

AN ASSESSMENT OF KNOWLEDGE AND USE OF WATER HYACINTH FOR PRODUCTION OF BIOGAS AMONG BEACH COMMUNITIES IN KENYA

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ABSTRACT

Water hyacinth is an aggressive weed that extensively invades the beaches blocking access to clean water for domestic, livestock, and recreational uses. A partnership approach that brings stakeholders together was adopted in 2013 by the beach communities along Lake Victoria in Kenya, in an attempt to reduce the weed and its negative effects and to explore ways of effectively utilizing the products of the weed. A cross-sectional study was carried out in March 2014 to determine the effect of the partnership approach used among these communities and their knowledge and use of water hyacinth to produce biogas for fuel and slurry for fertilizing urban and rural gardens. The study on 200 fishermen and farmers found that 98% of respondents had no knowledge about biogas, while the same percentage (98%) was interested in using biogas as a source of fuel. Most respondents (87%) had no knowledge that hyacinth could be used for production of fuel and for slurry, although 99% of the respondents were interested in using slurry. Knowledge about biogas and level of education was statistically significant ($p=0.00$). Production of gas from water hyacinth is a new technology that has potential for use by fishermen and farmers along lakeshores. A partnership approach can be used to engage communities in addressing household energy needs.

Key Words: *water hyacinth, biogas, partnership, renewable energy*

Introduction

Water hyacinth (*Eichhornia crassipes*) is a free floating aquatic plant widely regarded as one of the most highly invasive weeds in the world (van Wyk and van Wilgen, 2002; Tegene, 2012). Its rapid growth adversely affects flora and fauna. Where it occurs, water hyacinth has a potential biomass for biogas production because of its high growth yield and availability in large amounts throughout the year. There have been instances of complete blockage of waterways by water hyacinth making shipping, fishing and recreation very difficult.

Although there are issues with water hyacinth along lakeshores, limited efforts have been made to address the problem. This study presents an innovative approach that examines the potential economic use of water hyacinth through a community partnership concept. The

partnership concept promotes collaboration between communities, service providers, private sectors and training institutions and is based on strengths and reciprocal benefits. The approach ensures all partners and stakeholders are involved in activities of mutual interest.

This study examined the communities living along the beaches of Lake Victoria in Kenya that comprised of mainly farmers, fishermen and small business owners. These communities have been engaged in various development projects amongst themselves and with other partners and stakeholders, for example, government administration and ministries, training institutions, and the private sector. Some of these projects are community based agribusinesses that help the communities and households to achieve dignified living and sustainable development. The process of engaging these communities involves dialogue and penetrating the various levels of the formal and informal social and health service systems to reach the targeted individuals. Their situations and issues that could be addressed are identified and jointly prioritized for action and a common roadmap developed for implementation, based on capacities and locally available resources. Through this process of dialogue and full engagement with the communities, the problem of water hyacinth was expressed by community members as an issue that needed to be addressed.

Literature Review

There have been a number of studies on water hyacinth as a source of fuel, using different methods, context and populations. For instance, an experimental study in Harare Zimbabwe (Kunatsa, 2013) found that wet mass of water hyacinth produced more gas than dry water hyacinth. A study in Ghana (Richard, 2011) investigated biogas as a potential renewable energy source. The study focused on potential benefits, prospects and challenges of the biogas technology and explored alternatives to fuel given that 72% of the population used wood as a source of fuel. Studies in India (Anoop, 2013) and Dominican Republic (Pound, 1981) on organic manure from cow dung and production of biogas from slurry did not investigate the socio-economic aspects of communities.

A study in Kenya (Rodrigues, 2014) focused on converting water hyacinth to briquettes, illustrating attempts to control the noxious water hyacinth. The study explored water hyacinth briquettes as an alternative to the local wood fuels through a pilot briquette production process by appropriate levels of technology mediation. The survey of 152 randomly sampled rural respondents were mainly fishermen and small scale farmers from Beach Management Units (BMUs) in the Kenya. The study established commonly used firewood tree species whose samples were collected and tested for the calorific value, ash content, volatile matter, fixed carbon and moisture content. The study found that the calorific value of water hyacinth briquettes was different from those of local plant fuels indicating the potential use of briquettes.

A descriptive study in the Lake Victoria basin in Kenya (Mailu, 2001) focused on a preliminary assessment of the social, economic and environmental impact of water hyacinth and the status of control. The results revealed negative social impacts of water hyacinth

including lack of clean water, increased vector-borne diseases, migration of communities, and social conflict.

Evidence therefore from literature demonstrates limited studies on the socio-economic aspects of water hyacinth. Furthermore, available studies do not present partnership approaches to address the negative effects of the weed or information on community knowledge and use of water hyacinth as a source of fuel. The methodologies used in these studies do not address the knowledge gaps. Therefore, this study investigated communities' knowledge about use of water hyacinth to produce biogas for fuel and slurry for crop production, as well as the processes used to engage communities in addressing the negative effects of the weed.

Research Methodology

Study design

The study was a cross-sectional survey using qualitative and quantitative methods to investigate the variables on knowledge and use of water hyacinth as a source of fuel and slurry for crop production. This design allowed for comparisons between the different variables of age, gender, income and education level as they related to water hyacinth.

Population and sampling

The study population consisted of 200 respondents from 3 selected groups of fishermen, farmers, and restaurant owners in 7 sites along the beach. The sample size of 200 was arrived at through convenient sampling whereby anyone who lived along the lakeshores and was present at the time of the interview was included in the survey.

Study variables

The study variables were categorized into three thematic areas which included: demographic characteristics, socio-economic information and environmental information.

Data management

Validated structured and semi-structured questionnaires were used to collect data. Trained research assistants visited selected sites and administered the questionnaire through face-to-face interviews. Verbal and written consent was sought from all study participants. For the qualitative data, minutes of meetings were reviewed in terms of attendance of group members. Data cleaning was carried out to detect and correct errors and inconsistencies in order to obtain quality data. Data was stored in a safe place with appropriate back-up to maintain confidentiality, integrity and anonymity of participants and researchers, in line with research ethics.

Data analysis and presentation

Data was analysed using SPSS. Mean and standard deviations were computed for continuous variables while proportions were computed for categorical variables. To test association between various characteristics of respondents and outcomes, we employed chi-square tests. Data was presented in tables and graphs. In all analyses, a p value <0.05 was considered statically significant.

Research Results

Descriptive characteristics of the study population

The majority of respondents were farmers with primary level education. The study found that 13% (n=24) of the respondents knew that hyacinth can be used for production of biogas for cooking and slurry (Figure 1). At the same time 99% (n=197) of the respondents indicated that they would be interested in using slurry from biogas digesters. Out of the 200 respondents interviewed, 35% (n=70) had ever heard about biogas. Only 2% (n=4) of the respondents had ever used biogas as a source of fuel.

The study found that 29.9% (n=41) of the respondents had primary level of education and had knowledge about biogas. Of the respondents with secondary and above education level, 58% (n=29) had knowledge about biogas. The study also found that there was a significant relationship between level of education and knowledge about biogas ($p=0.00$).

Slightly over half of the respondents (58.6%, n=17) who were engaged in their own activities as a main source of income had knowledge about biogas. However, the 64.1% (n=41) of the respondents who were engaged in farming activities did not know about biogas (Pearson chi-square is significant, $p=0.01$). Fishers exact test also yielded a significant p value ($p=0.015$). There was a weak association between main source of income (which translated to occupation) and knowledge about biogas. Asymptotic tests may not be valid because of cell counts of below five.

Of the respondents interviewed, 70.3% (n=45) who were engaged in farming activities as a main source of income had primary education. There were few salaried respondents (3) and all had secondary and above level of education; the Pearson chi-square was significant at $p=0.01$. There was an association between education level and main source of income.

Seventy three percent (73%, n=144) of the respondents interviewed belonged to various social groups such as Community Based Organizations, Trade Unions and Savings and Credit (Table 1), while 27% (n=56) of the respondents did not belong to any social group. The respondents also indicated that they had held 3 group meetings where there was full participation of members. At these meetings discussions were held on development activities and how to address the problem of water hyacinth along their beaches.

Discussion

This study found that there was limited knowledge on water hyacinth for production of fuel and low use of biogas among rural beach populations with low income and engagement in social groups. Knowledge about biogas depended on education level in these communities.

Knowledge on use of water hyacinth as a source of fuel

While there was little knowledge that water hyacinth can be used for production of biogas for cooking, communities were willing to use the slurry which is a bi-product from biogas for crop production. Most (61%) of the households owned at least one acre of land and were engaged in small-scale farming for crop production. The willingness by the communities to use slurry is an indication of their entrepreneurship and interest in improving their crop harvests. Use of water hyacinth as a source of fuel is a new technology and greater awareness among communities on its use is essential.

The study by Rodrigues et. al (2014) among similar beach communities concluded that the decision by communities to use any biogas as fuel depends on its abundance and not on cost or amount of heat generated. The choice of water hyacinth as an alternative energy source could be embraced based on its abundance and economic value. This study therefore advocates for the production of biogas as an alternative source of fuel.

Knowledge and use of Biogas

While there is some knowledge on biogas, the usage is low. This could be because the community has different perceptions about biogas, including the view of biogas technology as an expensive venture in terms of purchasing or building a biogas digester. Availability of raw materials used to produce biogas could be another factor hindering usage of biogas. Water hyacinth moves from place to place depending on the direction of wind hence a limiting factor. Therefore an additional raw material could be provided such as cow dung when the hyacinth is unavailable. At the same time, the mechanism of harvesting water hyacinth could limit its use within communities.

The study community extensively uses kerosene despite the high cost of petroleum and the low level of economic activity. They also use firewood and charcoal which may influence the usage of biogas. Community awareness and advocacy on use of biogas may be one way of addressing the perceptions of high cost and unavailability of raw materials and in influencing relevant policy making organs to embrace innovations. Through the process of awareness and advocacy, knowledge on use of biogas could be increased in the community.

Education level and knowledge about biogas

The level of education proved to be a significant factor to consider when designing interventions at the community level. Ordinarily, an individual with secondary and above level of education would be considered more knowledgeable than a primary level individual as indicated by the results of this study. However, primary level individuals are expected to have more knowledge on biogas as they are the majority in the study community and are more likely to engage in activities that utilize local resources and which eventually would change their livelihoods.

Education level and main source of income

The level of formal education determines the main source of income of community members since it provides alternative opportunities. The study communities were mainly farmers and fishermen with primary level education. The partnership approach embraces individual with different levels of education and is therefore appropriate in promoting innovations such as use of biogas as a source of fuel.

Knowledge of biogas and main source of income

While there is little knowledge about biogas by self employed respondents, farmers did not have knowledge about biogas which was unexpected since farmers are more likely to use stocks and husks from crops for production of biogas. Unexpectedly, self employed individuals who were engaged in fishing activities had more knowledge about biogas.

Group Membership

The majority of respondents belonged to different social groups where they had joint meetings to discuss and address communities' agenda and activities. These groups consisted of fishermen, farmers and small business owners within the community. The innovative approach of partnership builds onto already existing structures such as the social groups within communities to address key issues affecting the communities and households. Communities held regular group meetings that utilized a partnership approach. The meetings were considered as very important as they helped the communities to address emerging problems including negative effects of water hyacinth. The group meetings were a proxy measurement of the partnership factor.

Conclusions and Recommendations

The utilization of water hyacinth to produce energy for communities represents a credible alternative source of fuel which promotes use of locally available resources and is likely to result in household income savings. Despite evidence of negative impacts of the water hyacinth on communities living along the lakeshores, there is need for innovative approaches

to make it economically useful. The study has shown that there is potential use of biogas and slurry from water hyacinth by fishermen and farmers living along lakeshores.

The use of water hyacinth and its products as an alternative and cheaper source of fuel is feasible since it is locally available, and will in the long run improve the livelihoods of communities and engender ownership and sustainable use of renewable energy. Findings from this study can assist local planning bodies to undertake policy initiatives for the adoption of biogas produced from water hyacinth. The implementation of such innovations requires engagement with stakeholders and communities through a partnership approach to enhance participation, ownership and sustainability.

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