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Contributions of Smallholder Farmers to Water Pollution in Selected Rivers and Streams in Lesotho

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ABSTRACT

Inappropriate use of fertilizers and agrochemicals by smallholder farmers farming along water bodies seriously affect the water ecosystem and the environment. Use of agro chemicals and fertilizers are climate change adaptation strategies for smallholder farmers in Lesotho. This qualitative study brings to light the unsustainable farming practices among 20 purposively selected small holder farmers with farms located along water bodies in Lesotho. The study observes leaching of agrochemicals into water bodies and soil. Again, the use of agrochemicals affects the health of farmers who apply them, and the high possibility of substandard and expired agrochemical use by the farmers. The study proposes a strict regulation for on the sale of agrochemical and intensive education on the use of agrochemical among farmers and agrochemical sellers.

Key words : *Agrochemicals, Fertilizers, Lesotho, Smallholder farmers, Water pollution*

Introduction

Agriculture accounts for less than 10 percent of Lesotho's Gross Domestic Product (GDP) and employs more than 70 percent of the rural population who are predominantly poor smallholder farmers operating on subsistence farming (The World Bank, 2019), but the Kingdom of Lesotho's (2020) estimate places Lesotho's agricultural jobs at 67 percent in 2019. Being the pillar of the rural economy (that is the main source of employment, income and food security for the majority of the rural poor) the agricultural sector contributes 8.6 percent of Lesotho's Gross Domestic Product (Lesotho Vulnerability Assessment Committee- LVAC, 2019; Kingdom of Lesotho, 2020). These figures underline the importance of agriculture to Lesotho's rural economy.

However, efforts to improve agricultural productivity in Lesotho is hampered by two climatic variables: erratic rainfall and severe temperatures (World Food Programme- WFP, 2016). Further, Mekbib *et al*. (2012) and Matarira *et al*. (2013) introduced hailstorms and severe winters as additional climatic variables hampering agricultural productivity in Lesotho. These variables identified here have put the rural natural resource and climate-dependent livelihoods like farming under great threat and created food insecurity (William *et al*., 2017 and World Food Programme, 2016). Kingdom of Lesotho (2018; 2020) reports a sharp decline, agricultural sector's contribution to national GDP of Lesotho from 11.8 to 7.2 percent from 1985 to 1994 and cur-

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rently a contribution of 5 percent. Lesotho's recent prolonged drought contracted crop production by 9.7 percent in 2018, making the country's food deficit and depend on food import (World Food Programme, 2016).

Coupled with the above is the fragile ecosystems (Matarira *et al.*, 2013; UNDP, 2014; Letsie and Grab, 2015) and a declining arable land of Lesotho (Mekbib *et al.*, 2012) makes the country highly vulnerable to the impact of climate change. The arable land of Lesotho is estimated at 9 percent of the total land area of 30,355 square kilometres and this is under serious decline through anthropogenic activities like deforestation, with resulting effects like intense soil erosion, making the soil thin (Mekbib *et al.*, 2012; Flannery, 1977). Farmers in Lesotho have adopted strategies to sustain their livelihoods amid these climatic challenges. One such strategy is the intensification of the use of manure, agro-chemicals and planting close to water sources such as rivers and streams. While these strategies have worked for these farmers to improve food security, it has indirectly created adverse environmental impacts. Mateo-Sagasta (2020) and Mateo-Sagasta, Marjani Zad and Turral (2018) argues that agriculture in developing countries causes water pollution. Feeding the ever-increasing population has led to an intensification in agriculture using unsustainable methods.

Through intensification of agriculture, farmers have resorted to intensive irrigation, agrochemicals, organic and inorganic fertilizers to increase food production. With unprecedented increase in its sales, sale of agrochemical is considered the most unregulated activity globally (Baldini *et al.*, 2015). Intensification of agriculture can pollute rivers and streams as fertilizers, agrochemicals and pesticides leach and make their way into these rivers and streams, negatively affecting both aquatic life and health of people who depend on the water. Because of this, Fianko *et al*. (2010) argues the condition of river systems depends strongly on externals factors like agrochemicals, agricultural fertilisers and industrial activities. Organic fertilizers like manure and its fine particles (slurries) from cows contain pathogens, ammonia and phosphate and large amount of antibiotics, vaccines and growth hormones (Mateo-Sagasta, 2020; Evans *et al.*, 2019). Intensive irrigation causes these contaminants (from manure and slurries) to leach and runoff into drinking water and pollutes it. Agrochemicals together with manure leaching contaminate the soil and water bodies.

In a recent study on Mohokare river in Lesotho, Chatanga *et al.* (2019) observe low water quality and attributes the cause to anthropogenic activities such as agriculture, industrial activities and increased human settlement. They performed water standard test on water quality indicators like pH, nitrate, total suspended solids, phosphate concentrations, electrical conductivity, temperature, turbidity, oxygen content, coliforms and biochemical oxygen demand and realised all the indicators were above the acceptable levels, thus reducing the quality of water in the river. This made the river a threat to animal, human and aquatic life. They further observe no correlation between the various water quality indicators and a significant change ($p<0.05$) in the different water quality tests, something they scientifically explained that the contaminants emanated from different sources such as agriculture and industrial.

This study becomes relevant to pursue because it seeks to raise public awareness on the dangers of water pollution through agricultural practices and the need to adopt measures that will increase food production and farmers' income and at the same time reduce to acceptable levels, or if possible eliminate water pollution. Again, Chatanga *et al* (2019) convincingly traced the causes of river contamination in their study to different anthropogenic activities like agriculture, human settlement and industrialisation. Thus, a study like this which seeks to unearth the activities of smallholder farmers who farm along water bodies is good to explain the possible contribution(s) these farmers make to low water quality in Lesotho. This will save aquatic life and livelihoods of people who depend on the water for survival (WHO, 2004; Kolpin *et al.*, 2002). It is important to study these unintended effects which follow the adaptation strategies adopted by these smallholder farmers on water resources. This is in line with the argument of the concept of sustainable development, which seeks to meet the needs of the current generation without endangering or compromising the needs of the future generation (United Nations Conference on the Human Environment, 1992). Where are the objectives. These are farmers' use of fertilisers and manure along water bodies, use of agrochemicals to control pest and diseases among the smallholder farmers and the leaching of agrochemicals and manure into water bodies.

Sustainable development concept

This concept raises awareness that humanity can

make development sustainable. It further argues that humanity must ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations General Assembly, 1987 and Stoddart, 2011). Simply, this is about making the environment better for everyone without destroying the possibilities for the next generations. Sustainable development in practice seeks to strike a balance among social development, economic development and environmental development.

Social development ensures the protection and progress of human resources through access to quality education, health, water and food. Economic development concerns itself with the proper use of environmental resources for production and how environmental resources are distributed fairly. Economic development investigates the production chain of products and places critical attention on sustainability in the production process, thus seeking to apply fair rules to all (production, environment and social) in the production process. Environmental development seeks the balance in the ecosystem.

An empirical study conducted by Kassem and Alotaibi (2020) prove a violation of agrochemicals, especially those they brand as substandard as it a source of health risk to the health of farmers, consumers of agricultural product and micro-organisms living in the soil. The situation has been exacerbated by an increase in substandard agrochemicals, with unknown toxic effects, flooding the market of most developing countries, contaminating soil and water. From this, the quest for economic development through intensive agricultural production should not be achieved at the expense of the environment (eco-system) and humanity. Leaching of agrochemicals and other harmful substances into water bodies, which is home to biodiversity and a source of drinking water for humanity, should be addressed.

Agrochemicals and its effects on achieving sustainable development concept

Kassem and Alotaibi (2020) raise attention on the influx and high patronage of fraudulent agrochemicals which negatively affect the environment and human health. To them, the market of developing countries is flooded with substandard (fraudulent) agrochemicals which contain different quantities of banned and restricted chemicals. Because these agrochemicals contain banned products, they are often packaged with minimal labelling to describe its use and no health and environmental precautions (Fishel, 2009) making it difficult to determine the toxic effect of those products (Kassem and Alotaibi, 2020).

Substandard agrochemicals pose a severe health risk to farmers due to exposure during its application (Ashour *et al.*, 2019). The health of consumers of food produced from such agrochemicals containing untested and unknown residues is also at risk (Murphy *et al.*, 2012; de Boef Hasson *et al.*, 2014). Again, substandard agrochemicals contain highly toxic impurities. These impurities when entering the soil and water contaminates it and negatively affecting the health of biodiversity (Federation of Indian Chambers of Commerce and Industry, 2015).

Agricultural activities (Fertilisers and Agrochemical) and River System

River system condition depends largely on external factors such as agricultural fertilisers, agrochemicals and industries (Fianko *et al.*, 2010). Through agricultural activities, such as application of fertilisers and agrochemicals, large amount of phosphates and nitrates enters water bodies through run-offs as reported by Genevieve and Neary in 2006, creating serious water pollution with negative health implications (DWAF, 1996).

Chatanga *et al.* (2019) studied the quality of water in theMohokare River in Maseru, Lesotho. Their study observes high levels of nitrogen and phosphate from agricultural and industrial activities as the main pollutant of the Mohokare River. Though not explicitly stated, the authors placed emphasis on agricultural activities such as the application of fertilisers and agrochemicals, as the major contributor to river pollution compared to industrial activities from the textile industry in Maseru. Their justification for their claim was firmed on the work of Oecotextiles (2012) which reports agriculture as the worse polluter of fresh water compared to textile industry.

High levels of nitrogen and phosphates were observed in their study and reports of the consequences on health of man and animals which depend on such water bodies (DWAF, 1996). In their study, nitrate levels were in excess of 22 mg/1 and phosphate levels of 0.1 mg/1, exceeding the 0.005 mg/1 water quality target for good health and integrity of aquatic eco-systems (DWAF, 1996) posing health risk to humans and animals which consume

water from it. Nitrogen and phosphates reducethe nutrients in waterbodies as it promotes eutrophication causing health risk to humans and animals which consume it (UNEP/GEMS/Water programme, 2006). The authors reported that nitrates and phosphates content in the river is higher than those reported by Abdul-Razak *et al.* (2009) in Ghana's Oti River.

Nitrogen and phosphate fertilizers from agricultural activities leads to a reduction in aquatic systems capacity to supply fresh water and support fish species (Millennium Ecosystem Assessment, 2005). Loading of nitrates and phosphates from fertilizers by smallholder farmers along water bodies reduces the dissolved oxygen, thus reducing the biological oxygen demand for fishes and other water living organisms (Fianko *et al.*, 2010).

Studies to unveil the extent of use of fake agrochemicals among farmers reported that 65 percent of famers have used fake agrochemicals, 52.7 percent have used counterfeit of genuine branded agrochemicals and 23.2 percent of farmers have used illegal parallel imported agrochemicals, where fake agrochemicals have been with ingenuine branded covers. They further give the features of fake agrochemicals to include those sold in simple packs with minimum information on their use and no mention of nay environmental or health precaution.

Study approach

This study adopted a qualitative research approach, rooted in social constructionism (Bryman, 2012). Being a theory of knowledge, social constructionism believes in developing an understanding of the world through an examination of jointly constructed understanding. Through this, there is a shared assumption about social reality. This implies that from a social constructionist point of view, everything we find self-evident, and believe objective truth, is socially constructed in facts and can thus change as society changes (Vinney, 2019).

Participants, sampling procedure and research instrument

Twenty (20) farmers were purposively selected for interview. The study reached a point of saturation as no new information emerged after the 20th interview. The selection of the farmers was made using the snowball approach. Semi-structured interview guide was used for data collection and this allowed the field data collectors to ask probing questions. Participants' confidentiality and anonymity were also protected in all aspects of this study. All interviews were conducted based on the preference of the participants.

Thematic analysis of data was employed in this study. Prior to the analysis, the recorded interviews were transcribed into English. The researchers perused the transcript consistently to identify themes and draw patterns. Theme and pattern identification paid important attention to similarities and differences in views of the participants as well as the frequency of the views expressed. The views of the respondents are reported in verbatim quotes to give emphasis to how the participants expressed their real world. For reference to the participants, pseudocodes 1 to 20 were ascribed for the farmers (for example P1 to P20).

Results and Discussion

The result and discussion for the study have been done in this section under background of the participants, use of fertilisers and manure, use of agrochemicals to control pests and diseases and leaching of agrochemicals and manure into rivers. Details have been presented below.

Background information of the farmers

All farmers have up to high school education except participant 2 (P2), who has never had any formal education. Farmers grow crops such as maize (P1, P2, P13), sorghum (P1, P8, P16) and vegetables (P18, P19, P20) along rivers. All the farmers have farmed along rivers for more than 10 years. For example, P1 narrates *"do you see me? Do you see how old I am? I have been farming here since 1941 when my father gave this farm to me"*On reasons for farming along rivers, all participants stated the moist nature of the land along the river which favours agriculture. In addition to soil moisture, P2, P 5, P 12, and P 14 further narrate*"I did not select this land, it was an inheritance from my father"*Participants (P1, P4, P8 and P16) narrate that *"farming along the river has not always been beneficial to their livelihood. Though they were not able to substantiate their claims,"*participants (specifically P1, P4 and P8) narrates that*"farming along the river has been good and bad"*Participants (specifically P2, P6, P9, P12 and P18) gave reasons to support their claim "why farming along the river had been bad. "P12 narrates*"I face a challenge when winter approaches in a sense that the cold breeze from the river damage my crops,*

so this puts me under a lot of pressure to plant before the planting season" participant P2 further narrates *"planting before season makes it expensive as I am poor so the plough owners only agree to help me when planting season is due. I end up paying huge monies to plough my land before planting season".*

In a study on the impact of climate change on smallholder farmers in Lesotho, Dick-Sagoe, Hope and Asare-Nuamah (forthcoming) observed that most of the farmers in Lesotho has high school education and has been in farming for more than ten years. It also came to light from the same paper that cold weather, coupled with snow during winter affect crops of farmers in Lesotho. This study on agricultural water pollution confirm these claims made by Dick-Sagoe, Hope and Asare-Nuamah (forthcoming). This study also supports Kassem and Alotaibi (2020) in terms of age of farmers, education of farmers and years of experience in farming. With these background information, especially the level of education coupled with the fact that the available agrochemicals have no inscriptions to guide their use for the farmers to follow, it is very likely that these smallholder farmers will have less perception on the environmental risk associated with the use of these agrochemicals as reported in the study by Kassem and Alotaibi (2020).

Use of fertilizers and manure in farming along river banks in Lesotho

All the farmers use fertilizers and manure from livestock such as cow, sheep and goat on regular basis on their farms, except P2 who narrates *"I do not use fertilizer on my farm"*None of the farmers was able to name the type of fertilizer they use on their farm, not to talk about the instructions for use and the safety directions for use of fertilizer. Farmers again buy the fertilizers from agro-chemical retail shops located in the capital of Lesotho, Maseru and apply them on their farm using their own locally acquired knowledge based on the experience they have gathered from years of farming and those passed on from their parents, from whom they learnt the trade from and other colleague farmers. Again, fertilizers purchased were put in empty containers without the inscriptions of the fertilizers and the directions for use and expiry date on it.

Use of fertiliser was also observed as a common practice among smallholder farmers in a study conducted by Dick-Sagoe, Hope and Asare-Nuamah (forthcoming), *therefore this current paper supports the observation made by Dick-Sagoe, Hope and Asare-Nuamah (forthcoming) on regular use of fertilizers.* This also indicates that smallholder farmers depend on knowledge from parents, their experience, other colleague farmers and agrochemical retail sellers for their choice of fertilizers. This was also raised by Kassem and Alotaibi (2020) study.

Use of agrochemicals to control pests and diseases along rivers in Lesotho

All the farmers use agrochemicals regularly to control pest and disease on their farm for which they all claim they do not know the name of the agrochemical they use on their farm. Participants (P1, P2, P13) narrate, *"I send my son to go to town and buy the agrochemical. He describes the pest and the disease to the agrochemical retail seller to recommend the agrochemical to use"*P2 further narrates *"anytime I see pest and disease on my crops, I apply agrochemicals"*To answer how agrochemicals are applied, all the farmers responded that they use their personal acquired knowledge and also depend on the experience of other colleague farmers to apply the agrochemicals on their crops. Participants (P2, P10 and P19) narrate, *"I use my own judgement to measure and mix the agrochemical in water and use it to water my crops"* Again, the study realised that check this well due to the sentences that follow when applying agrochemicals on their crops, a situation which exposes their health to the dangers of the chemicals. For examples, narratives such as *"I only cover my nose because the scent of the agrochemical is too powerful and when I inhale it, it causes irritation in my lungs and makes me cough (P2, P12, P13)"*Participant (P1, P5 and P7) you claimed that all farmers do not use protective gears but this is a protective gear because they fear agrochemicals will soil their dress.

This confirms the revelation in Kassem and Alotaibi's (2020) study where they observe farmers depend on other colleague farmers and agrochemical retail sellers to prescribe agrochemicals for use on their crops. The same authors also raises alarm on the high rate at which farmers have been exposed to fake and counterfeit agrochemicals, which has also been confirmed in this study, as all the farmers have used agrochemicals with no name /brand and without instructions for use and the potential effects on the environment. Again, Chatanga *et al.* (2018) observe traces of nitrate and phosphate in Mohokare River in Lesotho and attributed it to the high levels of leaching of agricultural fertilisers into water bod-

ies in Lesotho.

Leaching of agrochemicals and manure into rivers

All the farmers disagreed that agrochemicals and manure deposits leach into the rivers, however, they agreed that it leaches into the soil only, for which they further claim that after two days, the agrochemical becomes ineffective in the soil, making it harmless to any living organism in the soil (P1, P6, P11, P17 and P19). Because all the farmers disagreed to the leaching of agrochemicals into the rivers, none of them offered a solution to prevent thefurther leaching of agrochemicals into the rivers. All the farmers agreed that they cannot do without agrochemicals since that helps them to protect their livelihoods, for example, P2, P3, and P5 narrates, *"without agrochemicals, we will all be poor."* P2 further adds, without agrochemicals, *"there is no way we can fight pest and diseases and our crops will die"*Participant (P1), though disagreed that agrochemicals leach into the river further narrated later that*"pondering on your question further, I think, it is possible for agrochemicals to leach into the river when it rains heavily."*Participant (P1) further narrates *"I feel bad because people in my village depend on the river and also livestock such as cows drink from the water, therefore pollution from agrochemicals will affect these people and animals."*

Chatanga *et al.* (2018) observed traces of nitrate and phosphate in Mohokare River in Lesotho and attributed it to the high levels of leaching of agricultural fertilisers and agrochemicals into water bodies in Lesotho. Therefore, this present study goes to unearth how these agrochemicals and fertilizers from agricultural activities end up enteringriver bodies and pollute them in Lesotho.

Conclusion

Sustainable development concept raises the need for policymakers to integrate environmental, social, and economic concerns into all aspects of national decision making. Achieving such requires the protection of health of citizens and biodiversity from any activity which seeks to put their health in danger. By economic, sustainability argues for the proper use of natural resources to meet current need and future needs of the unborn generation and finally, environmental seeks to balance the ecosystem through the protection of biodiversity.

From this study, the use of agrochemicals and fertilisers including manure is predominantly intensive among the farmers since they do not have any other option to save their livelihoods from the negative effects of climate change. These agrochemicals negatively affect farmers' health, micro-organisms in the soil and aquatic life in rivers through spilling. Though farmers ignored that the application of agrochemicals and slurries of manure on farms leach contaminants to pollute river ecosystems and become a threat to human health and the environment, it was evident that the closeness of their farms to these water bodies poses a risk of water pollution during heavy rain downpour. Again, though the farmers claim agrochemicals becomes ineffective in the soil after two days, in reality, it is not true. These chemicals stay in the soil and later finds itself into water bodies and create harm to health. From the empirical studies, water bodies in Lesotho are under serious pollution mainly from agricultural agrochemicals and fertilisers such as those with nitrates and phosphates.

Farmers lack complete knowledge of the application of agrochemicals on their farm because they use their own personal experiences to apply the agrochemicals and have not received the needed education on the use of such fertilisers and agrochemicals. Coupled with this challenge is the low levels of formal education among these farmers. The resultant effect of this behaviour is the likelihood of increased overdose of agrochemical application on farmlands along rivers, which presents serious sustainability issues on these rivers and the health of those who depend on the river including humans and animals. Farmers' lack of knowledge on the use of agrochemicals raises policy concerns. Again, farmers seem to lack knowledge on the effects agrochemicals have on the environment (water and soil) and human life, this was evident as the farmers do not wear protective clothing when applying agrochemicals. Again, farmers believe that agrochemicals become ineffective in the soil after two days. Agrochemicals sold to farmers are not branded and has no written directions for use and expiry date. This raises eyebrows as the likelihood of the sale of substandard and expired products to farmers will be high.

It is obvious from the above observations that agrochemicals and slurries from manure to affect sustainable development through negative impact on health of the farmers who apply those agrochemicals. Again, these agrochemicals affect microorganisms (biodiversity) living in the water bodies and the soil.

Policy Recommendations

This study proposes these policy recommendations for the government of Lesotho. The study recommends a strict regulatory policy regarding the kind of agrochemicals which can enter the country. Again, the Ministry of Agriculture of Lesotho should organise training for all farmers in Lesotho on sustainable farming solutions. This training should touch on proper amount of fertiliser and agrochemical application, proper timing for the application of fertiliser and agrichemicals in a year and the right method for the application of fertilizer.

Areas for further studies

Water quality test on rivers and streams along agricultural farmlands in Lesotho

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