BIOCHAR PRODUCTION AS A CIRCULAR ECONOMY INNOVATION IN KENYA

Mapping impact assessments and the enabling environment through interviews with key stakeholders

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Preamble

This summary note is a synthesis of interviews conducted with key stakeholders that are active in the field of biochar as a soil amendment in the context of Kenya. This summary note explores key insights on how different stakeholders (knowledge institutions, private sector and policy makers) reflected upon (i) their impact assessments (domains/indicators) and (ii) the biochar landscape/value chain in Kenya (i.e., the enabling environment).

Introduction

This project aims to gain a better understanding of existing experiences in assessing circular economy (CE) innovations in agrifood systems in low and middle-income countries (LMICs), taking into consideration the specific context in which these innovations occur. The project builds on the Butterfly Framework which has been developed by Wageningen University and Research (WUR) to support assessing transitions towards a circular and neutral society.[2] Specifically, we look at two CE innovations: i) black soldier fly (BSF) production for animal feed and organic fertilisers; and ii) biochar production for soil improvement. In this note we focus on biochar in Kenya.

The Butterfly Framework intends to guide the assessment of CE innovations as a checklist or as a roadmap for assessment. For our specific case we employed the Butterfly Framework to facilitate the formulation of interview questions. The framework urges users to take a comprehensive system perspective and to take into account ecological, technical and socio-economic domains as well as their interrelations. The context in which CE innovations are implemented is captured by means of analysing specific drivers (i.e., barriers and enablers), interventions, goals and system boundaries. Depending on the scale of implementation, these processes may be influenced through interventions while other processes may not (i.e., drivers). With this in mind, the project team used the Butterfly Framework to formulate questions for an interview guide in order to map current impact assessments around biochar, the most relevant stakeholders and their enabling environment, within the Kenyan context.

Approach

Prior to the interviews, a short literature scan was conducted to understand what type of assessments have been used in the case of biochar for soil enhancement in the context of LMICs. Next, an interview guide comprising a wide-ranging (check)list of relevant questions related to the different aspects of the Butterfly Framework was developed.

[1] Please visit the project website for more information.
[2] A description of the Butterfly Framework can be found in Bos et al. (2021) and Bos, de Haas, & Jongschaap, R. E. (2022).

Five semi-structured online and in-person interviews were held in late 2023 comprising seven experts in the field of biochar. Interviews were voice-recorded after consent by interviewees to use their insights for further analysis. This note presents the key findings by the stakeholder groups in order to keep individual interviewees anonymous for privacy reasons.

Interview results

Knowledge institutions

The results from the interviews clearly demonstrated that academic stakeholders (primarily researchers) are conducting impact assessments of biochar in a comprehensive manner. This inclination is likely attributed to the inherent nature of biochar, prompting researchers to initially focus on technical aspects related to biochar production as well as the environmental impacts and implications of biochar application. Consequently, researchers integrate elements from agronomy, (bio-)energy, climate, soil, and other relevant areas in their impact assessments.

Researchers generally take into account the entire process of biochar production, that is from pre-processing to effects on crop yields and livelihoods. In terms of monitoring, soil properties, such as pH, soil type, texture, and biological activity, are key indicators to be measured before and after biochar application. Monitored effects on crops include crop yield, plant nutrient uptake, nutritional quality and nutrient use efficiency, with distinctions made between agroecological zones to understand contextual effects. Climate considerations involve evaluating the global warming potential of sustainably produced biochar compared to traditional techniques and alternatives, often by measuring greenhouse gas emissions related to biochar production and use. Diverse research methods were mentioned, ranging from highly technical lab measurements to life cycle assessments (LCAs) and extensive long-term field trials.

Depending on the research focus, environmental aspects may be substituted by or substantiated with socio-economic aspects related to biochar utilization such as willingness-to-pay assessments or cost benefit analyses. Interviewees highlighted the importance of incorporating economic evaluations to assess the impact of biochar on gross margins, net incomes and return on investments. Next to this, socio-cultural factors around farmers' knowledge, attitudes and perceptions towards the use of CE innovations were considered. Gender was also mentioned as a key aspect to consider in order to map current socio-cultural norms and to explore potential use case scenarios for biochar.

Recognizing the complexity of the biochar system, researchers actively pursue interactions and cooperation among various actors to form transdisciplinary teams. Collaboration extends beyond immediate colleagues within the same institute to include knowledge partners and private sector entities. Farmers are also considered integral members of the research team, emphasizing the importance of their participation and contribution.

Besides impact assessments, we were also interested in understanding the biochar landscape/value chain (i.e., the enabling environment) in Kenya. In this context, a key question is if the environment is conducive to the broad-scale adoption of biochar in Kenya. The results from our interviews indicated that research is ongoing to explore biochar as an innovation within the context of a circular bioeconomy. For instance, one knowledge institute was engaged in developing biochar-based fertilizers, another in biochar-based improved cookstoves, and yet another in nutrient conservation and emission drawdown technologies. Most of these applications were subsequently subjected to comparative assessments.

According to several knowledge institutes, enterprise development emerges as a key driver for scaling up biochar production. This development not only generates demand but also involves collaboration with established small and medium enterprise (SME) industries, such as those dealing with bagasse (a dry pulpy fibrous material from sugarcane processing) or rice husks (flaky fibrous material from rice processing). These feedstocks are often local waste streams, making decentralization of

biochar production possible. Decentralized production is frequently promoted by knowledge institutions, since this enables sustainable scaling of biochar production, where emissions related to transportation are kept to a minimum and private monopolies are prevented. Where household-level biochar production is observed through the use of specific cookstoves, larger-scale production depends on availability of start-up capital and availability of waste material for feedstock. The last remains a challenge particularly in Kenya's arid and semi-arid areas.

Private Sector

Our interviews revealed a diverse range of approaches among private sector stakeholders in their engagement with biochar impact assessments. In contrast to the comprehensive research-oriented approach, many private sector actors focus on a narrower topic. Although interest in holistic assessments was expressed, the profitability and scaling potential of biochar products was prioritized. As such, this stakeholder group generally employs value addition methodologies to reach an end product with biochar as one of the components. The end products (e.g., composite fertilizers) are then marketed, for which national certification is sometimes sought. The biochar component usually has a specific function in the product, which is assessed individually. Consequently, the scope of the analysis is limited and excludes certain domains for impact assessment, even though the interconnectedness of various domains is acknowledged. We found that environmental indicators are often considered prior to socio-economic or technical indicators.

Private sector stakeholders rely on research outcomes by knowledge institutes for the grounding of their business model. The analysis of biochar studies by private sector actors therefore typically addresses only few indicators within one prioritized domain. For instance, an assessment of biochar conducted by one private sector interviewee encompassed macro and micro-nutrient levels, pH, cation exchange capacity (CEC), and soil organic carbon. Socio-economic and technical indicators remained secondary to the analysis. When asked whether their assessment was considered, it was clear that no indicators were included to represent these domains. Research findings by knowledge institutes were used to fill these knowledge gaps in their business case.

All stakeholder groups agreed that upscaling of the biochar industry is anticipated to bring about a significant shift in farming practices in Kenya, moving beyond synthetic inputs. Often, the private sector is appointed a key role in this regard. Private sector actors are generally well disposed to offer usable and tailored solutions to farmers, and various interviewees reportedly saw many readily available products on the market that combine biochar with other agricultural inputs. The use of (agricultural) waste streams among SMEs has seen a rapid development as business opportunities are ample. Although initial investment is still a hurdle for large scale adoption of biochar production, requisite machinery to generate biochar could be attained through collaborations with the engineering sector.

Policy

The policy sphere was frequently mentioned as being instrumental to the (public) uptake of biochar as a CE innovation. Policy analysis is incorporated in the Butterfly Framework through assessment of the enablers and barriers to an innovation. In general, policy makers are not tasked with impact assessments. These stakeholders use the results of assessments performed by other stakeholders. Therefore, we did not target policy makers specifically when conducting the interviews. Instead, we asked stakeholders in the academic scene as well as private sector actors to share with us their experiences and engagement with policy (makers).

In general, our interviewees noticed a surge in governmental interest in the use of improved agricultural practices (including CE innovations). Demand from government exists to establish initiatives that empower farmers, with a focus on women and youth, to adapt to climate change and improve food security and household income. As such, biochar has been integrated into Kenya's 2020-2027 bio-energy strategy, aligning with the broader movement toward agroecological solutions for Kenya's

agriculture. Moreover, Kenya's Organic Fertilizer Standards are undergoing revision by the Kenya Bureau of Standards (KBS) to become more favourable to CE innovations. Here, alignment is sought within the African Union as well. Our interviews pointed out that biochar is already recommended by most African nations as a soil input, and certification issued by the KBS for commercially produced biochar allows export beyond the Kenyan border, increasing business potential.

Interviewees highlighted that collaboration with on-the-ground organizations and partnership with institutions and governmental bodies are of paramount importance for broad-scale adoption of biochar in Kenya. Continuous research is needed to generate information that can be used to make recommendations for the use of biochar in different agroecological zones. Wider scaling is also necessary to address the variety of production requirements depending on the farming systems. Despite ongoing efforts, interviewees frequently mentioned that there is a persistent need for farmer sensitization, where Kenya's extension service system should play a leading role. Where previously extension officers would be facilitated to visit their respective sub-county members, one now observes the opposite. Since facilitation remains out, members are now expected to visit the extension officers in order to gain access to the service. The result is a limited sensitization of novel approaches amongst agriculturalists. This gap is partially filled by other organisations (such as NGOs or knowledge institutes), though generally speaking these organisations only reach a limited subset of farmers in a target area. Where the trickle-down theory is still expected to disseminate information amongst agriculturalists, this proves to be difficult in practice.

The policy environment in Kenya is steadily becoming more favourable for biochar, being facilitated by the growing body of knowledge around the topic particularly aided by the results of long-term experiments. This goes hand in hand with an increase in attention toward biochar by the private sector. It is therefore generally assumed amongst interviewees that the biochar industry is set to grow. Competing uses for biomass streams will fall favourably toward biochar when the benefits become clear to the layman, and they are spurred on by governmental subsidies, for example. For instance, where smallholder insect rearing has taken off in recent years, interviewees suggest that a similar growth for biochar production and its use is foreseeable with effective knowledge dissemination.

Closing remarks

Overall, our results indicate that knowledge institutions are already conducting holistic impact assessments to infer on the (i) technical, (ii) environmental and (iii) social aspects of biochar in Kenya. However, impact assessments conducted by the private sector often focus on the technical and environmental aspects and rely on a reduced set of indicators. Furthermore, our results indicate that researchers and entrepreneurs are generally optimistic about the enabling environment in Kenya for broad-scale adoption of biochar. Nonetheless, market and policy mechanisms alongside increasing farmer's awareness were reported as potential bottlenecks that require multilateral collaboration and partnerships.