harrow/rotovator, planter/seeder/transplanter, sprayer, combine harvester, reapers, threshers, etc
Transportation and logistics related information	– Access to main roads network (distance to main roads, quality) in each (RpD) – Access to secondary roads in each (RpD) – Quality of secondary roads in each (RpD) – Local transports and distribution companies / network in each (RpD) – Other type of road/transport difficulties in each (RpD) – Access to local and regional markets (distance, quality) in each (RpD)

4.1 Deliverables

The assignment was scheduled from 17th February, 2020 to 31st March, 2020 and took place in Ghana. A detailed description and mapping Infrastructure and Mechanisation constraints of the targeted (RpD) in terms of Land preparation/ Harvesting, Milling/ Marketing energy resources, water/irrigation resources and road networks were to form an integral part of the draft report.

The final report was to be submitted to JAKF on 31st March, 2020. The reports were to be delivered as follows:

i. Concept Note for the development of the policy paper by 5th March, 2020.
ii. Draft Report by 13th March, 2020.
iii. Dissemination strategy document by 25th March, 2020.
iv. Final Report by 31st March, 2020.

Both soft and hard copies of the reports were to be submitted to JAKF contact person as below:
Jude Bopam Programs Officer
John A. Kufuor Foundation Cell: 0244 502064 email :j.bopam@kufuorfoundation.org

4.2 Time Frame

- Starting date: 17th February, 2020
- Ending date: 31st March, 2020

5 Structure of the Report

This section outlines the major contents of the various headings. The report is structured under nine (9) main headings as below with the main policy strategies detailed under Preliminary Findings and Conclusions and Recommendations.

Chapter 2: Introduction

Chapter 3: Background

Chapter 4: Terms of Reference

Chapter 5: Approach and Methodology

Chapter 6: Structure

Chapter 7: Mechanisation and Infrastructure Framework

Chapter 8: Opportunity for Influence and Impact

Chapter 9: Preliminary Findings

Chapter 10: Preliminary Conclusions and Recommendations

6 Mechanisation and Infrastructure Development Framework

This section defines the context for the policy paper. It describes the current general agricultural mechanisation and infrastructure situation in the country including the challenges and factors. It also highlights the modernization approaches and practices and lessons learnt in the past on infrastructure and mechanization related to rice production. It considers the triggers and options of improving agricultural infrastructure and mechanization deficit. Finally, it highlights the Asian experience in mechanization and rural infrastructure for rice development.

Infrastructure provision can contribute to transformation of traditional agriculture or subsistence farming into modern commercial and dynamic farming systems. It has direct and strong relationship with farmers access to institutional finance and markets, as well as increasing crop yields, thereby promoting agriculture growth. Infrastructure provision, such as irrigation, watershed development and management, roads, markets, storage facilities in close coordination with institutional infrastructure, such as credit institutions, agriculture research and extension, rural literacy and information communication technology (ICT) determines the nature and the magnitude of agriculture output. Telecommunications and rural electrification also play a major role in boosting agricultural productivity, but their impact is more evenly dispersed across all sectors, less specifically targeting agriculture.

According to World Development Report 1994, most poor households in developing countries live in rural areas and the growth of farm productivity and non-farm rural employment is closely linked to infrastructure provision.

Bhatia, 1999 examined the relationship between infrastructure development and agricultural output in India and proved that one of the state in India, Punjab which had the highest index of infrastructure also had the highest yield of food grains and value of agricultural production per hectare. The other states like Rajasthan and Madhya Pradesh which have a very low index of infrastructure also had low yield of food grains and total value of agricultural production per hectare.

Ghana's agriculture is estimated to operate at 20% of its potential due to the low level of integration of agriculture with industry and the relatively underdeveloped support infrastructure. This means that if Ghana develops more efficient rural support infrastructure such as irrigation, transportation, commodity markets, agro-based industries, pack houses, warehouses, foundries, rural electrification and workshops for repair and maintenance, the agricultural sector will be able to grow several fold increases in production through the adoption of more productive technologies.

Agriculture infrastructure primarily includes wide range of public services that facilitate production, procurement, processing, preservation and trade. Infrastructure projects, however, involve huge initial capital investments, long gestation periods, high incremental capital output ratio, high risk and low rate of returns on investments.

6.1 Agricultural Mechanisation

Agriculture in Ghana is characterized by over dependence on rainfall and the application of basic agricultural tools and inputs with the resultant tedium, drudgery and low productivity. The short cropping calendar and erratic nature of rainfall allowed for less than 60 days of effective land preparation for both major and minor cropping seasons in the South and mono cropping season in the North of Ghana. This meant that to be successful, farmers had to have timely access to farm equipment in order to prepare their fields for effective cropping. However, the poor farmer to equipment ratio makes it practically unachievable.

In some farming communities, the closest radius farmers could have access to tractor services for some form of land preparation (ploughing) is about 100 km, thus farmers in those communities solely relied on hoe and cutlass for farm operations. A survey conducted by a JICA consultant in 2013 on Acceleration of Tractor use in Northern region noted that in Tamale, 1 tractor serviced 37 households' whiles in West Mamprusi and East Gonja it serviced 77 and 404 households respectively.

The potential for comprehensive mechanised agriculture in Ghana is enormous and it is quoted as 8.0 million hectares (Mahama A. A., 2007). Out of this, about 30% are under some form of mechanized cultivation, and this is largely due to the limited access to appropriate agricultural machinery and equipment along the agricultural value chain.

Tractor population in Ghana stands at about 6,200 of which 50% are over ten (10) years old and mostly imported as secondhand tractors. The main application of the tractor in Ghana's agriculture is for ploughing and to a limited extent harrowing. Other uses include for shelling of maize, threshing of grains and for haulage.

On the average, a new tractor of between 65-75 horsepower is able to plough 240 hectares of land under rainfed condition in a year. Considering that the potential mechanized land is 8.0 million hectares, about 33,333 agricultural tractors are therefore required to mechanise the potential. Taking into account the current tractor population of about 6,200 a deficit of 27,133 tractors are therefore required. Farmer access to mechanized services in all the other stages of crop production (planting, crop maintenance and protection, harvesting, processing, etc.) are similar to that of land preparation.

The non-availability of agricultural machinery for timely harvesting and processing of farm produce for storage and value addition have resulted in the high levels of post-harvest losses of crops in the country.

Provision of well-organized and commercially viable mechanized services is lacking. This is because of the high cost of agricultural machinery and credit, which creates a barrier for many farmers and the local supply market.

To address the market imbalances in the sector, the Government of Ghana through the Ministry of Food and Agriculture introduced the privately managed Agricultural Mechanisation Services Enterprise Centres (AMSEC) strategy to offer mechanized services to smallholder farmers across the country. According to a JICA study in 2015 on AMSECs, out of the 89 AMSECs established between

2008 – 2011, 37% had seized operations as result of premature breakdown of equipment resulting from poor management and limited technical skill of operators.

Mechanization services from the current practice in Ghana is mainly to reduce the drudgery with farming but not geared at enhancing productivity. The type of implements used and the skill level of tractor operators limit them to only ploughing, a primary tillage practice which on its own does not contribute to enhancing productivity. Poor after sales services support and the absence of competent management system for farm machinery reduces the service-life of the machinery.

6.2 Irrigation Infrastructure

Poor distribution and erratic rainfall in Ghana make the achievement of successful cropping every year difficult. However, irrigation has the potential to allow multiple cropping in a year thereby increasing productivity. Water resources in its natural form are abundant in Ghana and the mean annual rain in millimeters range from 800 – 2200mm.

However, seasonal shortages are quite common due to the inability to store and manage the rainwater (including surface runoff and deep percolated water) for usage in dry periods. Other factor affecting the shortage of water is land degradation practices and other illegal human activities such as illegal mining (galamsey) which have led to the destruction of watersheds hence the shortage in water for agricultural purposes.

The Irrigation Policy of Ghana categorizes irrigation into three (3) types: *Formal, Informal and Commercial Irrigation* schemes. **Formal** irrigation schemes refer to government owned/managed irrigation dam projects in the country, whiles the **Commercial** irrigation schemes are hydraulic infrastructure (dams and weirs) developed by commercial farmers to harvest runoff and surface water for irrigation. The **Informal** irrigation schemes are made up of micro-scale irrigation infrastructure that are usually self-initiated, constructed and managed. They include irrigators who lift water with small pumps directly from surface water bodies (e.g. the Volta Lake) to irrigate crops, urban and peri-urban agriculture (UPA) irrigation farmers and groundwater users.

According to the irrigation component of the National Infrastructure Plan developed by NDPC in collaboration with GIDA, the current total area of land under irrigation is 222,003 hectares with a projected increase of about 820,000 hectares in the next 30 years. A number of issues that affect irrigation delivery in Ghana are enlisted in the Food and Agriculture Development Policy (FASDEP II). These include (among others):

1. Low levels of irrigation infrastructure and services.
2. High cost of irrigation development and low capacity of local contractors
3. Inefficient use of water at formal irrigation facilities
4. Most formal irrigation schemes are poorly designed and operated with little consideration for land and water degradation, and energy efficiency.
5. Limited skill and knowledge in irrigation farming.

These issues in the long term affect the potential yields of crops including rice. GIDA's policy document advances that to expand rice production under irrigation, existing schemes need to be rehabilitated while new gravity-and other irrigation systems should be developed. In the rain-fed lowlands, public sector and development partners should be encouraged to participate in the development of simple and low-cost water control structures (dykes, bunding, catchment areas protection, and drainage systems) for improved rice production. Farmers need be trained in the operation and maintenance of irrigation schemes and water harvesting and regulatory structures in rain-fed systems. Water measuring devices for improved water usage under irrigation should be provided. Private investors with usufruct rights to a particular scheme should be encouraged to operate a nucleus and out-grower system to ensure employment for indigenes and fair arrangements amongst parties.

6.3 Transportation Infrastructure

The access to good transportation infrastructure such as good feeder roads and farm tracks, efficient rail and water transport systems has positive impact on agricultural productivity. Particularly, rural roads are the priority to link farmers to towns to facilitate market entry of smallholder farmers. Trajectories through which rural roads promote agricultural produce marketing include rapid and frequent access to market centres, accelerated delivery of farm inputs and products, easy movement of people, increased production and productivity, crop diversification and increased profitability (World Bank, 2006). Without an efficient road network, movement of people and agricultural produce are impeded hence stifling agricultural and economic growth.

Many farmers in rural Ghana have difficulty accessing their farms or carting farm produce from their farms and the situation even worsens during the raining season when most road networks are cut off. The poor drainage of such roads further contributes to rice farms located in valley bottoms being submerged or flooded during heavy down pours. This results in postharvest losses and high cost of haulage, which could otherwise have been avoided if rural transportation infrastructure were well connected from farms to markets and vis versa. Averagely, out of the 24,000 km of feeder roads in Ghana, only 50% are in maintainable condition due to a lack of local resources to fund road maintenance (African Development Fund, 2003). Other concerns of rural transportation include

- Poor rural road network and condition
- Non-existence of intended roads especially to farms
- Underdeveloped other modes of transportation such as water, rail etc.

6.4 Market Development Infrastructure (Storage and Warehouse)

Partly due to lack of appropriate and adequate storage structures, large price differentials occur between harvest time and the beginning of the planting period for many food commodities. Efficient storage facility insures the producer against income instability because it prevents excessive fluctuations in prices.

The inadequate levels of post-harvest facilities in Ghana pose a major bottleneck to accelerating agricultural growth. Small-scale farmers are invariably forced to dispose of their produce immediately after harvest to meet urgent cash needs, an action which results in low prices and reduced farm incomes.

In order to promote and sustain profitable rice production, it is essential to minimize postharvest losses, reduce processing and marketing cost, as well as improve the quality of rice for the market. The design and construction of appropriate storage and warehouse facilities equipped with drying floors (patios), improved parboiling equipment, modern milling equipment (pre-cleaners, destoners, hullers, polishers, paddy separators, colour sorters, aspirators, and graders), bagging and sealing equipment are a pre requisite to improve on the quality of local rice. Furthermore, accessibility to production areas and marketing centers should be improved while the marketing centres are equipped with modern storage facilities.

6.5 Rural Energy Infrastructure

The main sources of energy for agriculture include fossil fuel, biomass and electricity (hydro, solar and thermal). In Ghana energy use in mechanization have been limited to mostly fossil fuels for farm machinery and electricity for agro processing machinery. The high cost of fossil fuels and the poor access to electricity supply suitable for processing industries especially in rural areas have contributed to the slow growth of rice processing.

To ensure that farmers have adequate and sustainable cheap energy supply to power their various farm power and processing equipment there is the need to explore and promote alternative sources of renewable energy such as solar, wind, thermal, etc. The huge waste generated from rice milling facilities may be utilized to generate biomass/biogas.

6.6 Local Equipment Fabrication and Maintenance Infrastructure

Workshops for repair and maintenance play vital role in the success of agro-processing industry. Majority of farm machinery suppliers and dealers are located in the big cities which are often far away from where the farm equipment operates. Hence, machinery users, operators, owners and farmers face difficulties in accessing spare parts and other essential services during repair and maintenance of their machinery. Time is wasted at critical times of operations when these machinery operators and owners have to travel to big towns for solution.

Additionally, the weak capacities of local artisans in the design and fabrication of efficient and quality farm equipment has created over reliance on foreign imported equipment by farmers. These equipment often designed for a specific region tend to break down prematurely when utilized on the local terrain. There is need therefore to build capacities of local artisans and fabricators to modify and adapt equipment to the local farming conditions in Ghana.

6.7 Asian Experience in Mechanization and Rural Infrastructure

Asian countries such as India, Thailand, Japan, Korea and China are leading in the world production and export of rice based on its high level of mechanization utilization and basic rural infrastructure existence in the rice sector among other factors.

According to Suebpongsang et al. 2020, Thailand has more than 80% of its rice growing area under rainfed conditions, which was revolutionized through not only the widespread adoption of improved varieties but also the rapid mechanization of production. They further describe that Mechanisation in the rice sector in Thailand evolved through the replacement of animal traction with multipurpose two wheeled tractors (power tillers) and now medium sized four wheeled tractors. In addition, the use of combine harvesters has superseded the use of mechanical threshers in the past. Broadcasting and transplanting equipment have overcome the peak labour requirement for planting. Additionally, small dug wells are developed by farmers close to their paddy fields for supplementary irrigation using portable diesel pumps. Lastly, the state support for the expansion and development of lowland fields have contributed to the high levels of production of rice in Thailand.

Hegazy et. al. 2013, describes that mechanization in Japan was developed based on small-scale rice cultivation due to the limited size of paddy fields in addition to the social needs and importance of increasing production after the end of World War II. In the recent half century, agricultural machines drastically helped to move Japanese agriculture from human-powered tools, through animal power, towards mechanically powered equipment. Types of agricultural machinery have also changed from walking types to riding types. Mechanization has therefore contributed to yield increases in Japan making it one of the leading producers of rice in the world.

Gummert et. al 2013, further inform that Korea achieved complete mechanization of rice cultivation in the 1990s. They point out that on average a farm household possession to farm equipment such as power tillers, tractors, rice transplanters and combine harvesters is 1.1 units per household comparable to a worse situation in Ghana which is 37 tractors per household. From literature the rest of the major Asian countries like India and China have similar situation as described above.

7 Opportunity for Influence and Impact Mechanisation & Infrastructure

The following discussion on strategies and experiences in Ghana sets the stage for identifying policy opportunities for influence and impact through improved mechanisation and infrastructure uptake.

7.1 Government Direct Involvement in Agricultural Machinery and Equipment Market

The country's economic recovery programmes of the mid 1990s prescribed devolution of government direct involvement in mechanized service operations. Following this government through various donor support programmes have promoted farmer-managed and private sector managed mechanisation interventions. This has been done through Government importing or taking delivery of tractors and selling to farmers on subsidized conditions.

An example is the Japanese Grant for underprivileged farmers (2KR), which introduced machinery particular for rice production for farmers to acquire and use. Others are line of credits and trade facilities between the government of Ghana and government of China, India, and Brazil at various times to support farmers and private enterprises to acquire machinery and equipment for their own use or set-up mechanisation centres.

Due to government direct involvement in the distribution, selection, sales, etc, there have been several challenges including low repayment recoveries, poor after sales services, inappropriate machinery, etc.

7.2 Overreliance on Tractorisation in the Promotion of Mechanisation

The promotion of mechanisation (mechanical power) in Ghana in the past has focused solely on the use of tractor for tillage (ploughing and to some extent haulage) rather than look at other mechanisation options along the crop production chain. That is, smaller equipment (power tillers), planters, sprayers, harvesters, threshers, rice mills, etc. Practice of mechanisation has focused on reduction of drudgery rather than significantly increasing productivity and quality.

7.3 Inadequate Research and Weak Local Manufacture of Farm Equipment

Research is considered as the engine of growth and should be used to strengthen the development, application and transfer of technologies. Ghana has over relied on foreign technologies in the development of agricultural engineering/mechanisation in terms of equipment and its applications. Some of these foreign technologies have generally been inappropriate and expensive. A major contributory factor to this state of affairs is the lack of structured and sustained research and development programmes.

Over 90% of the farm equipment used for tillage are manufactured in Europe, America or Asia. Blacksmiths, artisans and fabricators who mostly specialise in the production of agro processing equipment mainly dominate the local manufacturing industry for agricultural machinery. Other category of blacksmiths and artisans also produces simple hand tools and implements, spare parts and carts attached to draft animals or tractors, which are primarily for tillage and other farm operations. Most of these artisans are unskilled and operate in poor equipped workshops with ineffective tools. They use low grade input materials in production thereby producing low quality and ineffective products which are unable to compete with the imported machinery.

7.4 Poor Socio-Economic Engagement with Land and Water Resources

Some 90% of Ghana's agriculture, most of which remains rainfed, takes place on small farms and is characterized by a high level of subsistence production. Perpetuation of this situation is incompatible with Ghana's wish to modernize and commercialize its agricultural sector, while achievement of SDGs 2.3, 2.4 and 6.4 will remain an elusive dream.

Yet despite the contribution that a more diverse and commercializing agriculture sector could place in a growing and diversifying economy, demand for transformation opportunities will remain limited in the absence of awareness regarding what those opportunities are. Opportunities actually abound in terms of: farming systems; the productive use of crop residues; added value; markets and possibly carbon credits. But to realise these opportunities, investments – both public and private – will be needed in agricultural water management schemes and service provision; not least to attract the investments in market and value chains needed to realise the significant socio-economic transformation potential of the sub-sector

7.5 Irrigation Support Services need modernization and Commercialization

Although members of WUAs on state financed irrigation schemes to an extent agree that GIDA's service is of good value, the way that such services are currently provided is incompatible with the need for full recurring cost recovery and sub-sector commercialization in line with Ghana's broader economic objectives. In addition, there is a significant - but so far under-addressed - opportunity for GIDA to provide a one-stop shop for potential investors, and an equally significant opportunity for GIDA to play a pivotal role in the establishment of and participation in sub-sector PPPs in production and service delivery.

Also, a strengthened regulatory role for GIDA will benefit all types of irrigators in terms of both the sustainable achievement of service delivery standards as well as conflict resolutions: the sustainable, productive use of natural resources by the sub-sector and the importance of regulations in the context of the enabling environment for private sector investments.

8 Preliminary Findings

Initial findings identified through desk study and field observations were grouped under machinery/mechanization requirements and agricultural infrastructure requirements for the rice sector. It further highlighted on new forward-looking opportunities for impactful policy advocacy to modernize agricultural infrastructure and mechanization.

8.1 Rice Production Ecosystems

Mechanizing on and off field operations for rice production in Ghana is essential to improve productivity, enhance the timeliness of the production, and improve the quality of paddy rice to the volumes and quality demanded by consumers. Thus, mechanization can boost local production of high quality paddy, enhance competitiveness, and ultimately reduce rice imports. Improving mechanization for rice production can attract youth and women into agriculture thereby creating jobs and wealth in rural farming communities.

There are mainly three (3) ecosystems for rice production in Ghana. These are (i) irrigated rice areas; (ii) lowland/hydromorphic rice areas and (iii) upland rice areas. The area, yields and production data on the various ecosystems are presented in table 2 below:

Table 2: Rice Production Data by Ecosystems

Year	Rain-fed upland			Rain-fed lowland			Irrigated			Total/Average		
	Area ('000 ha)	Yield (MT/ ha)	Production ('000 MT)	Area ('000ha)	Yield (MT/ ha)	Production ('000 MT)	Area ('000ha)	Yield (MT/ ha)	Production ('000 MT)	Area ('000ha)	Yield (MT/ ha)	Production ('000 MT)
2008	7.98	1.5	**11.97**	111.72	2.5	**279.3**	13.3	4	**53.2**	133	2.7	**354.67**
2013	12.97	2.2	**28.5252**	181.524	3	**544.572**	21.61	5	**108.05**	216.1	3.4	**734.74**
2018	19.43	2.5	**48.585**	272.076	3.5	**952.27**	32.39	6	**194.34**	323.9	4.0	**1295.60**
2013 (actual)	24.3	1.5	**36.45**	168.5	2.5	**421.25**	34.6	4	**138.4**	227.4	2.7	**606.40**
2018 (projection)	19.4	1.8	**34.92**	252.7	2.8	**707.56**	51.8	4.5	**233.1**	323.9	3.0	**982.50**
2023*	24.3	2.5	**60.75**	340.2	3.5	**1190.7**	40.5	6	**243**	405	4.0	**1620.00**

*Source: (MoFA, SRID 2008; CSIR, 2008) *2023 – Current projections*

Out of the ecosystems, the most productive in terms of yield per hectare is the irrigated rice production. Proper mechanization can increase the land intensification ratio from 1 to about 2.5, improve productivity to above 6 tonnes per hectare and reduce the average cost of production significantly. Although rainfed rice production is much different from irrigated rice production in terms of water usage, mechanizing field and post-harvest operations in rainfed lowland/hydromorphic rice production can improve yields significantly as well as improving the quality of the paddy rice to meet the requirements of the rice millers. The upland rice production is comparatively not as productive in terms of yield/ha and requires investment in mechanization to improve the yields to about 4 tons per hectare.

Some constraints of production under rainfed lowland include; vulnerability to climatic variability (drought and submergence) causing yield fluctuations, inherent low soil fertility, poor infrastructure at farm level and poor access to farm equipment. Under irrigated ecology the constraints are biotic factors, that is, diseases, insects and pests among others rather than climatic factors.

8.2 Mechanization and Infrastructure Gaps Based on Rice Production Area and Yield

The various rice producing ecosystems within the various districts coupled with other geographical factors such as soils, climate, rainfall regime, vegetation as well as economic factors such as employment, agricultural practices, level of access to technologies and infrastructure, all contribute to the current rice production volumes in the country. From table 3 National Rice Production by Regions 2018, it is observed that Northern region represents the region with the largest area under rice cultivation with an area of 81,165 hectares followed by Volta region with 58,662 hectares and Upper East region with 37,530 hectares respectively. However, in terms of average yields, Volta region ranks the highest with 5.11 metric tonnes per hectare followed by Greater Accra with 4.82 MT/ha and Eastern region with 4.02MT/ha respectively. Northern and Upper East region rather records one of the lowest average yields (2.00MT/ha and 2.78MT/ha respectively) in the country even though larger areas are cultivated in these regions.

Several factors account for these differences in average yields and the area of land cultivated especially between Volta and Northern region. Generally, the sizes of rice farms among smallholder farmers in Volta region are small than in Northern region. For example, smallholder farmers in Volta region cultivates on average 0.8 hectare whiles smallholder farmers in Northern region cultivates about 2 hectares. Additionally, due to the small farm sizes in Volta region farmers are able to fully manage their farms, with all the good agronomic practices (GAP) whiles due to the rather large farm sizes in the Northern regions farmers after initial land preparation and seeding are unable to invest time and resources to fully manage and apply all the GAP to their farms leading to low yields.

On the other hand, factors that contribute to farmers in Northern region ability to cultivate larger areas include the nature of vegetation and topography of Northern region. Its vegetation is described as vast areas of grassland, interspersed with the Guinea Savannah woodland, characterized by drought-resistant trees such as the acacia, Shea and dawadawa of the Savannah. This vegetation is more conducive to apply any form of farm equipment and machinery to the farm with little obstacles to impede tillage operations as compared to vegetation in the Volta region, which has a blend of undulating highland and lowlands, and mix of guinea savannah woodland and semi-deciduous forest.

Again, the land tenure or ownership for farming also accounts for the levels of cultivation. In Northern Ghana land are in the trust of the traditional leaders and chiefs who manage its allocation. Due to the vast abundance of lands in the area, the chiefs allocate the land freely without conditions thus making access to farm land easier for production. Unlike the South of Ghana including Volta region were lands are managed by family heads and they are several conditions attached. Farmers in the Northern part of Ghana therefore have access to large tracts of arable flat land for agriculture.

This is the reason why over 70% of tractor population in Ghana are concentrated in the Northern Ghana and comparatively, smallholder rice farmers as compared to Volta region cultivate larger areas.

Other factors that support the high yields of rice in the Volta region include the soil classifications, soil fertility, climate and access to perennial water resources as these factors differ on regional locations. While soils in the Volta region are more fertile and supports productivity in terms of high yield, soils in Northern region are largely infertile hence, without application of fertilizers, productivity is greatly affected. The Volta region agro-climatic condition presents two (2) farming seasons (major and minor) under rainfed whiles Northern region represents only one (1) season under rainfed. Volta region rice farming calendar covers April to July as the major and September to November as the minor whilst Northern region rice farming calendar, covers June through to October.

As a result of the several perennial water bodies (natural) in the Volta region including the Volta lake, access to water for irrigation or supplementary irrigation is abundant in the Volta region compared to the Northern region. Under Ghana Irrigation Development Authority, several formal irrigation schemes including pump and gravity schemes have been developed in the Volta region, which supports rice cultivation.

From the data on the rice production districts and regions, it is observed that the Volta region have comparative advantage over Northern region in terms of rice farmers easy access to urban markets in Accra and Kumasi (proximity). The conducive infrastructural facilities such as fairly good road network in some districts, fairly good electricity access, and easy access to water resources and land in some districts in the Volta region also plays a major role to attract investors in rice production and processing.

Some foreign investors operating in the rice value chain in the Volta region with advanced farming inputs and technologies include Brazil Agro, GADCO, HGL, Prairie Volta Limited, etc. These companies invest in high quality inputs (seed, fertilizer, extension services, etc) as well as utilize modern farm equipment such as tractors with rotovators, laser levellers, transplanters, seed drills, boom sprayers, harvesters, modern mills, irrigation (pumps, canals, etc). These factors largely contribute to the high yields in Volta region.

There are number of rice mills installed in both regions. However, the rice mills installed in the Volta region are more efficient in producing quality grains. The mill components include pre-cleaners, destoners, dehuskers, graders and colour sorters. These equipment though expensive produce quality grains for the high-end markets.

In Northern Ghana, the style of processing rice is quite different from the South. It involves several postharvest practices called parboiling, which have influence on quality of milled rice.

It is defined as the partial boiling of paddy before milling in order to reduce breakages during milling, increase nutritional value and to change the texture. Traditional methods including sun drying on the floor are largely used which results in poor quality of milled rice. Improved parboiling equipment and construction of drying patios are therefore required to improve quality of milled rice from the North.

Table 3: National Rice Production Data By Regions – 2018

Region	Area (HA)	Yield (MT/HA)	Production (MT)
Western	34,797	1.37	47,554.34
Central	2,341	2.12	4,967.86
Greater Accra	4,687	4.82	22,576.52
Volta	58,662	5.11	299,893.71
Eastern	9,737	4.02	39,114.13
Ashanti	14,167	3.89	55,056.22
Brong Ahafo	10,077	1.75	17,628.45
Northern	81,165	2.01	163,544.61
Upper East	37,530	2.78	104,255.20
Upper West	6,545	2.26	14,809.82
Total	**259,709**	**2.96**	**769,400.87**

Source: Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric.- March, 2019.

8.3 Scoping the Mechanization and Infrastructure Requirements for Rice

For the purpose of mechanization or the utilization of agricultural machinery and equipment to rice production and processing, the various stages or operations within the rice value chain either at rainfed lowland, or at irrigated rice production ecosystems is differentiated. These could be grouped into the following: (i) land development; (ii) land preparation - tillage (iii) planting; (iv) crop maintenance (including chemical & fertilizer application, irrigation & water management); (v) harvesting (including reaping, threshing, and winnowing); (vi) Processing and Storage (including cleaning, drying, milling and marketing

8.3.1 Land Development

Land development for rice production entails the clearing of vegetation including removal of tree stumps, roots and stones. It includes levelling and construction of water regulatory structures such as contour/grid bunds and drains. It is a capital-intensive operation particularly for smallholder rice farmers and the operation is carried out once, especially when there is need to develop new lands or expand farmlands for production.

Most lowlands and farms in the rice growing districts are full of obstacles that hinders the effective operation of farm equipment such as tractors and implements. These situations results in frequent breakdown and damage to the implements and components of the farm equipment such as tractor tires, plough hubs and discs, rotovator tines and combine harvester knives. Tractor attachments such as seed drills cum fertilizers and boom sprayers are also not able to work effectively on such fields.

Several attempts by Government or donor funded projects to develop such lowlands and valleys for rice farming have been challenged by the poor quality of land development and levelling done by contractors who are mostly road contractors. They employ the use of heavy-duty equipment such as Bulldozers and Graders for clearing the farmlands. However due to inadequate skills of the equipment

operators, the top soil which contain the organic matter suitable for vegetative growth is scraped off and the land further forms a shallow hardpan thereby reducing the water holding capacity of the soil. This is one of the reasons why most lowland rain-fed farms get flooded early in the season and dries up quickly in the cropping season leading to poor yields.

To address this situation, there is need to introduce efficient land developing equipment such as skid shredders, mulchers, laser levellers, etc for vegetation clearing as well as build the skill capacities of contractors and their operators in proper land development.

8.3.2 Land Preparation

Land preparation is one of the most important activities to ensure that rice fields are ready for planting. A well-prepared field controls weeds, recycles plant nutrients, and provides a soft soil mass for transplanting and a suitable soil surface for direct seeding. Land preparation covers a wide range of practices from zero – tillage or minimum tillage that minimizes soil disturbance through to a totally puddled soil which actually destroys soil structure.

It entails primary tillage (ploughing to till or dig up, mix and overturn the soil) and secondary tillage (harrowing to break the soil clods into smaller mass and incorporate plant residue. Another aspect of the secondary tillage is rotovating (puddling) used within wet or dry fields. In wet fields, it works the soil into a muddy or watertight paste. This minimizes water loss and increases nutrient retention and availability. The last stage of the land preparation for rice production is levelling and forming contour bunds to regulate or conserve water for production.

The source of power for land preparation comes in various forms based on the source of power that drive it – human, animal traction and mechanical power – electrical or fossil engine. There are different rainfall patterns in the country. In a year, the estimated average rainfall in the coastal savannah is 800 mm whiles that of the middle and northern belts are 1200mm and 1100mm respectively. Mechanization with this type of rain pattern needs to be strategized by introducing engine-powered equipment to enhance the timeliness of operation.

In most rice growing districts in Ghana, due to the limited access and high cost of engine-powered machines such as tractors and power tillers, smallholder farmers employ the use of manual tools for land preparation thereby increasing their risk of missing the short rainfall season for farming activities. In the circumstance, they apply chemical by the use of manual knapsack to kill weeds and then broadcast seeds by hand. This result in low yields normally recorded by smallholder farmers. The situation gets a little better for farmers that employ the use of mechanical power such as tractors. However, due to the common practice of primary tillage (ploughing) as the only land preparation method and the fact that seedbeds are not thoroughly prepared yields recorded are also observed to be low.

To ensure that farmers obtain optimum rice yields there is need to encourage all farmers to adopt the entire tillage operations of land preparation. Additionally, there is need also to increase farmers' access to the full complement of equipment for tillage operations (ie ploughs, chisel ploughs, rotovators, harrows, rippers, etc).

8.3.3 Planting

Rice can be either direct seeded or transplanted. In direct seeding, seeds are sown directly in the field while in transplanting, seedlings are first raised in seedbeds before they are planted in the field. Direct seeding largely takes place under rain-fed lowland or upland whiles transplanting takes place under irrigated fields. From the field data, most farmers in the rice growing districts under rain-fed lowlands or uplands sow seeds by broadcasting manually (throwing handful of seeds onto the field). Some commercial farmers in Northern and Volta region who cultivate under rain-fed lowland use tractor attachments such as no till seed drills to sow. Other farmers cultivating under irrigated fields employ the use of either a hand push or self-propelled trans-planter equipment for transplanting seedlings. The seedlings are first produced in a nursery before being transplanted onto the prepared paddy field.

Transplanting and the use of seed drill equipment produces proper plant establishment and population and at the same time requires less irrigation, weeding and other agronomic practices. This translates to higher yields, which are thrice the yields in broadcasting. Poorly prepared fields pose a great challenge in the effective use of transplanters and seed drills. Conservational agriculture may be practiced on shallow or fragile fields. In such instance no till seeding equipment should be encouraged.

8.3.4 Crop Maintenance

Crop maintenance in rice production includes fertilizer application for soil fertility and nutrients, chemical application for pest and disease, weedicide application for weed control and water application or irrigation for water management. Weed control is important to prevent losses in yield and production costs, and to preserve good grain quality. It is estimated that farmers lose an average of 37% of their rice crops to pests and diseases every year. Smallholder farmers in the rice growing districts use manual means to maintain their crop establishment especially chemical application. Common manual tool used is the knapsack sprayers. Some commercial farms in the Volta region use tractor drawn attachments like the boom sprayers for this exercise. Under rainfed and irrigated production, birds pose serious threats to rice fields. The current practice of manual crop maintenance by smallholder farmers contribute to the low yields being recorded under both rainfed and irrigated.

The lack of water source or water holding basin with its accompanying components and structures as supplementary irrigation particularly under rainfed lowlands or uplands also affects production during limited or short rainfall period.

To ensure efficient crop maintenance for increased yield there is need to encourage farmers to use modern equipment such as boom sprayers, fertilizer spreaders etc and invest in irrigation or water management structures.

8.3.5 Harvesting:

Harvesting is a tedious labour intensive process of collecting the matured rice crop from the field. The harvesting activities include reaping, stacking, handling, threshing, cleaning (winnowing) and hauling. These can be done individually or through a combine operation simultaneously by use of combine harvester. The use of a reaper and thresher equipment may also be used. Due to the muddy nature of irrigated fields, combine harvesters with crawler traction are recommended whiles combine harvesters with pneumatic or wheeled tyres are ideal for dry fields for good traction.

Due to the high cost of harvesting equipment such as combine harvester, reapers and threshers, majority of the smallholder farmers in the rice growing districts employ the use of manual tools such as sickles for cutting and beat the straws on bare ground to thresh. Others also use tractors to drive over the straws to thresh. These common practices introduce foreign materials to the rice grain thereby affecting quality. In the Northern Ghana, rampant bush fires as result of high temperatures and low humidity have tendency to attack over dried rice fields due to limited access to combine harvesters. The nature of fragmented rice fields with bunds require mini crawler combine harvesters with header working width 1.8 – 2.2 meters to easily maneuver in between plots.

The poor land preparation performed by farmers coupled with low skill levels of combine harvester operators have greatly challenged the lifespan of the limited number of combine harvesters available especially in the Northern regions.

To reduce the high post-harvest losses associated with rice harvesting there is need to support farmers with harvesting equipment such as reapers, mini crawler combine harvesters and conventional wheeled combine harvesters.

8.3.6 Processing and Storage:

Processing of rice is described as a postharvest activity. It includes, winnowing, drying, parboiling (if necessary), hulling, polishing, cleaning, sorting, grading, and storage. Drying reduces grain moisture content to a safe level for storage. It is the most critical operation after harvesting a rice crop. When rice is harvested, it contains up to 25% moisture. High moisture level during the storage can lead to grain discolouration, encourage development of molds, and increase the likelihood of attacks from pest. It also decreases germination rate if its rice seed.

Milling is a crucial step in the postproduction of rice. The basic objective of rice milling system is to remove the husk and the bran of layers and produce an edible white rice kernel that is sufficiently milled and free of impurities. Most rice growing districts lack drying and milling facilities and other processing equipment such as moisture meters, which contributes to high postharvest losses and poor quality especially among smallholder farmers.

To ensure that rice produce attracts good market prices, there is need to promote the establishment of modern rice mills with the requisite equipment such as moisture meters, bagging facilities etc, with high standards for good quality grain. Warehouses are also required for effective storage.

8.3.7 Ancillary Support Services for Mechanisation

Farmers who acquire machinery employ the services of tractor or machinery operators who do not have any technical or skill on mechanism of the equipment and machinery. These operators normally have limited knowledge about proper and effective machinery operation. They have limited knowledge on good machinery management practices such as daily greasing, daily inspections, routine maintenance and record keeping thereby leading to frequent premature breakdowns.

These operators lack the requisite knowledge in safety operation precautions thereby causing injuries, disablement and fatalities. In addition, their limited capacity in the use of the machines/equipment has resulted to environmental impacts such as degradation of agricultural lands

Other challenges that have tendency to affect the performance of the machinery and equipment include unavailability of spare parts and high cost of maintenance and repair. Local mechanics hardly keep to the manufacturer's recommended maintenance procedures due to lack of training on machinery management for the mechanics. These factors render the equipment, which are capital-intensive investment unproductive after a few years of use.

8.3.8 After Sales Services

After sales service is very limited and provided by untrained technicians. These technicians use wrong and inappropriate tools and processes, and inferior parts and components that reduces the service

life of the machines. In Ghana, most tractor mechanics are not professionally trained but rather learn through apprenticeship with ignorant masters. The well-trained mechanics are in the cities and the cost and time it takes for them to reach to farming communities during the season is a big challenge. Thus, when tractors break down during the season it is costly because it takes a lot of time to get it repaired. In addition, availability of spares in the open market for most tractors is always a challenge with the exception of some old brands such as Massey Ferguson.

8.4 Opportunities Identified to Influence Policy and Sustainably Close the Gaps

According to FAO, the various stages or levels of agriculture mechanization include use of human muscle (manual), animal power (animal traction) and mechanical power such as tractors for agricultural production process at any level of economic development.

For the purposes of this report, data in Table 4 on 143 rice-growing districts in Ghana assesses the level of deployment of mechanization and or infrastructure development, along the rice production chain and how it contributes to yield of production. The percentage levels are used to determine the gaps and rank the endowment characteristic of the districts.

8.5 The Parameters and Level of Effort to Close the Gap

The level of mechanization application by rice farmers and the nature of basic rural infrastructure such as road, irrigation, farmland, storage facility in the districts are characterized and colour coded as **blue** -low, **brown**- medium and **green** -advanced.

The ***low-level*** entails rice farmers' use of basic farm tools (hoe, cutlass, sickle and animal traction) for production under rainfed and on undeveloped farmlands. No access to irrigation or water regulatory structures for supplementary irrigation as well as poor transportation network and condition between farms and markets are also classified as low level. It further involves no access to storage facilities and standard rice mills, poor access to electricity source and poor access to support services for fabrication and repair of basic tools. **Please see Annex for districts in this category.**

The ***medium level*** is described as use of mechanical powered engines like power tillers, tractor with primary tillage implement only (ploughing), reapers and threshers for production under rainfed on fair developed farmlands. Basic access to irrigation infrastructure (water source, pump set, earth canal) and other water regulatory structures for supplementary irrigation as well as fair access to transportation network and condition from farms to markets are classified as medium level. It also implies a fair access to electricity, storage facility with standard rice milling equipment (destoner, drying patios) and access to support services such as SME artisanal workshops (metal works, fabrication of simple tools and spare part dealers). **Please see Annex for districts in this category.**

Lastly, the ***advanced level*** is defined as the use of effective and modern farm equipment & machinery including power tillers, tractors with both primary and secondary tillage implements (tractor/plough/harrow/rotovators/levelers). Adequate access to seed drill equipment, transplanters, boom sprayers, combine harvesters, reapers and threshers. It further include producing under rain-fed conditions on properly developed lowlands or valleys or irrigation fields with adequate access to effective infrastructure and water regulatory structures (dams, pump or gravity, concreate canal, pipes) for supplementary irrigation, good transportation network and condition, adequate access to storage facility with modern rice milling equipment made up pre-cleaners, destoners, graders, colour sorters & dryers. It includes access to electricity and other sources of rural energy, good access to well-established high-tech manufacturing and fabrication hub (GRATIS, Homerku Engineering), mechanical and repair workshops, spare part dealers etc. **Please see Annex for districts in this category.**

8.6 Gaps Identified and Endowment Ranking in 143 Rice Production Districts

From the analysis it is observed that out of 143 sampled districts, about **67%** are classified as low-level, about **25%** are classified as medium level and finally about **6%** are classified as advanced level.

The **low level** rice growing district has nonexistence or poor access to basic agriculture ancillary infrastructure such as good roads, irrigation/water regulatory structures, warehouse, etc. All the regions do have low level of classification in some of their districts. Rice production under this classification is mainly carried out by manual and traditional methods along the whole rice production chain. Land preparation is by the use of hoe and cutlass and in some cases in the Northern part of Ghana, animal traction is employed. Under low level, production may be carried out under rainfed lowland ecologies with farmlands hugely undeveloped.

The dependence on scare farm labour during peak farming season and lack of farm equipment means farmers are unable to expand their farms or unable to fully take advantage of the rains for timely production. The undeveloped and uneven nature of their fields coupled with the absence of water regulatory structures such as contour or grid bunds and drains also means they are unable to conserve or control flood water for production. The absence of dammed irrigation facilities makes the matter even worse in the dry season or during drought. The weak infrastructure existence also compounds the difficulties farmer face in rice production. This situation translates into the persistent low yields of production recorded by farmers under this classification.

The lack of access to efficient simple harvesting equipment such as reapers, brush cutters and threshers as well as the high cost of labour for harvesting results in high postharvest losses and high cost of production. Farmers also have to travel long distances on bad roads to rice milling centres, which often operate low standard mill equipment, thereby affecting the quality of milled rice and ultimately reducing revenue to be made by the farmer.

The **medium level** category districts produce mainly under rain fed lowlands or valleys, which may be developed by some Governmental projects such as RSSP, NRGP, Inland Valley Rice project, etc. Majority of such valleys are cropped by medium to commercial farmers who turn to invest in some form of farm equipment such as tractor and plough for land preparation. Smallholder farmers who crop on these valleys also depend on tractor services from the commercial farmers or service providers from other districts. Under this category, utilization of mechanization is focused only at land preparation (primary tillage) and to some extent harvesting and processing. The inadequate number of tractors and other land preparation equipment within the districts and the over reliance of tractor services from other districts also turn to affect the farmers capacity in production. The few old tractors available also breakdown frequently and the tractor operators have to travel long distances to big cities to acquire spares for repair thereby increasing downtime of the machine which leads to low productivity.

For example, at the beginning of the farming season, farmers have to wait several weeks before they can access tractor services for primary tillage. This situation prevents farmers from requesting for other essential tillage services such as second ploughing, several harrowing passes and rotovating, which ultimately results in poor seedbed preparation contributing to low productivity.

The properly developed nature of the fields with all the necessary water management structures in place, i.e. water conservation bunds, drainage openings, levelled and stumped fields, the lowlands become conducive and attractive to farmers for production. However, the inadequate and timely access to combine harvesters and other harvesting equipment poses a threat to farmers especially in parts of Northern regions such as Fumbisi and Gbedembilisi valleys in the Builsa North and South districts where bush fire attacks on rice is very common due to high temperatures and low humidity.

The deplorable conditions of the roads linking the lowlands or valleys and milling centres also poses a great challenge to farmers in terms of marketing. The limited number of storage facilities to store grains after harvest also affects quality which in the long run affect farmer's income.

The **advanced level** category districts on the other hand mostly cultivate under irrigated ecology and are able to reach yields of about 6.0MT/ha and cultivate several times in a year. The scope of mechanization utilization almost covers the entire production chain under this category. Farmers cropping on such areas though utilize range of farm equipment in production they are however challenged with inadequate number of farm equipment such as power tillers and 4WD tractors with rotovators for seedbed preparation. The frequent breakdown of these equipment and the weak ancillary support services such as repair, maintenance and spare parts also hampers productivity. Some farmers use precision equipment such as transplanters and seed drills thereby improving yields. The limited access and high cost of these precision equipment though improves yield and quality also increases cost of production which affects smallholder farmers capacity to use such equipment.

The inadequate number of mini crawler combine harvesters within the irrigated ecology also increases production cost since cost of labour is high especially around Asutsuare in Shai-Osudoku and Weta in Ketu North districts. Low standard mills available around some of these irrigation schemes also affect quality of milled rice.

8.7 Identifying Opportunities to Influence and Impact Productivity and Production

Agriculture is a vital part of Ghana's economic ecosystem. The country is known for producing staple food crops, such as maize, soyabean, cowpea, yam, and cassava; cocoa is the main cash crop. More than half of the Ghanaian labor force and one-quarter of the country's entire GDP depends on agriculture. Given the sector's central role, it is important that data coming from the field is relevant and reliable for policymaking.

Having accurate data means that the Ghanaian government can identify, develop, and implement policies that benefit the country and its agricultural workers. The growth of the agricultural sector is dependent on the formulation of policies, explained "Key policies must be based on reliable and credible data, as they will be used in addressing challenges in the sector."

Table 4 below shows that the region with the most advanced level of mechanized assets and infrastructure deployment especially irrigation (Volta region with 44%) reported the highest average rice productivity yields of 5.1Mt/ha, and the highest level of rice production (39%), although area under production in the Volta region of 23% is less than the 31% reported by the Northern region.

The Northern region although has second highest level of production (21%) reported the lowest yield productivity of 2.01 mt/ha, lower than the weighted average of 2.96 mt/ha for all the regions. The Northern region ranked highest with (24%) in the Medium level of mechanisation and infrastructure deployment. It also came in the second in the Advanced Level range with 33%.

The Policy implications are that increased ***appropriate*** support at all levels of Mechanisation and Infrastructure deployment to address the current gaps will yield a positive return in terms of productivity and production.

Table 4: Levels of Mechanisation and Infrastructure Deployment Vis-à-vis Productivity

LEVELS OF MECHANISATION AND INFRASTRUCTURE OF DISTRICTS						
REGION	LOW	%	MEDIUM	%	ADVANCED	%
WESTERN	14	14%	2	5%	0	0%
CENTRAL	4	4%	3	8%	0	0%
GREATER ACCRA	0	0%	1	3%	1	11%
VOLTA	18	19%	3	8%	4	44%
EASTERN	5	5%	3	8%	0	0%
ASHANTI	16	16%	6	16%	0	0%
BRONG AHAFO	10	10%	3	8%	0	0%
NORTHERN	14	14%	9	24%	3	33%
UPPER EAST	9	9%	3	8%	1	11%
UPPER WEST	7	7%	4	11%	0	0%
TOTAL	**97**	**100%**	**37**	**100%**	**9**	**100%**
PERCENTAGE %	**68%**		**26%**		**6%**	
Tota # of Districts	143					

National Rice Production Data - 2018					
REGION	AREA (HA)	% ofArea	YIELD (MT/HA)	PROD'TN (MT)	% of Prod
WESTERN	34,797	13%	1.37	47,554.34	6%
CENTRAL	2,341	1%	2.12	4,967.86	1%
GREATER ACCRA	4,687	2%	4.82	22,576.52	3%
VOLTA	58,662	23%	5.11	299,893.71	39%
EASTERN	9,737	4%	4.02	39,114.13	5%
ASHANTI	14,167	5%	3.89	55,056.22	7%
BRONG AHAFO	10,077	4%	1.75	17,628.45	2%
NORTHERN	81,165	31%	2.01	163,544.61	21%
UPPER EAST	37,530	14%	2.78	104,255.20	14%
UPPER WEST	6,545	3%	2.26	14,809.82	2%
TOTAL	**259,708**	**100%**	**2.96**	**769,400.86**	**100%**

Source: Statistics, Research and Info. Directorate (SRID), Min. of Food & Agric.- March, 2019.

8.8 Policy Options Proposed to Help Address the Gaps Identified.

Table 3: Development Issues and Policy Dialogue to Address Gaps

Area	Developmental Issues	Effect on Rice Production	Policy Dialogue to address gaps
1.0 Land development.	1.1 Poor land development of rice fields as result of **tree stumps, roots, debris, etc** creating barrier for the effective use of farm equipment. 1.2 Weak skill capacities in developing lowlands with requisite water regulatory structures for rice cultivation.	1.1.1 Premature breakdown & damage to farm equipment such as tractor tyres, plough hubs and discs, rotovator tines, combine harvester knives affecting productivity. 1.2.1 Loss of soil nutrient, form shallow hard pan, reduced water holding capacity.	1.1.1.1 Promote use of appropriate equipment such as skid shredders, mulchers and laser levellers for land development. 1.1.1.2 Collaborate with developing partners to invest in proper land development of lowlands and valley bottoms for rice production. Ensure lands are secured for development. 1.1.1.3 Build skill capacities of bulldozer operators and contractors in proper land development for rice production.
2.0 Access to adequate and appropriate farm equipment for land preparation, seeding, crop maintenance & harvesting	2.1 High cost of farm machinery equipment. 2.2 Inadequate supply of appropriate (power tillers, reapers, threshers) and affordable	2.1.1 Farmers unable to procure equipment or access mechanized services.	2.1.1.1 Provide credit/subsidy schemes for farmers to acquire appropriate farm equipment (power tillers, reapers, threshers, mini combine harvesters, moisture meters). 2.1.1.2 Provide credit/import duty waivers/tax relief to suppliers and dealers of farm equipment to

Area	Developmental Issues	Effect on Rice Production	Policy Dialogue to address gaps
(entire production chain).	machinery and equipment. 2.3 Inadequate mechanization service providers and leasing companies. 2.4 Poor after sales service support including poor spare parts access.	2.1.2 Low production and productivity 2.1.3 Smallholder farmers unable to access mechanized operations. 2.1.4 Frequent breakdown and abandon equipment.	import equipment such as power tillers, tractor + rotovators, reapers, threshers, mini combine harvesters. 2.1.1.3 Provide tax relief to service providers who service smallholder farmers. 2.1.1.4 Provide import duty waivers/tax relief to local agents and dealers of spare parts to set up satellite spare parts depot in farming communities.
3.0 Access to Modern Equipment for Processing & Storage (Milling Facilities & Warehouse).	3.1 Most rice growing districts lack drying and modern milling facilities which contributes to the high postharvest losses & poor grain quality especially among smallholder farmers.	3.1.1 High postharvest losses and low quality of grains leading to lower prices for the paddy or in some cases outright rejection of the paddy.	3.1.1.1 Promote the establishment of modern appropriate rice mills (pre- cleaners, destoners, graders, colour sorters where applicable) with high standards for high grade quality to attract good market prices. 3.1.1.2 Introduce appropriate modern and efficient parboiling, cleaning and drying equipment (including drying patios) that will enhance the quality of the paddy rice to meet the requirements of the mills.
4.0 Skills and knowledge of machinery operators.	4.1 Most agricultural machinery/equipment operators do not have the requisite skills and knowledge to effectively and efficiently set the implement properly or even operate the machinery/equipment to enhance productivity.	4.1.1 Regular breakdowns, injuries, disablement and fatalities and degradation of agricultural lands.	4.1.1.1 Regulate and provide continuous modular comprehensive training for both operators and service mechanics. Provide certification to trained operators and mechanics.
5.0 Spare Parts Delivery.	5.1.1 Poor access and high cost of genuine spare parts.	5.1.1 Low productivity due to abandon equipment.	5.1.1.1 Provide import duty exemption/tax relief to spare parts dealers to set up satellite sales points in farming districts. 5.1.1.2 Build capacities of local artisan to fabricate simple replacement parts.

Area	Developmental Issues	Effect on Rice Production	Policy Dialogue to address gaps
6.0 Local Fabrication and Manufacture.	6.1 Weak local fabrication capacities to manufacture simple farm equipment and replacement parts. 6.2 High cost of steel materials. 6.3 Low quality of steel materials in the market.	6.1.1 Over reliance on low quality imported farm equipment.	6.1.1.1 Build capacities of local artisans and fabricators to standardise the manufacture of simple farm equipment and replacement parts. 6.1.1.2 Provide tax relief for the importation of high quality steel materials for agricultural machinery production; 6.1.1.3 Adherence to standards and specifications in the manufacture and supply of steel products;
7.0 Irrigation & water management	7.1 High cost of irrigation infrastructure and components (dams, dugouts, canals, pipes and pumps) 7.2 Low efficiency in existing irrigation schemes & lack of maintenance 7.3 Limited skill in design, construction and management of irrigation structures 7.4 Land degradation including illegal mining (galamsey) on water bodies	7.1.1 Over dependence on rainfed agriculture leading to low productivity 7.4.1 Destruction of watersheds hence the shortage in water for agricultural purposes	7.1.1 Provide funding to construct modern and effective irrigation infrastructure such as dams, dugouts, canals, pipes and pumps 7.1.2 Rehabilitate existing irrigation schemes under GIDA to improve efficiency 7.1.3 Build skill capacities of contractors and design engineers in the design and construction of modern and efficient irrigation structures; Build capacities of farmers/users on management of irrigation structures 7.1.4 Create awareness on environmental degradation and enforce bylaws
8.0 Road Network	8.1 Poor rural road network and condition	8.1.1 Low Productivity and inaccessible markets 8.1.2 High transaction costs for production and marketing.	8.1.1.1 Provide funding support to improve existing rural road networks and other modes of transport
9.0 Storage and Warehouse	9.1 Inadequate and poorly situated ware house facilities	9.1.1 High postharvest losses	9.1.1.1 Collaborate with stakeholders to establish well-equipped and properly situated warehouse infrastructure

9 Preliminary Conclusions and Recommendations

The conclusions and recommendations on policy advocacy to promote increased agricultural infrastructure and machinery deployment for rice production will be presented under this section.

From data on the rice growing districts it is observed that rice farmers within about 67% of the rice growing districts still employ the use of traditional methods and basic tools for production which contributes to the low productivity of the sector. The rainfed ecology which happens to be the main production ecology is affected by poor access to appropriate and modern farm equipment, undeveloped fields and weak infrastructure deployment including irrigation, roads, electricity distribution, warehouse and storage facilities.

Similarly, the irrigated ecology is also affected by inefficient irrigation systems, poor management of irrigation systems, high cost of development and management, limited skill and knowledge in design and operation, limited access and inadequate number of farm equipment which affects potential yield achievement. Other factors affecting the ecology is as a result of land degradation practices and other illegal human activities such as illegal mining (galamsey) which have led to the destruction of watersheds hence the shortage of water for agricultural purposes.

In order to increase productivity and enhance competitiveness of local rice production there is need to vigorously promote mechanization use in the rainfed lowland ecology by promoting the use of appropriate farm equipment such as power tillers, tractors with the requisite implements (harrows, rotovators, chisel ploughs, rippers, levellers, etc), combine harvesters with adaptative traction systems, reapers, threshers, boom sprayers, etc.

Currently, tractor ploughing is the most common practice of mechanization in Ghana. However, this practice when not thoroughly done or complemented with other essential implements the optimum productivity and benefits of mechanization are not achieved. To ensure that farmers obtain optimum rice yields there is need to encourage all farmers to adopt the entire tillage operations of land preparation. This may be achieved through setting up mechanization centers to offer range of mechanized services to smallholder farmers or providing incentives for smallholder farmers to procure low engine powered equipment such as power tillers, threshers and reapers.

Transplanting and the use of seed drill equipment produces proper plant establishment and population and at the same time requires less irrigation, weeding and other agronomic practices. This translates to higher yields which are thrice the yields in broadcasting of seeds during planting. There is need therefore to promote the use of such technology among smallholder farmers however, poorly prepared fields pose a great challenge in the effective use of transplanters and seed drills. Hence capacities of farmers need to be built in effective land preparation. Conservational agriculture may be practiced on shallow or fragile fields. In such instance no till seeding equipment should be encouraged.

To address issues with high post-harvest losses and drudgery associated with rice harvesting and poor quality during milling, there is need to support farmers with harvesting equipment such as reapers, motorized threshers, mini crawler combine harvesters and conventional wheeled combine harvesters. Additionally, there is need to introduce modern and high standard rice mills with destoners, graders, colour sorters and construct warehouses for effective storage and marketing.

There is also critical need to invest in irrigation development and proper development of lowland valleys with adequate water regulatory structures such as contour bunds, drains, weirs, etc. to conserve moisture for production. Furthermore, there is need to promote the use of efficient land developing equipment such as skid shredders, mulchers, laser levellers, etc for vegetation clearing as well as building skill capacities of contractors and their operators in proper land development.

To sustain the huge investments in mechanization and avoid premature machinery breakdown, there is need to train farm equipment operators and farmers on proper handling and maintenance of all farm equipment.

The poor conditions of ancillary infrastructures such as roads and electricity need to be upgraded to support production of rice at the various districts. Other ancillary mechanization services such as fabrication workshops, repair and maintenance, spare parts dealership need also to be strengthened through incentives to support mechanization delivery. Capacities of local fabricators should be strengthened through collaboration with Research Institutions in the design and manufacture of quality and simple farm implements and equipment.

9.1 Policy Advocacy Recommendations

The Policy implications are that increased ***appropriate*** support at all levels of Mechanisation and Infrastructure deployment to address the current gaps will yield a positive return in terms of productivity and production.

Therefore setting and reporting on yearly yield and production targets as well as post-harvest losses by district enables the policy makers to isolate and estimate a Return on Investment disaggregated by district, Region and ecosystem. Investments by the private sector needs to be recognized in the reporting for picture completeness.

The inadequacy of capital, particularly, through the provision of infrastructure and services, which could be delivered using government resources, has the potential to crowd out funds for alternative spending – farm expansion and input procurement.

Promote Policy to provide targeted incentives to private sector agribusinesses that will assist in reducing working capital requirements, and thereby free up additional capital for reinvestment in agribusiness.

10 References

Documents and reports referred to during the desk study are listed under this section.

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10.1 List of Stakeholders

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11 Annex

11.1 Profile of 143 Districts - Mechanisation and Infrastructure Endowment

Data on Rice Producing Districts in Ghana

Download Annex here:
https://agra.org/wp-content/uploads/2020/10/Annex-Ghana-Rice-Mechanisation-Report.pdf

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