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Towards systemic support for agricultural mechanization in sub Saharan Africa

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Agricultural mechanization and motorization play an important role in reducing the arduousness of work and contributing to food security. In sub-Saharan Africa, there remain many challenges before equipment becomes accessible to as many people as possible, is properly used and maintained, and deployed in an inclusive and lasting manner. Existing equipment is sometimes ill-suited, and there is a lack of information about access to mechanization and associated agricultural practices, as well as appropriate ways of intervening. Yet, some novel courses of action do exist, promoting systemic intervention incorporating the concepts of access, use and sustainability, notably by co-designing equipment and supporting stakeholders.

WHAT'S AT STAKE

Agricultural mechanization (including animal traction) and motorization (thermal or solar energy equipment) help to improve **labour productivity** and **reduce the arduousness** of agricultural work, with potential impacts on food security and improved living conditions for households. However, mechanization levels in sub-Saharan Africa are low. Over the past decade there has been **renewed interest among decision-makers and researchers in agricultural mechanization issues in Africa** as shown by the work of the West African Development Bank (BOAD 2024) and the FAO (Telemans et al. 2024), with past failures of mechanization programmes prompting a review of support initiatives (Daum and Birner 2020). The challenge is not to repeat the mistakes of past initiatives and to contribute to sustainable mechanization that is appropriate for African farms of different sizes.

Access to suitable equipment and to **operational support services** is the first challenge: experience has shown that equipment ill-suited to requirements is likely to remain unused; and poorly used or poorly maintained equipment, particularly due to a lack of training for users and mechanics, has a limited lifespan (Side and Havard 2016). In addition, **unequal access to mechanization** could benefit large farms and lead to the disappearance of the smallest, with consequences for agricultural employment (Baudron et al. 2015). Equipment must be accessible to the wide variety of farms in sub-Saharan Africa.

Negative effects of mechanization on soils and the environment are often highlighted. They may be direct, such as the effects on soil of poorly executed ploughing. Other consequences are indirect: for example, the increase in cropped areas enabled by mechanized ploughing may lead to extra work for non-mechanized operations, such as weeding, so mechanization may lead to increased herbicide use to cope with new peaks in workload (AFD 2025). Identifying the ways mechanization can be agroecological is thus a second challenge.

Lastly, data on anything involving the **ongoing transformation of farming systems** and the **best ways of intervening** are patchy. There is little research on the usage and equipment, that could help achieve appropriate and inclusive mechanization, with research mainly focusing on equipment and its agronomic efficiency in a context of top-down interventions. Moreover, the effects of mechanization on a local or national scale are outstanding issues, such as the consequences for rural employment (especially for young people) and environmental effects.

KEY MESSAGES

► Renewed interest in agricultural mechanization needs to result in interventions that combine actions providing access to equipment, its rational use and its maintenance.

► Research has a major role to play in producing knowledge on farmers' practices and their effects on agrarian systems to capitalize on experience and help to integrate mechanization in agroecological systems.

► Co-designing equipment ensures its relevance in the local context and incorporates farmers' criteria, which are variable, multiple and difficult to anticipate.

► Equipment co-design processes rely on feedback loops between improvements made by local craftsmen and tests carried out by farmers.

► Connecting the people involved in mechanization and providing backing for support services, notably training and advice in agronomy and machinery, are a prerequisite for sustainable mechanization.

NEW INSIGHTS

The MecaWAT project (2023-2025, funded by the French Ministry for Europe and Foreign Affairs) focused on the sustainable mechanization of cropping operations in Côte d'Ivoire, Ghana and Benin. By taking a multi-scale and multi-disciplinary approach, this project enabled us to rethink the current dynamics of agricultural mechanization and the interventions supporting its deployment.

In Africa, mechanization mostly involves annual crops and soil tillage, transport and post harvest operations. **Existing research is fragmented and partial**, and it primarily concerns techniques for tractors or post-harvest mechanization. There have been **few studies of the changes occurring on farms and of effects** on the social, economic and environmental dimensions of farming systems. Neither has there been much work on training and advisory systems in the use and maintenance of equipment, though that is crucial for extending the lifespan of equipment and limiting negative impacts on the environment.

By co-designing equipment, farmers' requirements can be met and system sustainability can be guaranteed

Fieldwork in Ghana, Benin and Côte d'Ivoire with farmer groups has shown that **the criteria used to assess equipment vary and are difficult to anticipate**. The criteria are numerous: cost and labour time alone do not explain farmers' choices. Some criteria, such as discomfort, are difficult to measure but are very important to users (vibrations, noise, smoke, etc.). Access to training in the use and maintenance of equipment, or accessibility to spare parts, are also paramount in whether or not farmers decide to adopt a given item of equipment.

In order to propose equipment compatible with agroecological principles and adapted to the realities faced by farmers, a participatory approach involving **farmer groups and local craftsmen** was tested. The research team took a novel **co-design approach**, based on a back-and-forth process between field testing and prototype improvements, which culminated in **equipment that was validated with the farmers and tested in agronomy trials**. These co-design processes were conducted to adapt equipment for plantain cropping and to improve already motorized systems in cotton-growing areas.

This participatory process revealed that the **needs and constraints of farmers vary depending on the locations**, as illustrated in figure 1 in the case of plantain.

The effects of mechanization are still not fully understood

Our work indicates that **mechanization can vary the use of hired or family labour**. For example, in Ghana, mechanization can increase the use of hired labour and lead to an intensification of rice-growing systems (herbicides, fertilizers). In other contexts, such as plantain in Côte d'Ivoire, initial trends indicate a drop in the use of hired labour.

Studies on work organization have also provided fresh insights into agricultural mechanization. Indeed, **partial mechanization in cotton-growing areas** (tillage and sowing) creates new **bottlenecks**, worsened by the increase in cropped areas that mechanization allows. This leads to a **heavier workload**, passed on to women or temporary workers, which encourages **increased herbicide use**. Demand from farmers for equipment that helps limit herbicide use illustrates the importance of considering system sustainability very early on in the intervention process.

Action research with stakeholders strengthens the sustainability of mechanization

Discussions with mechanization stakeholders brought out the **central role played by support services and policies**. Equipment quickly falls into disuse when the **services needed to sustain mechanization** are lacking: agronomic training and advice for sustainable use, access to spare parts and training in mechanics for maintenance and repairs, along with available appropriate credit for all types of farmers, including the smallest, for access to and renewal of equipment.

Craftsmen, mechanics, drivers, farmers, equipment importers, microfinance organizations, agricultural training and extension services, state and private institutions etc. **Various operators are involved in access to equipment, its use and maintenance. Yet, they often lack coordination in their operations**, which hinders the effectiveness of support services. In Ghana and Benin, **the launch of innovation platforms**, i.e. spaces for exchanges between these stakeholders, has made it possible to provide support to these networks of actors and increase the exchange of information.

The research also confirmed that in areas that are already mechanized, **service provision is the most widespread means of access to mechanization**. Nonetheless, there is a lack of training for farmers and service providers in equipment use that complies with agroecological principles.

Figure 1. Examples of equipment prototypes developed for hole digging (making holes prior to planting) for plantain

RECOMMENDATIONS

Take a comprehensive approach to mechanization

Access to equipment (credit, imports, adaptation of materials) has to be considered, but so does **its rational use** (training and extension, research), as well as **the lengthening of its lifespan** (repair, maintenance). For example, a **continuum between training, research and development**, through action-research or capitalizing on experience, is crucial for more effective implementation of mechanization projects or policies.

In particular, **research has a role to play in filling knowledge gaps** about the current state of mechanization and its evolution. Studying farmer practices and their consequences, i.e., investigating how farming systems work (agronomic processes, work organization, etc.) and the knock-on effects of mechanization, is **essential for improving the effectiveness of interventions and limiting their negative impacts**. The consequences for work organization and employment in rural areas – especially jobs for young people – are an example of blind spots in mechanization-related research and public policies. Mechanization risks increasing pressure on natural resources (water, land, etc.), and raises the issue of public support and regulation, and therefore the role of public authorities in large-scale mechanization. Including the social sciences in an action-research initiative is relevant for studying interactions between stakeholders, farming systems, work and jobs.

Consider the link between mechanization and agroecology

Many stakeholders see mechanization, and especially motorization, as agricultural "**modernization**", and often consider it to be for large farms and focused on tractors. Agricultural mechanization is often absent from discussions on **agroecology**. Yet, small-scale mechanization or light motorization (two-wheel tractors, brush cutters, etc.) can prove to be sustainable, and also adapted to small farms, women and young people. By considering how mechanization can reduce work peaks and the arduousness of agroecological practices, mechanization stakeholders can help to **make agroecology more attractive and promote its adoption** on a wider scale in sub-Saharan Africa.

Exploring a **diversity of options** during mechanization interventions remains crucial. The need to consider different types of equipment is increased by the fact that the requirements and constraints of stakeholders vary depending on the country, the area and the adaptation of agroecological principles. Moreover, interventions could **focus more on currently non-mechanized operations**, as experience has shown that those operations promote non-sustainable practices, such as herbicide use. Likewise, **non-mechanized crops** are labour-intensive, while they are often food crops, of great importance for household food security (e.g., plantain banana).

Co-design equipment and cropping systems with farmer

Co-designing equipment with farmers **ensures the relevance of that equipment in its local context**, making it possible to find the best compromise between the farmers' various requirements (cost and efficiency of the equipment, arduousness, ease of use and repair, safety, etc.). The participatory process gears the search for technical solutions towards the most time consuming or arduous tasks depending on the context. Co-designing also makes it possible to **ensure that the agroecological principles proposed to farmers can actually be implemented**. It is thus possible to adapt agroecological principles to different contexts. For example, provided farmers approve them, developing mechanized weeding and hoeing tools helps to reduce herbicide use.

Encourage networking between mechanization stakeholders

National and local strategies including all those involved in mechanization (local craftsmen and mechanics, microfinance organizations, agricultural advisory and training services, equipment importers, etc.) are needed to sustainably develop mechanization in sub-Saharan Africa. Developing training and advisory services that combine agronomy and machinery expertise is crucial for equipment use and maintenance. Support must also be provided for provision of services (private or collective) that are compatible with minimizing environmental impacts. **Innovation platforms**, such as those set up in Benin and Ghana, are examples of forums where stakeholders can communicate with each other, identify priority needs and promote the exchange of information, that could be replicated.

The co-design process with farmer groups resulted in three different models, adapted to local constraints:

a) a sliding auger (Ghana), compact and lightweight, so easily transportable to distant fields, and allowing operators to use their legs to push the auger into the ground (model suitable for compact soils and requiring less force);

b) 3-wheeled auger (Benin), which can be attached to the back of a motorbike for transport. The wheels are readily-available motorbike wheels;

c) single-wheel auger (Côte d'Ivoire), allowing easy movement between yam mounds, a crop commonly intercropped with plantain in Côte d'Ivoire.

CONCLUSION

After being long neglected, there is now renewed interest in agricultural mechanization in Africa, leading to a reconsideration of intervention methods in light of past mistakes. To sustain mechanization efforts, stakeholders involved in research, training, agricultural advice and development in general, need to coordinate actions in support of access to equipment, its use and maintenance, while taking into account the great diversity of farms in sub-Saharan Africa. Research in particular has a role to play in studying mechanization usage and its consequences, in order to limit negative environmental and social impacts and pave the way for mechanization that is compatible with agroecological principles.

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Projects and partnerships

MecaWAT Project (Mechanization and Work in Agroecological Transitions)

Overall objective: contribute to developing agroecological farming systems in sub-Saharan Africa, through mechanized crop production, with a view to improving labour productivity and work arduousness, with work organization favourable to women and young people. Locally adapted mechanization can help create rural jobs, provided that specific constraints in the innovation ecosystem are removed.

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MecaWAT

References and other links

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