PARI Interim Report 2023

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Project description:	**PARI** **“Program of Accompanying Research for Agricultural Innovation”**	
Project duration:	**December 01, 2014 – December 31, 2024**	
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submitted by

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Center for Development Research (ZEF) of the University of Bonn

in cooperation with PARI Partners

Program of Accompanying Research for Agricultural Innovation

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Zusammenfassung

Die *Begleitforschung für landwirtschaftliche Innovationen* (PARI) vereint Partner in Afrika, Indien und Deutschland, um zu nachhaltiger Transformation von Ernährungssystemen und Ernährungssicherheit beizutragen. Highlights in 2023:

Skalierung von Innovationen zur Förderung einer sektorübergreifenden und nachhaltigen Produktion

Multisektorale Ansätze in kleinbäuerlichen Produktionssystemen: PARI-Forschung hat Faktoren identifiziert, die das Wachstum der **Aquakultursektoren** in Ägypten, Kenia und Nigeria beeinflusst haben. Darüber hinaus werden im Rahmen einer laufenden Studie Gebiete mit hohem Potenzial für die Ausweitung der **Agroforstwirtschaft** in Afrika ermittelt. Im **Viehzuchtsektor** wurden die Auswirkungen alternativer Entwicklungspfade in Bezug auf Armut, Geschlechtergerechtigkeit, Ernährung, Umwelt und Tierschutz verglichen. Die Studien verdeutlichen, wie wichtig zielgerichtete Investitionen sind, die auf einem detaillierten Verständnis des landwirtschaftlichen und politischen Kontextes, der beteiligten Akteure und der möglichen beabsichtigten und unbeabsichtigten Folgen beruhen.

Förderung von nachhaltigen Produktionsmethoden: PARI-Forschung ermittelt, inwieweit nachhaltige Produktionsmethoden im afrikanischen Kontext eingesetzt werden können, mit Schwerpunkt auf **agrarökologischen Praktiken** und **'carbon farming'**. Erste Ergebnisse deuten darauf hin, dass agrarökologische Praktiken die Erträge im Vergleich zu Monokulturen im Durchschnitt um 34% steigern. Erwartete Ertragsveränderungen variieren jedoch je nach Praktiken, Kultur, klimatischen Faktoren und Bodeneigenschaften. PARI-Forschung untersucht außerdem die Wirksamkeit von Dürrepolitik und Agrobiodiversität, um die **Widerstandsfähigkeit der LandwirtInnen** gegenüber den Auswirkungen des Klimawandels und anderen Schocks zu erhöhen.

Stärkung der Rolle der Frauen: PARI-Forschung untersucht **Zeitnutzung und Zeitbelastungen von Frauen** und die damit verbundenen **Auswirkungen auf Produktivität, Wohlstand und Ernährung**. Eine in Ghana durchgeführte Studie zeigt, dass an Tagen, an denen Frauen mehr Zeit mit dem Verkauf auf dem Markt verbringen, die Ernährungsqualität der Kinder abnimmt. Infrastrukturinvestitionen, qualitativ hochwertige Kinderbetreuungseinrichtungen und eine Änderung der sozialen Normen hin zu einer gleichmäßigeren Verteilung der häuslichen Betreuungsarbeit würden es den Frauen ermöglichen, die wirtschaftlichen Chancen zu nutzen und gleichzeitig die Ernährungslage ihrer Kinder zu sichern.

Lernen und Austausch zwischen Indien und Afrika: Zwei PARI-Studien untersuchen die Faktoren, die zum Wachstum der von Kleinbauern dominierten **Geflügel- und Milchsektoren in Indien** beigetragen haben. Der Milchsektor profitierte in hohem Maße von der unterstützenden Politik der Regierung, während der Privatsektor die treibende Kraft hinter der Expansion des Geflügelsektors ist. In beiden Sektoren sind zusätzliche Anstrengungen erforderlich, um den Zugang zu hochwertigem Futter zu verbessern, die Lebensmittelsicherheitsstandards zu erfüllen und den ökologischen Fußabdruck zu verringern.

In einer laufenden Studie werden die **Auswirkungen öffentlicher Ausgabenentscheidungen in ausgewählten indischen Bundesstaaten und afrikanischen Ländern** auf das wirtschaftliche Wachstum sowie die Verbesserung der Ernährungssicherheit ermittelt.

Investitionen in Infrastruktur und Qualifikation

Investitionen in die Infrastruktur: PARI-Forschung untersucht, wie verschiedene **Infrastrukturinvestitionen zur Schaffung von Arbeitsplätzen** in der Sahelzone beitragen könnten. Konkret wird in der Studie das Beschäftigungspotenzial von Investitionen in Kleinbewässerung, Energie, Transportinfrastruktur (insbesondere Zubringerstraßen und überregionale Straßen) und agroindustrielle Parks anhand der Fallstudienländer Niger und Côte d'Ivoire bewertet.

Entwicklung von Qualifikationen von KleinerzeugerInnen: PARI-Forschung befasst sich mit der Frage, wie **Ausbildungseinrichtungen und landwirtschaftliche Beratungsdienste** verbessert werden können, um LandwirtInnen mit den notwendigen Fähigkeiten auszustatten, damit sie ihre Produktivität steigern und gleichzeitig soziale und ökologische Ziele verfolgen können. Eine Studie legt nahe, dass landwirtschaftliche Beratungsdienste in Afrika zunehmend versuchen, mehrere Nachhaltigkeitsziele zu fördern, dass diese Bemühungen jedoch durch institutionelle Beschränkungen behindert werden.

Unterstützung nachhaltiger und fairer Ernährungssysteme durch digitale Technologien

PARI-Forschung untersucht die **Verteilungseffekte von digitalen Plattformen** in der afrikanischen Landwirtschaft. Erste Ergebnisse zeigen, dass ErzeugerInnen zwar die digitalen Technologien der Plattformen wenig nutzen, jedoch trotzdem durch eine bessere Marktintegration und geringere Transaktionskosten von diesen Technologien profitieren.

Ein weitere PARI Studie zum Schutz von persönlichen Daten, die von afrikanischen ErzeugerInnen erhoben werden, zeigt, dass sich die **Datenschutzbestimmungen** in Afrika weiterentwickelt haben, die Einhaltung durch die Anbieter digitaler landwirtschaftlicher Dienstleistungen jedoch begrenzt ist.

Über die Produktionsebene hinaus untersucht eine PARI Studie das Ausmaß und die Auswirkungen der **Automatisierung in der landwirtschaftlichen Verarbeitung** auf die Beschäftigung. Einblicke von ca. 500 afrikanischen Lebensmittel- und Getränkeherstellern zeigen, dass Regierungen die Automatisierung in diesem Sektor durch den Aufbau von technischen Kompetenzen und ‚soft skills', der Einbindung von Frauen in technische Berufe und sozialen Sicherheitsnetze für geringer qualifizierte Arbeitnehmer, die eher von Arbeitsplatzverlusten betroffen sind, vorantreiben können.

Strukturelle Umgestaltung der nationalen landwirtschaftlichen Innovations- und Forschungssysteme

PARI-Forschung untersucht, inwieweit **landwirtschaftliche Innovationssysteme** mehreren Nachhaltigkeitszielen wie Klimaresilienz, Erhaltung der biologischen Vielfalt und Stärkung der Rolle der Frau Priorität einräumen. Darüber hinaus befasst sich eine neue Studie mit Möglichkeiten zur Stärkung von **Start-up-Ökosystemen für biobasierte Innovationen** im afrikanischen Lebensmittelsektor.

Beteiligung an der Gestaltung der Ernährungs- und Agrarpolitik

Um PARI-Ergebnisse in politische Prozesse einzubringen, haben die Partner des PARI-Konsortiums im Jahr 2023 mehrere Veranstaltungen organisiert oder daran teilgenommen. Zu den Höhepunkten zählten die PARI-Veranstaltungen auf der *8. African Agribusiness and Science Week* und der *7. African Conference of Agricultural Economists*, sowie der Teilnahme am *African Union Summit* im Februar 2023 und Food System Veransaltungen bei der *UN General Assembly* im October 2023. Zudem nahmen PARI Teammitgliededer regelmäßig an Sitzungen des Strategischen Begleitkreises und andern Foren der Bundesregierung teil und brachten Forschungsergebnisse im *Global Forum for Food and Agriculture 2023* ein. Anfang 2024 trafen sich rund 50 PARI-Partner aus verschiedenen afrikanischen Ländern, Indien und Deutschland zum *PARI Research & Partnership Meeting* in Ghana, um die Ergebnisse der PARI-Forschung zu diskutieren sowie Forschungsprioritäten für die Zukunft zu erörtern.

Die Öffentlichkeitsarbeit wurde durch soziale Medien und Veröffentlichungen unterstützt, darunter Policy Briefs, Studien und Meinungsbeiträge. PARI profitiert insbesondere von seinen Multi-Akteurs-Partnerschaften mit regionalen und panafrikanischen Institutionen, sowie einem Netzwerk aus über 300 ForscherInnen.

Executive Summary

The Program of Accompanying Research for Agricultural Innovation (PARI) brings together partners from Africa, India and Germany to contribute to sustainable agricultural growth, food systems transformation and food and nutrition security in Africa and India. Highlights in 2023 include:

Scaling innovations to promote multi-sectoral and sustainable production

Multi-sectoral approaches in small-scale production systems: PARI research investigated the factors that have influenced the development of the **aquaculture** sectors in Egypt, Kenya and Nigeria. In addition, an ongoing mapping exercise will identify high potential areas for **agroforestry** expansion in Africa. In the **livestock** sector, research compared the implications of alternative development pathways with regard to poverty, gender equity, nutrition, environment and animal welfare. The studies highlight the importance of carefully targeted investments based on a detailed understanding of the agricultural and policy context, the actors involved and likely intended and unintended consequences.

Promotion of sustainable production methods: PARI research assesses the suitability of sustainable production methods in the African context, with a focus on **agroecological practices** and **carbon farming**. Preliminary results suggest that agroecological practices, on average, increased yields by 34% compared to monocrop systems. However, yield changes vary by practice, crop, climatic factors and soil properties. PARI research further explored the effectiveness of drought policies and agrobiodiversity to increase the **resilience of farmers** to climate change impacts and other shocks.

Empowering women: PARI research investigates **women's time use and related impacts on productivity, welfare and nutrition.** A study assessing the linkages between time use and child nutrition carried out in Ghana suggests that on days where women spend more time selling at the market, children's dietary quality declines. Infrastructure investments, high-quality childcare facilities and changing social norms towards a more equal distribution of care work in the home will enable women to take advantage of economic opportunities while maintaining nutritional outcomes for their children.

India-Africa learning and exchange: Two PARI studies examine the factors unterlying the growth of the **smallholder-dominated poultry and dairy sectors in India**. The dairy sector benefited greatly from supportive government policies while the private sector is driving poultry expansion through contract farming arrangements with small-scale producers. In both sectors, additional efforts are needed to improve access to high-quality feed, meet food safety standards and reduce the environment footprint.

Another study is assessing **impacts of public spending decisions in selected Indian states and African countries on economic growth and food security**. Preliminary findings suggest that Indian states and African countries that have prioritize education, agriculture and social protection exhibit better economic performance.

Investment in infrastructure and skills

Infrastructure investments: Newly launched research is investigating **how different infrastructural investments could contribute to generating employment in the Sahel region**. Specifically, the study assesses the employment potential of investments in small-scale irrigation, energy, transport infrastructure (notably feeder roads and transregional roads) and agro-industrial parks, using Niger and Côte d'Ivoire as case study countries.

Skill development for small-scale producers: Ongoing PARI research investigates **how training institutes and agricultural advisory services could be improved** to equip farmers with the necessary knowledge and skills to enable them to raise productivity while also addressing social and environmental goals. Focusing on

agricultural advisory services, one study suggest that extension services in Africa increasingly try to promote multiple sustainability goals, but that these efforts are hampered by institutional constraints.

Supporting sustainable and fair food systems through digital opportunities

PARI research examines the **distributional effects of digital platforms in African agriculture**. Preliminary findings show that while farmers do not use the digital tools of the platforms, they nevertheless benefit from these tools through better market integration and reduced transaction costs.

Another PARI study explores the **protection of data collected from African producers** shows that data privacy regulations in Africa have been evolving, but compliance among digital agricultural service providers is limited.

Beyond the production level, PARI research also investigates the **extent and employment impact of automation in agroprocessing**. Insights from around 500 African food and beverage manuacturers shows that governments can advance automation in the sector by building technical and soft skills, bringing women into the technical professions, and developing social safety nets for lower-skilled workers who are more likely to be affected by job losses.

Structural transformation of national agricultural innovation and research systems

Ongoing PARI research evaluates the **extent to which agricultural innovation systems prioritize multiple sustainability goals,** such as climate resilience, biodiversity conservation and women empowerment. In addition, PARI launched a new research activity in 2023 to identify **opportunities for strengthening start-up ecosystems for bio-based innovations** in the African food sector.

Engaging with food and agriculture policy making to enhance food and nutrition security

PARI team members actively shared research results in African, German and international policy discussions. Among the highlights, PARI hosted sessions at the *8th African Agribusiness and Science Week* and the *7th African Conference of Agricultural Economists* and actively participated in the *African Union Summit* and food system-related events at the *UN General Assembly*. In addition, PARI members shared insights at the meetings of the Strategic Advisory Group and other forums of the German Federal Government as well as the *Global Forum for Food and Agriculture* in Berlin. In early 2024, around 50 PARI partners from various African countries, India and Germany gathered in Ghana for the *PARI Research & Partnership Meeting* to discuss PARI research findings and identify research and policy priorities for the future.

Outreach activities were supported by social media and publications, including policy briefs, studies and opinion pieces. Online statistics show that PARI is reaching and engaging a wide audience of African policy stakeholders. PARI benefits in particular from its multi-actor partnerships with regional and pan-African institutions, as well as its large network of over 300 researchers.

1 Project overview

1.1 Objective of the Program of Accompanying Research for Innovation – PARI

PARI brings together partners from Africa, India and Germany **to contribute to sustainable agricultural growth, food systems transformation and food and nutrition security in Africa and India**. PARI offers independent scientific advice to the German government's activities to combat hunger and malnutrition. Among other activities, German government seeks to achieve its objectives through its network of 14 Green Innovation Centres (GICs) in Africa as well as India. The research-based information generated in PARI serves to strengthen the integration of the GICs into national, regional and continental institutional partner settings, in order to enhance value chains contributing to rural and agricultural development. Specifically, the PARI pursues the following strategies:

1. Analysis of the **potential and impact of innovations – policy, institutional and technical innovations** (which innovations to invest in, where and for whom – considering women, youth, small-scale producers),
2. Identification and assessment of **supportive measures to strengthen framework- and policy conditions** for the generation and dissemination of promising innovations in food systems and rural areas, and
3. Engaging food, nutrition, agriculture and rural areas' **science partners and policy makers** to inform reforms and investment decisions that can improve job creation and food and nutrition security.

1.2 Research partners

Coordinating partner	**Focal point**
ZEF Center for Development Research University of Bonn	Prof. Dr. Joachim von Braun, Project Director Dr. Heike Baumüller, Project Coordinator
FARA Forum for Agricultural Research in Africa	Dr. Yemi Akinbamijo, Executive Director (until 06/24) Dr. Aggrey Agumya, Executive Director (since 06/24) Dr. Wole Fatunbi, Project Coordinator
AKADEMIYA2063	Dr. Ousmane Badiane, Executive Chairperson Dr. Getaw Tadesse, Project Coordinator
University of Hohenheim	Prof. Dr. Regina Birner, Head of Social and Institutional Change in Agricultural Development Dr. Thomas Daum, Project Coordinator (since 2023 Associate Professor at the University of Gothenburg)

An overview of core research partners who have regularly engaged in PARI activities between 2014 and 2023 is provided in Figure 1 and a detailed list is included in the Annex. In addition, other experts and institutions are brought in where needed to complement the network's capacities.

Figure 1: Core research partner 2014-2023

2 Activities and achievements in 2023

2.1 Scaling innovations to promote multi-sectoral and sustainable approaches for small-scale producers

In this work package, PARI research focuses on supporting the implementation of innovative solutions, in particular the development of strategies for scaling innovations based on a thorough understanding of the critical success factors.

Multi-sectoral approaches in small-scale production systems, incl. animal production and aquaculture

What is needed to scale African aquaculture sectors?

Building on the PARI study that reviewed African countries' performance in the development of their aquaculture sectors published in 2022, PARI research evaluated in more detail the **success factors and challenges that have influenced the growth of the aquaculture sectors in Egypt, Kenya and Nigeria**.[1] The research sought to identify investment and policy priorities that can sustainably advance aquaculture across Africa to boost income and employment, rural development and food security. Among other factors, the study highlights the need to not only increase productive capacity but also linkages to markets and consumers, adopt national policies that provide targeted support to high-potential areas, increase local research capacities and scaling of research results, decentralize seed and feed production for improved access, and promote sustainably produced fish as a promising source of animal-derived protein.

[1] Walakira et al. (2023) Scaling aquaculture for food security and employment in Africa: Insights from Egypt, Kenya and Nigeria and Policy Brief No. 34.

Research continued on **mapping current extent, recent dynamics and future potential for agroforestry across Africa and evaluate costs and benefits resulting from observed and projected changes**. Specifically, the study assesses changes in agroforestry area and tree cover over time since 2000 and projects possible scenarios until 2050. Preliminary findings show that silvopasture systems, which integrate trees and grazing livestock operations, are the predominant form of agroforestry across Africa. These areas continuously decreased between 2000 and 2020 – a trend that is predicted to continue under the status quo. Agroforestry losses over the past two decades are estimated to have cost close to 14 billion USD in ecosystem services. Proactive measures to support agroforestry expansion are needed, based on granular investment analysis to identify areas where such investments are economically attractive.

Which regions in Africa have the highest potential for agroforestry investments?

Several PARI studies focus on **how to advance sustainable livestock development in Africa**. Previous research, which investigated whether African livestock policies adequately address possible trade-offs between environmental sustainability, human health, and animal welfare in three African countries[2], was expanded to the entire continent. In addition, an ongoing study assesses the development potential of major livestock systems in Burkina Faso, Kenya and Zambia. Specifically, the research analyses the drivers of changes in livestock systems (including livestock innovations) and how alternative development pathways affect sustainability trade-offs concerning poverty, gender equity, nutrition, environment and animal welfare, among others.,

How can different livestock farming systems be scaled sustainably across Africa?

Promotion of sustainable production methods

Various ongoing PARI studies are focusing on the **extent, impact and perceptions of agroecological practices in Africa**. Based on a systematic review of empirical literature, one study assesses the **land and labour productivity effects of agroecological practices** on the continent. Results of a meta-analysis suggest that agroecological practices, on average, increased yields by 34% compared to monocrop systems. However, the size and direction of yield changes vary by practice, crop, climatic factors, soil properties and type of control.

How are agro-ecological practices performing in Africa?

Other ongoing studies related to agroecology include a **mapping of agroecological interventions** in Uganda, Senegal, Ghana, Malawi and Kenya, including challenges and opportunities for the adoption of agroecological practices and the impacts of these interventions on productivity, income and labour requirements. In addition, an online survey conducted across Africa (with a focus on Uganda and Senegal) will offer insights on the **perceptions of agricultural actors** regarding the scope and impact of agroecological practices in their local contexts.

How widespread are agroecology projects in Africa? How is agroecology perceived by agricultural actors?

PARI research assessing the **potential of carbon farming (i.e. agricultural practices that reduce or promote active sequestration of carbons in the soil or vegetation) in African agriculture** continued in 2023. A scoping review concludes that carbon farming practices have the potential to contribute to reducing greenhouse gas emissions, generate financing for farmers and improve productivity.[3] However, smallholder farmers face a number of financial and non-financial barriers to engaging in agricultural

Can carbon farming benefit smallholder farmers in Africa?

[2] Kariuki et al. (2022) Do African livestock policies address sustainability trade-offs? Evidence from Kenya, Zambia, and Burkina Faso

[3] Schilling et al. (2023) Carbon farming in Africa: Opportunities and challenges for engaging smallholder farmers.

carbon markets, such as participation rules that discriminate against mixed, small-scale production systems, lack of secure land tenure, high transaction costs, lack of resources to cover investment costs, and lack of education or technical assistance.

What policy interventions are needed to increase drought resilience of agricultural producers in the Sahel region?

Focusing on the Sahel region, a PARI study examined **current and future-oriented drought policies to identify opportunities for increasing resilience of agricultural producers**. The study highlights the importance of disseminating climate-friendly agricultural practices accompanied by strong monitoring and evaluation systems. Providing information on early drought warning and preparedness and mobilizing more financial resources in implementing policies for building drought resilience will also be crucial. Finally, a drought policy should be participatory and results-oriented, and be based on long-term forecasting to ensure sustainability and resilience.

Can greater crop and genetic diversity on the field increase farmers' resilience to shocks?

Another ongoing PARI research activities evaluates the **role of agro-biodiversity in making agriculture more resilient** to climate change and other shocks and stresses. Taking a comparative case study approach, the study investigate which factors influence farm crop and genetic diversity in two countries in West Africa, Burkina Faso, and Ghana. The research also assesses benefits and challenges to ensure that crop and genetic diversity can indeed contribute to risk management for resilience by farmers.

How can trade-offs between labour productivity and biodiversity conservation be resolved?

Another PARI study highlights the complexities of adopting sustainable production practices. Specifically, the study examines **potential trade-offs between biodiversity conservation and labour productivity in agriculture**.[4] The study shows that adopting technologies that improve the productivity of labour helps farmers to achieve multiple socio-economic goals, but such technologies can also have negative impacts on biodiversity. Conversely, technologies that promote biodiversity often increase the burden of labour, leading to limited adoption by farmers. Therefore, there is a need to develop biodiversity-smart agricultural development strategies, which address biodiversity conservation goals *and* socio-economic goals.

Targeted measures that specifically support and empower women

What measures could help to reduce women's time burden while at the same time ensuring productivity, welfare and nutrition?

PARI research continued to investigate **women's time use and related impacts on productivity, welfare and nutrition**. Specifically, a study being conducted in Ghana, Ethiopia and Uganda seeks to understand how different technologies and innovations are changing time use patterns in the household and consequently productivity and welfare. The second study in Ghana offers insights on the links between the allocation of women's time to various activities and their children's nutrition outcomes. The study suggests that on days where women spend more time selling at the market, children's dietary quality declines.[5] However, this effect can be mitigated through the presence of alternative caregivers and access to piped water. Thus, infrastructure investments, high-quality childcare facilities and changing social norms towards a more equal distribution of care work in the home will enable women to take advantage of economic opportunities while maintaining nutritional outcomes for their children.

[4] Daum et al. (2023) Addressing agricultural labour issues is key to biodiversity-smart farming.
[5] Saleemi et al. (2024) Impacts of mothers' time on children's diets.

Evaluation of experiences with the widespread dissemination of relevant technological and institutional innovations – Africa and India

What policies and innovations are driving growth of the poultry and dairy sectors in India?

The PARI team concluded two studies that examine **the factors that have contributed to the growth of the poultry and dairy sectors in India as well as challenges that remain to be addressed**.[6] India has moved from a milk-deficit country in the 1950/60s to becoming the largest milk producer in the world. While the poultry sector is comparatively small, it is the fastest-growing agriculture sector in the country. Both sectors are driven largely by smallholders. The dairy sector benefited in particular from supportive government policies, such as the promotion of modern technologies and establishing a National Milk Grid. In the poultry sector, vertical integration models through contract farming played a decisive role, driven by the private sector.

How are public spending decisions in Africa and India impacting economic grow and food security?

Another study compares **public spending patterns in food and agriculture in selected Indian states and African countries as well as impacts of public spending decisions on economic and agricultural growth and food security improvements**. Preliminary findings suggest that Indian states and African countries that have prioritize education, agriculture and social protection exhibit better economic performance. The analyses also show that agricultural spending positively influences nutrition outcomes. In particular spending on agricultural infrastructure can play a key role in reducing stunting.

2.2 Investment in infrastructure and skills as framework conditions for rural development and urban linkages

Research to identified cross-cutting interventions that can promote rural development in Africa has increasingly gained importance in PARI, with a focus on job and income generation for the youth. The processing industry can play an important role in this regard – as a reliable market for small-scale producers, an employer and a driver of technological change. PARI research has identified two emerging areas of cross-cutting investments that could greatly benefit the food and agriculture sector as a whole:

Complementary investments in hard and soft infrastructure

How could infrastructure investments create jobs in the Sahel region?

Newly launched research is investigating **how different infrastructural investments could contribute to generating employment in the Sahel region**. Specifically, the study assesses the employment potential of investments in small-scale irrigation, energy, transport infrastructure (notably feeder roads and transregional roads) and agro-industrial parks, using Niger and Côte d'Ivoire as case study countries.

How could uptake of decentralized renewable energy technologies be promoted?

Another PARI study analysed the **potential synergies and trade-offs created by the adoption of renewable energy technologies in Ethiopia**.[7] The findings show that a 10% subsidy to the price of biogas digester increases the use of decentralized modern energy sources. Household crop production patterns are not changed substantially as a consequence of the biogas subsidy, despite the competition over resources between crop and energy production. Nonetheless, the subsidy policy can lead to family labour reallocation from collecting fuelwood to agricultural activities. Overall, the benefits generated by the biogas subsidy in terms of increases in net household incomes outweigh the total costs of the subsidy program.

[6] Gulati and Juneja (2023) on poultry and dairy

[7] Lokonon & Mirzabaev (2023) Renewable energy adoption and rural livelihoods in Ethiopia.

Innovative approaches to skill development for small-scale producers

How could training institutes and extension services better assist farmers in pursuing multiple sustainability goals?

Ongoing PARI research is investigating **how training institutes and extension services could be improved** to equip farmers with the necessary knowledge and skills to enable them to gain higher yields while also helping them to address social and environmental goals. One study that focuses on agricultural advisory services (extension) seeks to answer a number of questions: To what extent and how do agricultural advisory services in African countries promote knowledge and skills to drive sustainable agricultural transformation? Are they sufficiently set up to achieve this goal, for example, is the working environment of extension agents facilitating them to work on this transformation? Are they making use of innovative methods to promote knowledge and skills development? PARI is exploring these questions based on empirical data from extension agents as well as qualitative interviews with extension managers in Benin, Kenya, Mali and Nigeria.

2.3 Supporting sustainable and fair food systems through digital opportunities

Who benefits from the growth of digital agricultural platforms in Africa?

The PARI team continued research launched in 2022 that seeks to assess the **distributional effects of digital platforms in African agriculture**. To this end, surveys, focus group discussions and key informant interviews with digital platform users (farmers, vendors) and providers were carried out in Kenya (Twiga Foods) and Nigeria (Agromall). Preliminary findings suggest that farmers and agents make extensive use of mobile phones in their business transactions. The more sophisticated digital tools of the platforms are mainly used by the platform companies and at the retail stage. Producers can nevertheless benefit from these tools, however, through better market integration and reduced transaction costs. For now, the impact of digital platforms on market structures is more apparent at the supply than at the retail stage.

Are data provided by African farmers adequately protected?

PARI research examined the **level of and demand for the protection of data collected from African producers** based on a review of national personal data protection laws in Africa, as evaluation of the level of compliance among digital agricultural service providers and insights into the perceptions on personal data protection among African producers.[8] The analysis shows that data privacy regulations in Africa have been evolving, but legislation at times fall short on provisions of particular importance to digital service provision. Compliance with national data privacy laws among digital agricultural service providers is limited, highlighting enforcement challenges. Awareness of data protection issues is low among agricultural producers, as is the ability to control access to their data.

How has the uptake of digital technologies impacted agricultural productivity globally and in Africa?

Taking a macroeconomic perspective, another PARI study assessed the **potential of digital technologies to increase land and labour productivity in agriculture**.[9] Using data from 86 countries for the period 2000 to 2019, the study concludes that globally uptake of digital tools has raised both land and labour productivity. This effect is observed among both lower and higher income countries. Looking in more detail at the global regions, however, shows that in Africa, ICTs only increased labour, but not land

[8] Chichaibelu et al. (2023) Protecting the Data of African Agricultural Producers: A Review of National Laws, Compliance and Perceptions.

[9] Rajkhowa and Baumüller (2024) Assessing the potential of ICT to increase land and labour productivity in agriculture: Global and regional perspectives

productivity, possibly due to the lack of availability of more sophisticated digital technologies in the region and other constraints in the agriculture context.

How can automation in African agro-processing be promoted? How will jobs be impacted?

Beyond the production level, PARI research also investigated the **level and employmet impact of automation in agroprocessing**, based on a survey of around 500 food and beverage manufacturers in South Africa, Kenya, Nigeria and Ethiopia.[10] All of the surveyed companies use power-driven machinery and around half employ automation technologies. A number of factors could influence the adoption of automation, including firm size, labour costs, skills, infrastructure and access to machines and their spare parts. The results also suggest that automation is likely to change the nature of rather than replace jobs. To advance automation in the agroprocessing sector, governments should invest in building technical and soft skills, bring women into the technical professions, and develop social safety nets for lower-skilled workers who are more likely to be affected by job losses.

2.4 Structural transformation of national agricultural innovation and research systems

How should innovation systems be designed to move beyond productivity growth to also advance broader environmental and social goals?

Ongoing PARI research is examining the **extent to which agricultural innovation systems prioritize multiple sustainability goals** and identify opportunities, challenges and strategies for moving beyond the productivity paradigm. While a focus on increasing agricultural productivity continues to be highly relevant in many African countries, meeting the SDGs requires efforts to also contribute to other environmental and social goals such as climate resilience, biodiversity conservation and women empowerment. Based on interviews and surveys with representatives from research, extension and education in Benin, Kenya, Mali and Nigeria, the research will provide insights into how the structures (i.e. actors, institutions, interactions and infrastructure) and functions of agricultural innovation systems need to change to enable a transition from a productivity-oriented to a sustainability-oriented innovation system.

How could start-up ecosystems be strengthened to support the commercialization of bio-based innovations?

PARI launched a new research activity in 2023 to identify **opportunities for strengthening start-up ecosystems for bio-based innovations in the African food sector**. To this end, a study will map bio-based start-ups and evaluate the different elements of the start-up ecosystems in four countries in East Africa. Based on a number of case studies of selected start-ups operating in the study countries, the research will then identify success factors and challenges that support or hinder the growth of local start-ups in the region.

2.5 Engaging with food and agriculture policy making to enhance food and nutrition security

Close engagement with and active participation in policy processes has played an important role in PARI since the program's inception. PARI will continue efforts to feed research findings into African and global policy processes through its own policy dialogues, participation in existing processes, and dissemination of research findings.

[10] Baumüller et al. (2023) Mechanization and automation in Africa's agroprocessing sector: Implications for employment and skill needs, and Policy Brief No. 33.

Support multi-actor partnerships

PARI continued to strengthen its existing pan-African networks in the current phase of PARI through its core partners. Particular emphasis was placed on linking and building the capacities of **AGRODEP members** through joint workshops and research development as well as mentoring by senior AKADEMIYA2063 researchers. Moreover, widespread outreach activities and dissemination of PARI research findings among **FARA's extensive network of policy actors** in Africa served to raise awareness of PARI among key stakeholders, engage new researchers in PARI activities and foster linkages between the research community and policy makers.

PARI continued its collaboration with the **African Economic Research Consortium** to further strengthen research capacities in Africa related to food systems and agricultural development. In the current phase, PARI is supporting research activities of seven Master students from Ethiopia, Malawi (2), Sudan, Tanzania, Lesotho and Zimbabwe.

Collaborative activities also continued with the **Africa chapter of the World Aquaculture Society** and its network of aquaculture experts across Africa, as well as the **Agrhymet Regional Centre of the Permanent Interstate Committee for Drought Control in the Sahel** (CILSS).

Evidence-based input into high-level African policy fora

Policy Briefs

PARI Policy Brief No. 34: Farming for Fish: Success factors for expanding Africa's aquaculture sector

PARI Policy Brief No. 33: Mechanization and automation in Africa's agroprocessing sector: Implications for employment and skill needs

PARI Policy Brief No. 32: Building digital bridges in African value chains: Use and impact of digital technologies among agricultural intermediaries

Policy Events

7 June 2023, Durban, South Africa

How to turn the agrifood sector into an engine of job growth for Africa's youth

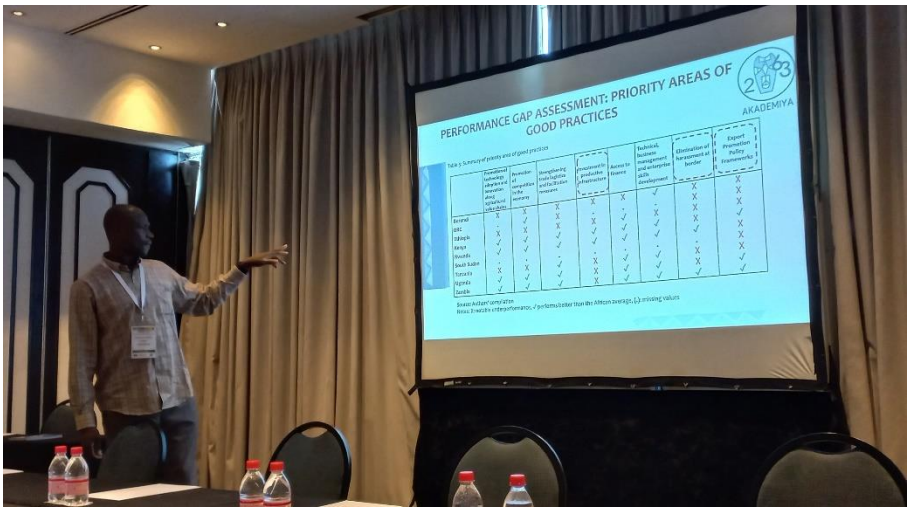
PARI hosted a hybrid side-event to the 8th African Agribusiness and Science Week, where participants discussed concrete proposals on how to grow and shape the agrifood sector so that it can become engine of job and income growth for Africa's youth. The food and agriculture sector can significantly contribute to job creation for Africa's growing youth population, particularly in the agro-processing sector. The importance of supportive polices and targeted investments to promote job creation in this sector was one of the core agendas of discussion.

Speakers and panellists at the PARI event @ AASW8 2023

20 September 2023, Durban, South Africa

Strengthening agrifood markets to improve resilience and food security in Africa

PARI held a side-event to the 7th African Conference of Agricultural Economists to discuss options for improving market access for smallholder producers. As well functioning markets will be key to strengthening the resilience of agri-food systems in Africa, this session took a holistic view of market integration in Africa. The panel discussed mostly focused on the possible measures needed to enable African small-scale producers and business to better integrate into local, regional and international agrifood markets and consequently increase their resilience and improve food security in the continent.



Dr. Mahamadou Tankari, AKADEMIYA2063, presenting PARI research

2 February 2024, Dakar, Senegal

Promoting sustainable development in Africa through agroforestry

This seminar was co-organized by CSE and ZEF in Dakar, Senegal, to share the scientific results of their research collaboration which aimed to (1) provide a clear understanding of the agroforestry expend across the African continent by carrying out remote sensing-based mapping of past, current and future agroforestry areas in Africa and (2) assess the direct ecosystem benefits and indirect socio-economic

benefits of agroforestry, contributing to sustainable food systems, poverty reduction, and employment in the context of climate change adaptation and mitigation.

Dr. Aziz Diouf, CSE (one of the lead authors)

5-6 February 2024, Accra, Ghana

PARI Research & Partnership Meeting

Around 50 PARI partners from various African countries, India and Germany gathered in Ghana for the PARI Research & Partnership meeting to present and discuss PARI research findings and identify research and policy priorities for the future. In particular, the question of how the food system can create jobs and income for Africa's youth was a recurring theme throughout the discussions. The participants represent the institutional diversity of research partners in PARI, including national agricultural research institutes, leading universities and pan-African and regional research organizations. In addition, future priorities for Africa's food systems were discussed in an open hybrid session with around 130 participants from politics, civil society and the private sector.

Participants at the PARI Research & Partnership Meeting

In addition to these PARI-hosted events, PARI team members actively shared research results in African, German and international policy discussions, in particular through participation in the African Union Summit in February 2023 and Food System events at the UN General Assembly in October 2023, the meetings of the Strategic Advisory Group and other forums of the German Federal Government, and the Global Forum for Food and Agriculture 2023 in Berlin.

Social Media Outreach

PARI is using social media, notably Twitter, to disseminate key research findings, including through dedicated social media accounts hosted by PARI as well as through accounts hosted by PARI partners. **FARA's communication channels** play a critical role in reaching key African stakeholders. The most extensively used channel are FARA's DGroups which allow direct dissemination of research outputs to over 40'000 members across Africa. The FARA Twitter account is followed by over 34'700 users while the FARA Facebook page has around 77'500 and the LinkedIn page close to 34'000 followers.

3 Publication List 2023

Publication Title	Lead partner	Geography
Proactive policy options for drought resilience in the Sahel region (Journal Article)	Agrhymet Regional Centre, ZEF	Sahel Region
Renewable energy adoption and rural livelihoods in Ethiopia (Journal Article)	University of Parakou, ZEF	Ethiopia
Mechanization and automation in Africa's agroprocessing sector: Implications for employment and skill needs	ZEF	South Africa, Kenya, Nigeria, Ethiopia
The role of agricultural sector performance in attracting foreign direct investment in the food and beverages sector (Journal Article)	ZEF	Africa
Productivity growth and the role of mechanisation in African agriculture (Journal Article)	ZEF	Africa
Protecting the data of African agricultural producers: a review of national laws, compliance and perceptions (Journal Article)	ZEF	Africa
Building digital bridges in African value chains: Exploring linkages between ICT use and social capital in agricultural marketing (Journal Article)	ZEF, ARCN, CSIR-Stepri, KALRO, IER, ARCN	Ghana, Kenya, Mali, Nigeria
Impacts of mothers' time on children's diets	ZEF, CSIR-Stepri	Ghana
Carbon farming in Africa: Opportunities and challenges for engaging smallholder farmers	ZEF, ICIPE	Africa
Scaling aquaculture for food security and employment in Africa: Insights from Egypt, Kenya and Nigeria	WCS Africa, ZEF	Egypt, Kenya, Nigeria
White revolution in India: What smallholders can do given the right ecosystem	ICRIER, ZEF	India
Poultry revolution in India: lessons for smallholder production systems	ICRIER, ZEF	India
Animal traction, two-wheel tractors, or four-wheel tractors? A best-fit approach to guide farm mechanization in Africa (Journal Article)	UOH	Africa
Made in Africa – How to make local agricultural machinery manufacturing thrive (Journal Article)	University of Hohenheim, INRAB, KALRO, IER, ARCN, ZEF, FARA	Kenya, Mali, Benin, Nigeria
Addressing agricultural labour issues is key to biodiversity-smart farming (Journal Article)	UOH, CIMMYT, University of KwaZulu-Natal, ZEF	Ethiopia, Indonesia
Comprehensive livestock driven typology for food and nutrition security in Africa: case study from Ethiopia	AGRODEP/ AKADEMIYA2063	Ethiopia
Industrial clusters and firm-level innovation in Africa	AGRODEP/ AKADEMIYA2063	Africa
Livestock Feed Development Pathway in Nigeria: Drivers, Challenges, and Opportunities	AGRODEP/ AKADEMIYA2063	Nigeria

Annex: Core research partners 2014-2023

Coordinating partners

Center for Development Research (ZEF) at the University of Bonn

Forum for Agricultural Research in Africa (FARA)

AKADEMIYA2063

Indian Council for Research on International Economic Relations (ICRIER)

University of Hohenheim

Regional/international research partners in Africa

African Growth and Development Policy Modeling Consortium (AGRODEP) hosted by AKADEMIYA 2063

African Economic Research Consortium (AERC)

Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle (AGRHYMET)

BioInnovate Africa

World Aquaculture Society Africa Chapter

International Food Policy Research Institute

International Livestock Research Institute

National research partners in Africa and India

Agricultural Research Council of Nigeria (ARCN)

Centre de Suivi Ecologique (CSE)

CSIR Science and Technology Policy Research Institute (CSIR-STEPRI)

Department of Agricultural Research Services of Malawi (DARS)

Initiative Prospective Agricole et Rurale (IPAR)

Institut d'Economie Rurale (IER)

Institut de L'Environment et de Recherches Agricoles (INERA)

Institut de Recherche Agricole pour le Development (IRAD)

Institut National des Recherches Agricoles du Bénin (INRAB)

Institut National de Recherche Agronomique de Tunis (INRAT)

Institut Sénégalais de Recherches Agricoles (ISAR)

Institut Togolaise de Recherche Agronomique (ITRA)

Kenya Agricultural and Livestock Research Organization (KALRO)

Lilongwe University of Agriculture & Natural Resources (LUANAR)

Makerere University – College of Agricultural & Environmental Sciences

National Agricultural Research Organisation (NARO)

Policy Studies Institute (PSI)

Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)

Université Cheikh Anta Diop de Dakar (UCAD)

University of Addis Ababa

University of Ghana – Institute of Statistical, Social and Economic Research (ISSER)

University of Nairobi – School of Computing and Informatics

Zambia Agriculture Research Institute (ZARI)

Technische Universität München