GHANA CLIMATE INNOVATION CENTRE (GCIC)

ENGAGEMENT OF A RESEARCH CONSULTANT

Terms of Reference

Study on Agricultural Management Practices to Reduce Greenhouse Gas Emission in Rice Cultivation

Background

The Ghana Climate Innovation Center (GCIC) is a pioneering business incubator with a unique focus of developing entrepreneurs to support Ghana’s transition to a green economy. GCIC is managed by a consortium led by Ashesi University, and includes Ernst and Young, SNV Ghana and the United Nations University’s Institute for Natural Resources in Africa (UNU-INRA). The center’s work support five key economic sectors – energy efficiency & renewable energy; solar power; climate smart agriculture; domestic waste management; water management and purification. UNU-INRA’s role in the consortium is to provide policy and regulatory support to enable the growth of entrepreneurs in the green economy space. This call is aimed at providing policy support for businesses in the climate smart agriculture space, with specific emphasis on rice cultivation.

Rice consumption and production in Ghana

Rice is a global staple food that feeds billions of people in the world annually. In 2012, more than 3 billion people, representing nearly half of the population, relied on rice every day. In Ghana, rice is the second most important staple, with per capita consumption increasing steadily (SRID, 2016). But more than half of the rice consumed in the country is imported. The share of domestic rice production compared to the rice available for consumption decreased from 55% in 2014 to 44% in 2016, but showed a marginal increase to 47% in 2017 (MoFA, 2018). Domestic production has consistently fallen short of demand, mainly due to limited cultivated area and low agricultural productivity. Statistics available indicate total imports of more than 620,000 tons since 2015, with a high annual import bill of about USD 376 million (MoFA, 2018).

To boost local production of rice, reduce imports, improve livelihoods (SDG 1) and achieve food security (SDG 2), the government of Ghana has launched a five year strategic policy called planting for food and jobs (PFJ). The policy provides farmers with subsidized inputs, extension services, access to market and an electronic platform for monitoring activities in the sector. Priority crops under the policy are maize, rice, soybeans, sorghum and vegetables (tomato, onion, chili pepper). Support from the PFJ campaign has so far yielded positive results. For example, the estimated cereal output for 2018 (3.4 million tons) is about

1 http://ricepedia.org/rice-as-a-crop
2 http://mofa.gov.gh/site/?page_id=15114
9 percent higher than the 2017 output and 21 percent above the five-year average\(^3\). The marginal increase in local rice production observed in 2017 is attributable to improved yield and increased area put under rice cultivation under the PFJ campaign coupled with favorable rainfall and enhanced extension services (MoFA, 2018). Recently, Ghana’s minister of Agriculture announced plans to exponentially increase rice production through the PFJ and halt importation of the commodity by 2023\(^4\).

But the planned increase in rice production could have dire consequences on the environment and socio-ecological systems. Whereas increasing production is critical to achieving key SDGs (e.g. 1 – no poverty; 2 – end hunger), care must be taken not to compromise the attainment of other SDGs. In particular, unsustainable agricultural practices in rice cultivation could derail efforts to achieve SDGs 13 (climate action) through increased GHG emissions and SDG 15 (life on land) through land/soil degradation. Thus, as efforts are being made to intensify rice production across the country for food security, it is important to build sound scientific knowledge of best agricultural management practices that enhance agricultural production at a minimal cost to the environment (climate, land, etc.) and society (Tian et al. 2018).

**Rice cultivation and GHG emission**

Rice fields are one of the major sources of anthropogenic methane (CH\(_4\)) and nitrous oxide (N\(_2\)O) emissions in the world. Compared to CO\(_2\) (carbon dioxide), methane, for instance, has about 23 times higher global warming potential in a time horizon of 100 years (IPCC, 2001), making it an important gas to monitor. Additionally, methane from global rice cultivation currently accounts for one-half of all crop-related greenhouse gas emissions (Kritee et al. 2018). The emission of CH\(_4\) and N\(_2\)O are influenced by agricultural management practices. Principal among them are water regime/management, fertilizer application and crop residue management. For example, the addition of nitrogen to soils, such as in the application of organic and synthetic fertilizers, is believed to be a major source of N\(_2\)O, accounting for about 13% of annual global N\(_2\)O emission (Olivier et al., 1998) or 24% (Kroeze et al., 1999; Mosier et al., 1998). Water management practices such as intermittent irrigation or continuous flooding have been found to have varying impacts on CH\(_4\) and N\(_2\)O emission patterns (Dong et al. 2017). The incorporation of crop residue as a means of improving soil fertility for rice production provides a source of readily available C (carbon) and N (nitrogen), which is believed to induce a high CH\(_4\) release from paddy rice fields. Studies have showed that these management practices often have conflicting effects on CH\(_4\) and N\(_2\)O emission. For example, compared to continuous flooding, intermittent irrigation is known to decrease CH\(_4\) emission but amplifies the emission of N\(_2\)O (Zou et al. 2005). Conversely, continuous flooding is known to generally reduce N\(_2\)O emission but increases the release of CH\(_4\). Thus, there is the need to investigate these management practices in relation to emissions and identify trade-offs for enhanced agricultural productivity and reduced emission of both GHGs. In other words, studies are required to recommend a

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mix/combination of suitable management practices that reduce both emission sources and increase crop yield.

Inadequate Research in Ghana and Africa

Previous studies have concentrated on major rice growing areas such as Asia (Cai et al. 1997, Zou et al. 2005, Dong et al. 2018, Tian et al. 2018) and North America (Simmonds et al. 2014, Weller et al. 2015). Unfortunately, limited studies have been conducted in Ghana (Boateng et al. 2017) and other parts of Africa (Bayabil et al. 2016, Koglo et al. 2016, Zougmore et al. 2016), despite the grand plans for increasing rice production and the fact that Africa faces the worse impacts of climate change. The limited number of studies can be attributed to the lack of measurements/experiments to estimate emission rates vis-à-vis management practices (Bayabil et al. 2016). Investments are needed to set up experiments to measure GHG fluxes on agricultural fields to generate the knowledge needed for recommending optimal management practices for high crop yield and low GHG emission. But before these investments are realized, lessons or recommended management practices can be learnt from studies conducted in regions with similar cropping systems and environmental conditions as Ghana.

Research objective

The objective of this study is to identify a set of recommended management practices for the rice sector in Ghana that potentially reduce GHG (CH₄ and N₂O) emission and at the same time achieve high crop yields. This will be based on a review of management practices in Ghana against findings of studies conducted in similar agro-climatic zones that recommended optimal management practices from actual measurement of GHG fluxes. Despite the present lack of actual measurements in the country, a comprehensive review of other studies is expected to provide some direction and support to the Ministry of Food and Agriculture in terms of developing appropriate extension services in the rice sector. Findings of this research can be incorporated into extension manuals which will support the country’s efforts to achieve food security while minimizing GHG emission. Recommendations from this research will be timely for the country’s planned increase in rice production from now till 2023 and beyond.

Specific objectives of the study are:

1. To review the existing rice production systems in Ghana and their associated management practices including water, fertilizer and crop residue management.
2. To review studies that measured GHG (CH₄ and N₂O) fluxes on paddy rice fields and investigated optimal agricultural management practices that increase crop productivity and reduce emission of both GHGs.
3. To provide a mix of recommended management practices for the rice sector in Ghana based on specific objectives 1 and 2.
Scope of work

UNU-INRA and GCIC require the services of a consultant to conduct this study. The consultancy is expected to be a desk study. However, minimal fieldwork to obtain a better understanding of the existing production systems can be considered. The consultant will work closely with staff of the climate change unit of MoFA as well as relevant staff at UNU-INRA and GCIC. The consultant will be required to carry out the following specific tasks to achieve the deliverables:

Task 1: Review of rice production systems and associated management practices in Ghana

This task will entail a comprehensive review of the rice production systems in Ghana. This includes upland/lowland (inland valley) systems, rainfed/irrigated systems and their associated management strategies. Current water, fertilizer and crop residue management strategies in each of the systems will be reviewed and documented. The task will include investigations into farmer’s real knowledge and perceptions of the impact of different management strategies on crop yield in the different production systems.

Task 2: Review and identification of global studies of local relevance

This task will require a comprehensive review of studies that recommended optimal management practices in rice cultivation based on actual measurement of GHG (CH$_4$, N$_2$O) fluxes. This is expected to be purely a desk study to analyze the plethora of studies on rice cultivation and emission of methane and nitrous oxide. The task will include a categorization of the studies based on geography, management, environmental conditions, and production systems to enable easy extraction/identification of studies that are relevant and applicable to Ghana in terms of recommending optimal agricultural management practices for Ghana that enhance production at minimal cost to the environment.

Task 3: Identify a set of recommended agricultural management practices in rice cultivation:

Based on findings of tasks 1 and 2, this task will focus on providing a set of recommended practices on water regime, fertilizer and crop residue management for the different production systems. This task will, as much as possible, provide concrete information that can be integrated into extension manuals at the ministry of food and agriculture to aid the envisaged rice expansion program. The consultant will provide an overview of the policy relevance/implications of the recommended management practices.

Task 4: Report writing

The consultant will write a final report outlining the approaches taken, and results obtained, in each of the three preceding tasks.

Deliverables

The following are the expected deliverables:

1. Final report detailing the methodologies employed, and findings obtained, in tasks 1, 2 and 3.
2. A short report detailing the policy relevance of the research as far as climate smart agriculture is concerned.
3. Compilation of the electronic versions of all documents/articles consulted during the research and web links from which information were sourced.
4. Survey protocols used during the research and results obtained, if any.
5. List of contacts established with private sector, academia, government bodies and development partners during the research period.

Duration

The consultancy is expected to be conducted with 25 input days in the month of August 2019. These days include days for field work, if any.

Qualification and requirements

A suitable consultant for this assignment must have:

1. At least a Master of Science (Msc) degree in agricultural science, environmental science, natural science or related fields with 5 to 10 years sustained research experience.
2. Previous experience with climate smart agricultural projects focusing on GHG measurements or monitoring.
3. Demonstrable research experience, e.g. publications in peer-reviewed journals.
4. Previous experience in rice research is an advantage.

How to apply

Interested applicants are invited to submit an Expression of Interest, including a detailed CV, implementation plan, proposed daily rate (in USD) and examples of similar work to recruit-inra@unu.edu latest by 17hrs GMT, 16th September, 2019. Only shortlisted applicants shall be contacted.
References


Mosier, A. R., and C. Kroeze (1998), A new approach to estimate emissions of nitrous oxide from agriculture and its implications for the global N2O budget, Global Change Newsl., 34, 8–13


