



External Review of the Programme of Accompanying Research for Agricultural Innovation (PARI) and future Perspectives of the Program

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Executive Summary

The Program of Accompanying Research for Agricultural Innovation (PARI) was launched in 2014. The project emerged as part of the German Government's "One World – No Hunger" initiative which sought to increase the income of smallholders, generate employment in agricultural value chains, and improve food supplies through innovations in the agricultural and food sector in Africa and India. **The overall goal of PARI is to improve food and nutrition security and enhance sustainable agricultural value chains in the African and Indian food systems through independent analysis and policy advice.** It is a collaborative project between **German, African and Indian research organizations.**

By reviewing publications and conducting Key Informant Interviews (KIIs), this review takes stock of the evolution of PARI over time. In so doing, it assesses whether the project is aligned with African and German policy priorities, evaluates the outcomes of the project and their relevance and likely sustainability, and identifies thematic areas for the next phase of the project. The exercise also offers thoughts on assessment and evaluation approaches to other accompanying research activities.

While PARI's overarching goal was maintained throughout the project period, some refocusing of the specific thematic areas was necessary to accommodate new challenges and expectations. Accordingly, several new strategic focus areas have been identified and implemented based on changes in local and international circumstances. Rather than focusing only on one location or value chain, there has been a shift towards a scaling up of innovations that are of relevance across a number of countries or sub-regions. Some emerging issues through various phases of the project include promoting rural development and rural-urban

linkages, with a particular focus on youth employment and skills development, creating decent jobs, and supporting sustainable and fair food systems through digital opportunities.

PARI is well aligned with African priorities on food and agriculture and the German government's overall strategy for Africa and its agriculture sector in particular. The project's complementarity to these strategies and ambitions is demonstrated through a review of the various African policy documents that seek to advance the food and agriculture sector on the continent (including Agenda 2063; the Comprehensive African Agricultural Development Programme; the Science Agenda for Agriculture in Africa; the Science, Technology, and Innovation Strategy for Africa 2024; and the Feed Africa strategy of the African Development Bank), the German government's strategy on Africa, and PARI interventions.

PARI has produced commendable results in terms of scientific outputs, capacity-building interventions, networking, and policy engagement. This is exemplified by the number of publications it had produced by the end of 2023 (278) and the number of experts it has engaged (>300 from around 75 organisations in 25 countries). Particularly noteworthy is the extensive engagement of African researchers which constitute more than 70 percent of the authors of PARI publications, and the strong Africa-India exchange. The network of African, Indian, and German researchers created over the years is one of the outstanding features of PARI which will persist even beyond the duration of the project. In addition, PARI's long-term impact will be supported through its capacity-building efforts, provided both directly through financial support to 52 Masters and PhD students and indirectly through close and long-standing collaborations between the PARI research partners.

Research dissemination and policy engagement have been central elements of PARI throughout the project period. They were achieved through the organisation of 44 PARI events, participation in external events, the PARI website as well as social and traditional media outreach activities. Notably, PARI regularly hosted events and participated in sessions at the annual African Green Revolution Forum (now Africa Food System Forum) which brings together the leading policy actors engaged in African food and agriculture. PARI also played an important role in mobilizing African contributions to the UNFSS, through FARA and other African partners.

While PARI has made notable contributions during the last ten years, there are some areas that will require further attention, consideration and improvement in the next phase of the project. To address the challenges faced by PARI during the implementation of project activities, additional efforts should focus on

- further **strengthening the capacities** of the African partner institutions and researchers,
- **broadening the focus on research partners** from Africa's national agricultural research systems to include regional research organisations and universities, and
- expanding **outreach to and engagement with policy makers** on both the African and the German side.

Based on the African continental development strategies, the German Africa strategy, and feedback from PARI partners and network groups, the next phase of the project may require a focus on both existing thematic areas and new ones:

- Major areas suggested to be continued from the previous phase include mechanization, digitalization, employment generation, engagement of youth and women, market access, input delivery and Africa-India exchange.

- Examples of possible topics for more in-depth analysis include policy reform, climate change and adaptation, green energy, nutrition security, conflict, governance, and rural infrastructure.
- While the challenges facing the African agriculture and food system are many and diverse, PARI 2.0 could contribute significantly if it focuses in particular on agricultural production for food and nutrition security, climate change and adaptation issues, natural resource management, green rural energy production, and digitalization for agricultural development.

1. Background

1.1. Purpose of the review

The main objective of this review is to examine the progress PARI has made over the last ten years in achieving its stated objectives, as outlined in the project proposal and its related updates, and through its contribution to the development of the food and agriculture sector in Africa. It also aims to suggest some forward-looking recommendations or thematic interventions that would require further engagements beyond the current phase.

More specifically, the following are the objectives of the review process as stated in the Terms of Reference:

1. Briefly review the evolution of PARI over time (how and why);
2. Relate the PARI research and outputs in a structured way to African development priorities, such as Agenda 2063, etc., to identify overlaps and gaps;
3. Review PARI research and outreach activities as well as policy relevance and the capacity-building and network effects of PARI work and its sustainability; and
4. Develop priorities for the next phase beyond the current project period (PARI 2.0) that may emerge from the evaluation.

In the process of achieving the above stated purposes, the review aims to assess whether PARI's work and activities have contributed towards the accomplishment of the project objectives. It will also evaluate the general strategy pursued and assess whether priorities have been useful from an African and German perspectives. Lastly, the review will assess the quality and relevance of PARI's research outputs.

¹ Agriculture together with fishery and forestry, contributed more than \$310 billion to Africa's GDP in 2019 (World Bank, 2020a).

1.2. Setting the context

In order to put the review of PARI in perspective, it is important to briefly assess the importance of Africa's food system, in general, and that of the agriculture sector. Areas that are key to understanding the development process of African countries include crop and animal production, fisheries and agroforestry, value chains, and markets.

Although its contribution varies greatly from one country to another—on average, accounting for some 15-34 percent of Gross Domestic Product (GDP)—agriculture and the rural economy play a fundamental role in the development process of the African continent (Kelsey, 2013; World Bank, 2020a).¹ Smallholder farming² contributes more than a third of the food production on the continent (Herrero et al., 2017). The agriculture sector is an important driver of food security improvement and revitalization in Africa (Delgado et al., 1994; IFPRI, 2019; World Bank et al., 2017). The sector is also important in creating jobs for the growing population by providing employment opportunities for about 65-70 percent of the continent's labour force (World Bank, 2020b; Oxford Business Group, 2019). Growth in agricultural output can also fuel growth in the non-agricultural economy through a variety of mechanisms. Hence, enhancing food production in Africa could have the potential to enhance economic transformation, create jobs for youth and women, increase government revenue, and ensure accelerated economic growth and development on the continent (Baumüller et al., 2020).

The African continent is endowed with wide agroecological variations which could potentially produce much more than the current output levels.

² Small farms continue to dominate production. About 70–80 percent of farms in Sub-Saharan Africa are smaller than 2 ha (Lowder et al., 2016),

While other parts of the world are reaching their limits, more than 60 percent of the global unused arable land suitable for production is found in Africa (World Bank, 2013). This means, Africa can still substantially increase yields from increased area expansion and by improving productivity (Badiane, et al., 2023; Baumüller, et al., 2020).

Nevertheless, agricultural productivity—both in production and processing—is much lower than the global average as the continent generates only about 10 percent of the global agricultural output. The low levels of productivity are also compounded by high post-harvest losses of about 14 percent (Sawicka, 2019). Africa is still a net importer of a substantial amount of food—with a third of all calories consumed in Africa being imported—resulting in a negative net agricultural trade balance, (AfDB, 2015)³.

In spite of a number of potential opportunities for agricultural production, the majority of the rural population in Africa lives in extreme poverty (Barrett et al., 2017; Hansen et al., 2019; Clay and Zimmerer, 2020). According to the FAO (2023), more than 700 million people globally suffered from undernourishment in 2022 out of which 282 million were in Africa⁴. The continent is still unable to feed itself and healthy diets are unaffordable for nearly a billion Africans (FARA, 2021).

There are several reasons why the region was unable to live up to its potential. Low agricultural productivity; unexploited irrigation opportunities, limited use of yield-increasing technologies, lack of hard and soft infrastructure and weak institutional capacities, weak innovation capacity, and unfavourable policy environments are some of the

major factors for explaining the gap between potential and reality.

In view of the above and many other challenges, improving the performance of the food and agriculture sector and raising productivity levels through innovations in a sustainable manner remains a fundamental development goal for Africa. Traditionally, the increased use of inputs and expansion of agricultural land have been the main source of agricultural growth in Africa. Studies show that innovations accounted for only 1 percentage point of African agricultural growth, while the rate is about 3 percent in Asia and Latin America (Fuglie and Rada, 2013). Improvements in productive and processing capacities could reduce rural poverty and improve food security by ensuring a sustainable supply of healthy and affordable food, generating export earnings and higher income for agricultural producers, increasing employment and income opportunities, and by creating linkages between agriculture and other sectors that drive the rural economy and provide capital and labour for growth in various sectors (Baumüller et al., 2020).

Consequently, agricultural innovations and scientific research are needed to sustainably increase production and productivity. Innovations in the food and agriculture sectors will be critical for the sustainable transformation of the sector and unlock the potential to reduce malnutrition and reduce losses and waste. New innovations and advances in science and technology are crucial not only to increase food production but also because the returns on investments in terms of poverty reduction effects are often highest in this sector.

³ Despite an abundance of uncultivated farmland, African countries spend US \$35 billion importing food rather than creating the conditions to grow more food locally. If no structural changes occur, this will rise to \$110 billion by 2030.

⁴ Growth from agriculture is 11 times more effective at reducing extreme poverty than any other sector (FAO, 2015).

African countries have recognized the important role of the agricultural and food sector and have made major commitments to invest in the sector. For instance, the Comprehensive African Agricultural Development Programme (CAADP), an integral part of the New Partnership for Africa's Development (NEPAD), and the publishing of the Science Agenda for Agriculture in Africa (S3A) in 2014 are examples of these attempts. S3A—which is operationalized within CAADP framework—articulates the science, technology, extension, innovations, policy, and social learning that Africa needs to apply to meet its agricultural and development goals. More specifically, the S3A is the broader framework for the implementation of the Framework for African Agricultural Productivity (FAAP). The African Union Agenda 2063, the African Development Bank's Feed Africa Strategy, and the Great Green Wall of the Sahara and Sahel Initiative (GGWSSI), and the Agricultural programs within the Regional Economic Communities (RECs) are also other African initiatives.

Against this background, the Program of Accompanying Research for Agricultural Innovation (PARI) emerged. The aim of this review is to briefly reflect on how PARI was conceived, launched and implemented, identify what achievements were realized and challenges were faced, and establish the policy relevance of the project. In addition, the review also identifies some potential topics in which PARI 2.0 should focus on in the future.

1.3. Methodology

1.3.1. Theoretical framework

An evaluation is an assessment, as systematic and objective as possible, of an on-going or completed project, program or policy, its design, implementation and results with the aim of determining the relevance and fulfilment of objectives, developmental efficiency, effectiveness,

impact and sustainability (OECD, 2010). Designing a framework for evaluating research and development interventions within any given environment is a daunting task as there could be different ways and approaches to undertake the evaluation. For instance, one approach is to use a before and after methodology in which a counterfactual reference is identified and the impact of the intervention is assessed. But, finding a comparable case is always a difficult exercise. Another approach which is also widely used is the OECD evaluation framework.

Accordingly, we have adopted the OECD evaluation framework due to the absence of a counterfactual and considering the needs of the program stakeholders and the context of the evaluation in this particular assignment. The OECD framework consists of the following six evaluation criteria, which should be used thoughtfully considering the broader context of the evaluation (OECD, 2021).

- **Relevance**, which examines the extent to which the intervention objectives and design respond to the needs of the beneficiaries and continue to do so if circumstances change.
- **Coherence** refers to the compatibility of the intervention with other interventions in a country, sector or institution.
- **Effectiveness** is the extent to which the intervention achieved, or is expected to achieve, its objectives, and its results, including any differential results across groups.
- **Efficiency** is about the extent to which the intervention delivers, or is likely to deliver, results in an economic and timely way.
- **Impact** is the extent to which the intervention has generated or is expected to generate significant positive or negative, intended or unintended, higher-level effects.
- **Sustainability** involves the examination of the financial, economic, social, environmental, and institutional capacities of the systems needed to sustain benefits over time.

Using these criteria, this evaluation hopes to provide information that is credible and useful, enabling the incorporation of lessons learned into the future interventions.

1.3.2. The Empirical approach

In order to generate information and assess the outcome of PARI using the earlier stated criteria, a combination of approaches was adopted. Secondary data was acquired through a comprehensive desk review of the project proposal, outputs of the program, project reports, and documented studies, all of which provided relevant information for assessing the achievement of expected program results. In this case, the review of project documents—such as PARI proposals, PARI annual reports, policy briefs, events, BMZ strategies, PARI input papers to the BMZ strategies, Africa’s updates on food and agriculture (including Agenda 2063), CAADP, joint African statement under the UN Food Systems Summit, Dakar 1 and 2 and other African policy documents—have been the major source of information for understanding the project, what it sought to achieve, and how it relates to African policy priorities. Data obtained from the project’s reports were useful for establishing trends of project intervention and for determining the extent to which project objectives have been achieved.

In addition to the secondary information that was compiled from the above sources, primary information was also acquired from the consultation of key PARI partners and network groups through a key informant interview (KII) by telephone or email communications, as well as from the consultation with PARI management and project staff. In this regard, the key project staff—including those at the University of Bonn, ZEF, and those who are involved

in the project from other partner institutions—were approached. A checklist of questions has been used to seek responses from key informants identified for the purpose of the review (see Annex I and II).

2. Review of PARI concept, design and evolution over time

2.1. Introduction

The contribution of innovations for sustainable and enhanced agricultural growth in Africa has been well recognized and emphasized in the Science, Technology, and Innovation Strategy for Africa 2024 (STISA 2024). Based on progress made on the social, economic and technological fronts, the strategy has underscored the central role of innovations to improve and expand African agricultural and food systems. To support this ambition, the German government provided support for the “One World – No Hunger” initiative (SEWOH⁵), including establishment of Green Innovation Centres (GICs)⁶ in Africa and a few Asian countries, with the aim of improving food security and sustainable agricultural development in Africa.

To achieve the science, technology and innovation policy goals and encourage evidence-based policy dialogues, strong international scientific collaboration is imperative. Accordingly, it became necessary to support the “One World – No Hunger” interventions through independent scientific advice on identifying and developing strategies for scaling promising interventions. Subsequently, PARI was conceptualized and initiated towards the end of 2014 in response to the demand from end users of research outputs including the “One World – No Hunger” initiative and other actors in various value chains, to enhance science-based policy making

and advisory services, which feed innovations from farms to the actors in the value chains, including the private sector.

⁵ SEWOH: Sonderinitiative “Eine Welt ohne Hunger”

⁶ Coordinated by the GIZ, GICs include research organizations, demonstration farms, agricultural schools, decentralized training and continuing education courses,

with a unique collaborating framework between African, Indian and German partners.

PARI was originally conceived as an independent accompanying research program funded by the Federal Government of Germany through the Ministry of Economic Development and Cooperation (BMZ) with a goal of considering the needs of end users and other actors throughout the value chains, including to:

- support and improve the work of existing African innovation institutions;
- accompany specified innovations at the GICs with impact research and identify further innovation opportunities; and
- foster synergies with and links to existing innovation centres in the respective countries' innovation systems.

PARI is a unique and innovative project in the sense that it complements the “One World – No Hunger” initiative by providing science-based evidence on the potential and scaling of innovations in the food and agriculture sector. It has provided sound, science-based applied knowledge from the field, which other agencies were not able to generate. The systematic analyses and assessments by accompanying research institutions facilitate learning and thereby increase the chances for transmission and multiplication of local experiences. PARI has played an active role in putting science-based information on food and agriculture at the centre stage of the development process.

The project has been able to bring together experts from African countries, India and Germany as part of the “One World – No Hunger” initiative to work together to contribute to sustainable agricultural growth and food and nutrition security in Africa and India. Hence, a consortium of three German universities (ZEF/University of Bonn, University of Hohenheim, TU Munich), FARA (and its network of

national agricultural research organizations), and the African Growth and Development Policy (AGRODEP) Modeling Consortium (initially coordinated by IFPRI and later transferred to AKADEMIYA2063) was formed to implement the program. Other African partners have also joined the program later.

PARI has provided relevant information to key actors in the program, including to the respective GICs, national and regional African partners and the BMZ. With the generated research-based information, PARI serves to strengthen the national, regional and continental institutional partner settings to enhance value chains and rural and agricultural development in Africa. In addition, the outputs of PARI assists the BMZ to make informed future investment decisions related to innovation for agricultural development and food security and its strategic collaboration with African countries. PARI also promotes the reputation of the program and supports evidence-based political dialogues.

The conceptualization of PARI was based on wide-ranging scientific and political consultations and engagement with the most capable African food and agriculture-related knowledge networks and their respective institutions, which were integrated into the relationship with the GIC. The countries where research has taken place in this program are Benin, Burkina Faso, Cameroon, Ethiopia, Ghana, India, Kenya, Malawi, Mali, Niger, Nigeria, Senegal, South Africa, Togo, Tunisia, Uganda, and Zambia. The program is being implemented through an international and interdisciplinary consortium team consisting of ZEF, FARA, AGRODEP of AKADEMIYA 2063 (formerly hosted by IFFPRI), the University of Hohenheim, and, in the early phase, the Technical University of Munich. There are also some 20 national and 4 regional partners spread out across the African countries and India (see Figure 1). The consortium and the network partners of PARI—including relevant African organizations addressing

agricultural innovation and research, the CGIAR centres, and the network of partners in Germany—form a strong basis for achieving the tasks of the accompanying research program. This collaboration framework is unique due to its

- (i) strong and well-established network in Africa, India, and Germany
- (ii) strong and rich analytical capacities in evidence-based programs on innovations
- (iii) ability to engage policy analysts and advisors in the partner countries.

In order to provide strategic guidance to the project, some priority areas have been identified. These priorities were based on the needs of African countries, as indicated by the Comprehensive African Agricultural Development Program (CAADP) and the African Union Agenda 2063. Usually research priorities were identified in discussion with project partners through regular in-person and virtual project meetings. The criteria for

prioritization include feasibility, needs and potential of each country, expected impact and expected returns to investment in terms of food security and sustainable agricultural and rural development, as well as the cross-cutting nature of the theme. Based on these and other considerations, issues related to productivity, policy, market, natural resource management, and their implications for nutrition and health, product development and gender have been identified by the project as core research areas. The project duration was initially planned to be from December 1, 2014 to December 31, 2019 but was subsequently extended several times until December 31, 2024.

2.2. Main goals of PARI and their evolution

PARI was conceptualized to support efforts for improved food security and sustainable agricultural development in Africa and India. It was to act as an independent accompanying research program by

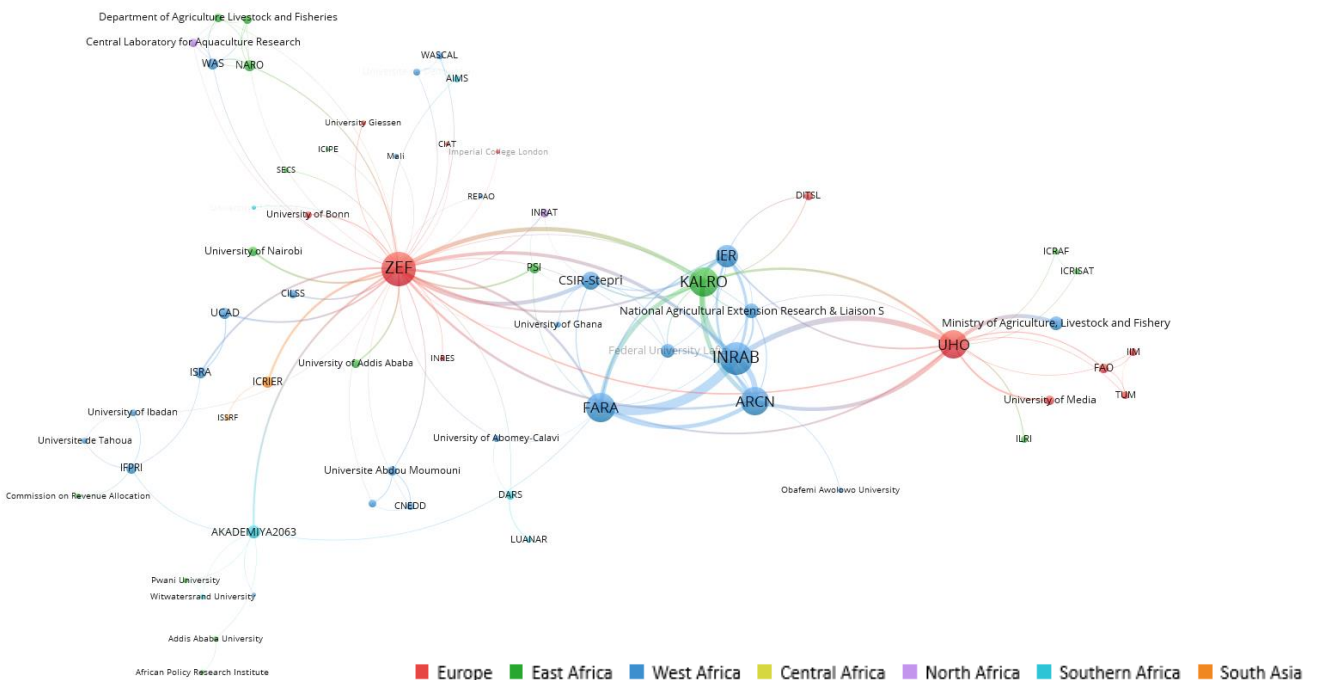


Figure 1: Research collaborations among PARI institutional partners

Note: Collaborative research activities PARI partner organizations (i.e., affiliation of authors) for all publications 2014-2023 (as of 6 November 2023). Dot = organization. Size of the dot = number of publications by the respective organization. Generated using VOSViewer. Cartography: Heike Baumüller.

linking the needs of end users and other actors throughout the value chains.

More specifically, PARI aims to:

- analyse, promote and support the scaling up of proven innovations in the agriculture and food sector;
- support and enhance investments in agricultural innovation in a sustainable manner, and identify, assess and scale up innovations in the agri-food sector;
- identify and assess supportive measures to strengthen framework and policy conditions for the creation and dissemination of promising innovations in food systems and rural areas; and
- provide a platform for effective engagement of science partners and policymakers for the generation of innovation and reform around food and nutrition security in the intervention countries.

The overall goal of PARI is to improve food and nutrition security and enhance sustainable agricultural value chains in the African and Indian food systems. It aims to do this by supporting investments in GICs in a sustainable way by means of dedicated cooperation between research, application, and policy in Africa. While this has been the overarching objective of the program, the interventions and thematic focus areas of PARI have been evolving and changing over time, depending on the existing circumstances on the ground. Thus, it will be important to reflect on and review the evolution of the program over the years. This section briefly reviews the evolution of PARI interventions from inception up to the current time period. Overall, these interventions can be categorized into four major phases based on changing goals, thematic interventions and funding schedules.

2.2.1. Phase I (2014 -2017) program objectives

At the start of the program, PARI intended to contribute to sustainable agricultural growth and food and nutrition security in Africa and India in three ways: 1) by analysing the potential and impact of innovations; 2) by identifying and assessing supportive measures for the generation and dissemination of promising agricultural innovations; and 3) by engaging the food and agricultural development policy makers to make informed investment decisions that can improve job creation and ensure food and nutrition security.

More specifically, project goals during the first phase of the program included:

1. To support and improve the work of existing African agricultural innovation institutions;
2. To provide information and consultation platforms for stakeholders (including government and other actors on agricultural policy), institutional capacity building, and rural infrastructure and value chains, based on the wide-ranging scientific and political consultation network of consortium members in Africa;
3. To provide inputs for the selection of promising innovation domains in the respective contexts;
4. To accompany specified innovations at the GICs with impact research and identify additional innovation opportunities, including those expressed by end users of research in collaboration with the multi-stakeholder Innovation Platforms; and
5. To foster synergies with and links to existing innovation centres in the respective countries' innovation systems.

In order to achieve these overarching goals, various thematic research areas were identified and implemented in the various countries in collaboration with the different PARI consortium

members. The main thematic research intervention of the program during this phase primarily focused on innovation research with future-oriented impact analyses, identification and stimulation of technological and institutional innovations, and engagement with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security.

Based on institutional and policy analysis focused on these thematic focus areas, PARI has provided inputs and advice for selecting appropriately adapted and promising innovation domains in the respective countries by the in-country implementing stakeholders. In this respect, some of the activities undertaken by PARI on the first thematic area include developing methodologies and undertaking baseline studies, identification and screening of promising innovations, institutional analysis of the GICs, and modelling, mapping and scaling up of innovations. With respect to engaging African policy makers and participating in the policy making process, PARI has organized a variety of local events with the aim of enhancing collaboration and discussion to improve food and nutrition security.

Phase I of the project was focused primarily on building a productive network among the African, Indian and German partners and facilitating mutual learning and knowledge exchanges on innovation opportunities. During this period, PARI has achieved good results, particularly in creating a good network in the respective countries where research has been undertaken and engaging them more effectively. The consortium that was formed between ZEF, FARA, UOH, AGRODEP (IFPRI) and TUM has been able to lead and manage the project well. In addition several national partners have been identified in most of the focus countries. The partner organizations had been given much flexibility in designing their research agendas based on their national development priorities, but were encouraged to follow similar or comparable

outlines. This phase has enabled partner organizations to produce several comparable research outputs, which have wider relevance beyond national boundaries.

2.2.2. Phase II (2018- 2019) program objectives

During the second phase of the project, the original goals were still maintained but new thematic research areas were identified and launched on top of the previously identified topics. Accordingly, two additional thematic areas—namely, African ICT Platform for Agricultural Innovations and Vocational training for farmers and other actors in the agri-food value chain—were identified in collaboration with partners.

One of the challenges faced during Phase I was related to an attempt to undertake all activities in all 12 countries. Each country was participating in all the thematic working groups without any focused intervention. With efforts spread over all 12 countries, efficiency was reduced. In order to make the project more efficient, the second phase has come out with a more structured approach where activities were organized under selected thematic issues. In this way, the lessons from intensive but rigorous studies could be adapted and scaled up to other countries needs as well.

2.2.3. Phase III (2019 – 2021) program objectives

As pointed out earlier, the research-based information generated by PARI strengthens innovation and scales up, promotes and enhances value chain approaches that are expected to contribute to rural and agricultural development. Based on this principle and building on the experiences gained during the previous periods, PARI continued to identify investment opportunities in the African agriculture sector. This was done with the aim of improving food security and creating employment and income opportunities, but with

more emphasis and re-focusing of the research and innovation activities. Indeed, during this period PARI continued to focus on the objectives of the “One World – No Hunger” initiative. The research and innovation activities, as well as the policy outreach and consultation efforts, continued during this period. However, some refocusing and reorientation of the specific research themes were needed, based on the needs and expectations of BMZ’s SEWOH initiative and the innovation research challenges and opportunities in the partner countries in Africa and India.

Accordingly, several strategic focus areas were identified and implemented during this period. For instance, rather than focusing only on one location or country, the focus shifted towards value chains that are of relevance across a number of countries or sub-regions, with the aim of more easily scaling up innovations generated in one country across the continent. In addition, more emphasis was placed on promoting rural development and rural-urban linkages, with a particular focus on youth employment combined with skill development. Interventions focusing on creating decent jobs and improving the wellbeing and nutrition of people also became more pronounced during this period. Finally, the reorientation also underscored the need for strengthened South-South learning and exchange of innovations between Africa and India.

Based on the strategic shift, research interventions that facilitate the scaling up and broader impact of innovation investments within the selected countries were identified and organized under the following five clusters:

1. Targeting investments in innovations and framework conditions;
2. Mechanization and skill development for productivity growth, employment, and value addition;
3. Digitalization in agriculture, food, and nutrition;

4. Enhancing opportunities for youth in the rural economy; and
5. Improving the policy context and contributing to evidence-based policy.

Project partners could opt into these different clusters depending on their research priorities.

2.2.4. Phase IV (2022-2024) program objectives

Like in the previous phases of PARI’s research and innovation activities, the current focus continues to be on achieving the main objective of BMZ’s “One World – No Hunger” initiative and the interest of partner countries. Given the strong collaborating framework and its well-established network of researchers in Africa, Germany and India, PARI continued to deliver relevant policy analysis and scaled up promising innovations for promoting sustainable agricultural growth and food security in Africa during this phase.

Taking stock of the experience gained from the previous three phases, the program tried to identify specific innovation opportunities in Africa that can enhance the continent’s capacity to sustainably and equitably develop its food and agriculture sectors. In this phase of PARI, more emphasis was placed on identifying the necessary framework conditions for scaling up promising innovations or governance-related aspects. The thematic areas identified for this period focused on:

- (i) Scaling innovations to promote multi-sectoral and sustainable approaches for small-scale producers;
- (ii) Investment in infrastructure and skills as framework conditions for rural development and urban linkages;
- (iii) Supporting sustainable and fair food systems through digital opportunities;
- (iv) Structural transformation of national agricultural innovation and research systems;
- (v) Participation in African and global food and agricultural policy making.

These themes have been identified based on specific criteria, such as the feasibility, needs, and potential of each country, the CAADP framework, and the expected impacts and return on investment in terms of food security, sustainable agriculture and rural development. Cross-cutting themes were taken into account.

Based on the thematic areas, several research topics were identified and implemented during this period. Accordingly, one of the topics identified within the first thematic area was multi-sectoral approaches in small-scale production systems. This topic included crop, livestock, agroforestry, and aquaculture with the aim of benefiting from synergies and broadening opportunities between sub-sectors. Additional topics under the first thematic area included the promotion of sustainable production methods, targeted measures that specifically support and empower women, evaluation of experiences, and the widespread dissemination of relevant technological and institutional innovations in Africa and India. Other important topics considered include conserving and enhancing biodiversity through the promotion of mixed cropping systems and combatting invasive species, sustainable land and soil management, land use planning, water resources and irrigation management, agricultural biomass and energy systems, and challenges for agriculture and food security (e.g., climate change, variability adaptation and mitigation measures).

Complementary investments in hard and soft infrastructure and innovative approaches to skills development for small-scale producers were the main topics planned under the second thematic area. Since digitalization is leading to systemic changes in improving the productivity, efficiency, and integration of African and global food systems, attempts are being made to promote business-to-business (B2B) platforms as intermediaries for knowledge, financing, and product markets under the third thematic area. Such digital platforms have

the potential to integrate small-scale producers and SMEs into local and global supply chains.

Finally, PARI research plans to identify targeted measures to strengthen human capacity and improve linkages between a number of domestic stakeholders, including national agricultural research systems (NARS), producers, extension systems, universities, and private sector innovators. Additionally, opportunities for strengthening international linkages—including with the CGIAR system—are being examined to ensure more effective development, better use of agricultural research outputs, and active participation of African research stakeholders in priority setting, R&D, and dissemination of research outputs. Because active participation in and close engagement with the policy development processes has played an important role in PARI's activities, the project continues its efforts to feed research findings into African and global policy processes through its own dialogues, participation in existing processes, and dissemination of research findings.

3. Alignment of PARI research with African and German development priorities

If an intervention is based on the needs and priorities of the partner organizations or countries, its potential for success is huge and the sustainability of the intervention is ensured. As PARI has been initiated and implemented in selected African countries, assessing whether the program is aligned with African countries' existing realities and priorities as well as assessing whether the program complements the German government's development intervention goals is essential. African countries have committed themselves to supporting the development of agriculture through a number of strategies. Examples include formulating various strategies and programs, increasing budgets for

agricultural development, supporting private sector participation, encouraging donors to significantly increase commitments, and establishing policies aimed at increasing investments in the sector. Accordingly, PARI has been initiated after assessing various African strategies and in consultations with German, African, and Indian partners. In this section, we will briefly review whether PARI is aligned with the African development priorities, as reflected in the various strategies and focus areas of the African continent and the BMZ.

3.1 PARI's relevance to African development priorities

Agriculture and food security have become priorities on Africa's political agenda, as exemplified by the adoption and implementation of significant continent-wide initiatives. Continental agreements such as Agenda 2063, the CAADP, the Malabo Declaration on "Accelerating Growth and Transformation in Agriculture for Shared Prosperity and Better Livelihoods", the Science Agenda for Agriculture in Africa (S3A), and the African Development Bank's financial commitments to the agricultural sector show that modernizing the food and agriculture sector is a major focus of African governments.

3.1.1. African Union Agenda 2063

As pointed out earlier, agriculture is primarily the main source of livelihood and economic growth in many African countries. Accordingly, African countries have committed themselves to increasing their support to agricultural development, as reflected in the various continental strategies and documents. Among them, Agenda 2063 (the Africa we want) is the African Union's flagship strategy, which was launched in May 2013 as the new path for attaining inclusive and sustainable economic growth and development on the continent. The genesis of Agenda 2063 was the realization by

African leaders that there was a need to refocus and adjust priorities. Since then, the Agenda has emerged as Africa's blueprint and master plan for transforming the continent into a global powerhouse of the future. It is the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development and is a concrete manifestation of the pan-African drive for unity, self-determination, freedom, progress, and collective prosperity pursued under Pan-Africanism and the African Renaissance. It is the concrete manifestation of how the continent intends to achieve this vision within a 50 year period from 2013 to 2063. Agenda 2063 seeks to deliver on a set of Seven Aspirations—each with its own set of goals—which, if achieved, will move the continent closer to securing its vision for the year 2063: "A Prosperous Africa based on Inclusive Growth and Sustainable Development."

Agricultural development is an important focus of the African Union's Agenda 2063. Modern Agriculture for Increased Productivity and Production, which focuses on raising agricultural productivity, is among the seven goals of the first aspiration. Agenda 2063 argues that by taking advantage of its untapped arable land and water resources, Africa could be a major player in the global agro-food economy. African agriculture can be a competitive food and agriculture system that meets the fast-growing and diversifying agro-food demands of intra-African, local, national, regional, and global markets.

The goal of Agenda 2063 is to modernize agricultural production in Africa by capitalizing on emerging development and investment opportunities in areas such as agri-business, infrastructure development, ICTs, health and education, as well as the value addition in African commodities. Together, these initiatives aim to lead to an accelerated and rapid transformation of the sector. Additionally, the Agenda aims to end poverty, reduce inequalities of

income and opportunity, create jobs, (especially with regard to youth unemployment), address challenges related to rapid population growth and urbanization, and improve habitats and access to basic necessities of life. It also stresses the need for radically transforming African agriculture to enable the continent to feed itself and be a major player as a net food exporter. Measures are also put forward to help sustainably manage the continent's rich biodiversity, forests, land, and waters using mainly adaptive measures to address climate change risks.

According to the strategy, if Agenda 2063 is properly implemented, Africa will be able to create a broad-based foundation in agricultural development, including access to production inputs, financing, and enhancing the role of women farmers. Accomplishing this will lead to enhanced agricultural productivity, make local food production competitive enough to replace food imports, and generate surpluses for export, thereby positioning Africa to feed the rest of the world. In so doing, the share of intra-African trade in food and agriculture will increase significantly through broader and deeper continental market integration. This will be facilitated by the establishment of adequate market and trade infrastructure, including transport services, ICT, irrigation, storage and agro-processing facilities, commodity exchanges, market information, and other structured trade facilitation services. These improvements will connect farmers to local, national, and regional markets through a dynamic network of efficient value chains of strategic food and agricultural commodities.

The agricultural transformation will also have resulted in increased commercialization of agriculture and reduction in labour employed in agriculture. The significant value addition in agriculture will drive manufacturing and the structural transformation of African economies. The strategy also argues that improved productivity will result from a modern and productive agriculture

system anchored in a solid science knowledge foundation and build resilient food and agricultural systems with self-financing of agricultural development. Additionally, investments will result in consistent supply of agricultural commodities and attract financial capital to agri-based value chains, which will create employment opportunities. According to the strategy, modernizing agriculture will put an end to human drudgery in agriculture, whereby African agriculture of the future will see the banishment of the hand hoe, and finally render the sector modern, profitable, and attractive to the continent's women and youth.

As the previous paragraphs clearly show, modernizing the agricultural sector is one of the cornerstones of Agenda 2063. This ambition is well aligned with the PARI interventions, which aim to improve agricultural productivity on the continent through innovation research and policy analysis. PARI's innovation research—with future-oriented impact analysis, the identification, stimulation and scaling up of promising technological and institutional innovations, as well as its engagement with food and agriculture policy making—contribute to improvements in food and nutrition security on the continent and directly complement the efforts to achieve Agenda 2063. A review of the proposals and the various annual reports of PARI clearly shows that the research undertakings are well aligned with the African Union priority areas of research and development, as captured by Agenda 2063 framework.

3.1.2. Comprehensive African Agricultural Development Program (CAADP)

In addition to Agenda 2063, there have been several programs and initiatives to support the development of the food and agriculture sector on the continent. Among these strategies the CAADP is the main continental strategy adopted by the African Union in Maputo, Mozambique in 2003. The

CAADP strategy aims to promote agricultural development and reduce poverty to ensure food security on the continent. The CAADP aims to help African countries eliminate hunger and reduce poverty by raising economic growth through agriculture-led development. The program defined agriculture as a main engine of economic growth and called for African governments to allocate 10% of their annual budget to the sector, with a 6% annual growth target.

The CAADP has identified four priority areas:

- (i) Extending the area under sustainable land management and reliable water control systems;
- (ii) Improving rural infrastructure and trade-related capacities for market access;
- (iii) Increasing food supply, reducing hunger, and improving responses to food emergency crises; and
- (iv) Improving agriculture research, technology dissemination, and adoption.

The Program also supports countries to enhance resilience to climate variabilities through the development of disaster preparedness policies and strategies, early warning response systems, and social safety nets.

The Maputo commitments were renewed in 2014 in Malabo, Equatorial Guinea when African heads of state and governments committed to building a climate-resilient African food system. This vision includes ensuring that the continent is prepared to respond to present and future climate variabilities and shocks and providing social protection provisions for rural and vulnerable groups. The Malabo Declaration is now the reference point and measure of commitment for Africa (AUC, 2017).

Among its most notable achievements, CAADP has significantly raised the political profile of agriculture and most countries have signed CAADP agreements.

Nevertheless, reports indicate that only few countries have met the 10 percent Maputo target, despite renewed commitments in 2014 through the Malabo Declaration (AUC, 2020). In addition, while some countries are making positive progress toward the CAADP goals, investments in R&D have not been increased sufficiently.

In view of the above-mentioned goals of CAADP, it can clearly be observed that PARI's research and innovation activities are aligned with the main goals of CAADP. The CAADP thematic priority research areas were central to determining the focus areas of research within the PARI project and were also used as a strong reference framework when PARI was initiated. All the activities of PARI are strongly anchored on the main pillars of CAADP and the selection of the target countries of the PARI interventions are based on those countries with high potential. PARI has focused on those countries that have

- (i) a track record of political commitment to fostering sustainable agricultural growth, as indicated by performance under CAADP,
- (ii) shown actual progress in sustainable agricultural productivity driven by related innovations, as indicated by comprehensive productivity measurement and innovation actions on the ground, and
- (iii) prioritized actions for hunger and malnutrition reduction and showing progress (Husmann et al., 2015).

3.1.3. The Science, Technology and Innovation Strategy for Africa 2024 (STISA 2024)

In addition to Agenda 2063 and the CAADP framework, African countries also formulated a science, technology and innovation strategy to foster agricultural innovations in 2014. STISA-2024 was developed to provide support for agricultural research and innovation on the continent. The Strategy was adopted as the continental framework

for accelerating Africa’s transition to an innovation-led, knowledge-based economy within the overall framework of the broader and long-term Agenda 2063. It is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact across critical sectors.

The STISA-2024 has six priority areas, one of which is the eradication of hunger and achieving food security. Other priority areas are the prevention and control of diseases, communication (physical and intellectual mobility), protection of our space, living together; and wealth creation (AUC, 2014).

The implementation of STISA-2024 will take place at the national, regional, and continental levels. Member states are encouraged to integrate the strategy into their national science, technology and innovation programs. Meanwhile, regional economic communities, regional research institutions, networks and partners are urged to incorporate the strategy when designing and coordinating initiatives. The Africa Union Commission and the NEPAD Agency are expected to advocate and create awareness, mobilize necessary institutional, human and financial resources, track progress, and monitor implementation (AUC, 2014).

The formulation of PARI is also closely related to the main goals of STISA-2024, as outlined above. Both aim to eradicate poverty and hunger and achieve food and nutrition security in Africa. The Program places a strong emphasis on promoting and scaling up innovations as mechanisms to improve agricultural production on the continent. Hence, as in the case of Agenda 2063 and CAADP, PARI is well aligned with Africa’s science and technology agenda.

3.1.4. The Feed the Future Strategy (Dakar 1), Food Sovereignty and Resilience Summit (Dakar 2)

Among other African initiatives to support the CAADP process and meet the visions of Agenda 2063, the African Development Bank’s Feed Africa Strategy for Agricultural Transformation in Africa 2016-2025 is a partnership strategy between African governments, donors and the private sector. The High-Level Conference “Feeding Africa – Achieving an African Agricultural Transformation” (Dakar 1)—which convened in Dakar, Senegal in 2015—recommended that nutrition programs across Africa be scaled up to end malnutrition and hunger and led to the formulation of the Feed Africa Strategy. The overarching aim of the Strategy is to drive inclusive gains in agriculture to sustainably transform the lives of all, including the poorest and most vulnerable Africans. It is intended to add to, and not duplicate, earlier efforts.

The Feed Africa Strategy was developed on the assumption that conditions for agricultural transformation are beginning to materialize in a number of African countries and there is a need for scaling up these localized small-scale transformations if some important conditions are simultaneously created:

- A large-scale dissemination of productivity-increasing technology and inputs, plus input intensity and capital intensity;
- The development of input and output market structures and incentives that allow the full realization of the value of increased production; and
- A well-functioning and vibrant private sector that can manage and allocate skill and capital to scale emergent success and drive long-term sustainable agribusiness growth.

Based on these assumptions, the Strategy renewed the effort to transform African agriculture into a globally competitive, inclusive and business-

oriented sector. These conditions, it is argued, will help create wealth, generate gainful employment and improve quality of life. The vision is anchored to the CAADP as articulated in the Maputo (2003) and the Malabo (2014) Declarations and intends to further contribute to and build on these commitments. The Strategy also echoes the vision set out in the 2063 Strategy for Africa to “consolidate the modernization of African agriculture and agro-businesses.” More specifically, the Strategy plans to execute the CAADP goals of contributing to the elimination of extreme hunger, malnutrition, poverty, and increase prosperity. This will be achieved in partnership with key stakeholders, including farmers, agribusiness, and civil society, while exploiting regional comparative advantages and seizing opportunities for trade and collaboration.

In view of the required resources to transform entire value chains, the Strategy underscores the importance of targeted investment. While in the long run the Strategy aims at strengthening a broad range of value chains, priority will be given to selected agricultural value chains and related agro-ecological zones. Selection will be based on expected future demand, competitive advantages, potential to drive massive increases in productivity, and potential to contribute to broad-based nutrition value chains. The Strategy aims to bring to scale existing and successful interventions across Africa, while further developing the required capacity of actors, including the public and private sectors throughout the system to sustain the positive impacts of these interventions.

As a follow up of Dakar 1, African heads of State convened an action-driven summit on Food Sovereignty and Resilience in Dakar (Dakar 2) in January 2023 and discussed the challenges of rising food prices and the disruption of food supply due to COVID-19, climate change, and the Russia-Ukraine conflict (and its implication on food security in

Africa). Achieving and sustaining food sovereignty requires delivering agricultural technology to farmers at scale, raising food production, and increasing investments in food and agricultural systems. The Summit reemphasized that it is time for Africa to feed itself and fully unlock its agricultural potential to help feed the world. This requires increased investment for raising agricultural productivity, supporting infrastructure, and creating climate-smart agricultural systems. With private sector investments, these supports along the food value chain can help turn Africa into a breadbasket for the world.

The Summit agreed and endorsed the establishment of Country Food and Agriculture Delivery Compacts in collaboration with country stakeholders, development partners, and the private sector to achieve food security and self-sufficiency. It was also agreed that the implementation of the Country Food and Agriculture Delivery Compacts would be supported through time-bound and clearly measurable indicators for success. Examples of supports include concrete national policies, incentives, and regulations to establish an enabling environment for wider and accelerated investments across the agriculture sector and mobilizing and increasing financing from national budgets in line with the Maputo and Malabo Declarations.

In summary, it can be concluded that both Dakar 1 and Dakar 2 summits adopted strong plans for agricultural transformation in Africa. Key actions include scaling up food and nutrition programs across the continent to end hunger and malnutrition, executing bold plans to achieve rapid agricultural transformation across Africa through raising agricultural productivity, and accelerating investments in integrated infrastructure to improve Africa’s competitiveness in processing and value addition to agricultural products.

The review of the Dakar 1 and Dakar 2 Summits clearly shows that African governments have placed a high priority on developing the food and agricultural sector, which are in line with the main or primary goals of PARI. PARI was initiated after carefully reviewing these and many other strategies and programs in order to ensure that it is aligned to the priorities of the continent.

3.1.5. Food System Transformation in Africa

As repeatedly stated, the role of agriculture and the food sector in stimulating economic growth and enhancing the economic transformation in Africa is huge. The previous sections have clearly shown the policy attention given to the agriculture and food sector by African governments. Africa's food systems have begun to transform as a result of rising incomes, expanding middle class, rapid urbanization, a growing population, and digitalization among other factors. As a result, there is a need to refocus the agricultural development agenda under CAADP and other interventions and adopt a food systems lens in Africa, which requires cross-sectoral coordination beyond what was needed for CAADP to achieve the vision of the AU Agenda 2063 and the UN Food System Summit (UNFSS)'s aspirations. Food system transformation is required in Africa in a way that enhances nutrition outcomes, improves livelihoods and protects and enhances the environment.

The UNFSS has provided important moments for shaping the future of the region's food systems and ensuring that the much-needed agriculture-led growth and development agenda can simultaneously deliver on improving nutrition and health, saving lives, and protecting the environment (Badiane et al, 2023). The Food Systems Summit offers opportunities for stakeholders in African food systems to improve the supply of safe and nutritious

food for all while restoring and protecting the degradation of natural resources to ensure sustainability for future generations. African governments need to embrace a food systems approach to policy design and implementation through policies and interventions targeted at food and agriculture trade, infrastructure development, finance, and science and technology for food systems, as well as capacity and skill strengthening.

PARI played an important role in mobilizing African contributions to the UNFSS, which were led by FARA through a consultative process resulting in the statement "One Africa Voice"⁷.

3.1.5. Conclusion

As stated in the various PARI publications, the project was initiated and formulated after a careful review of the major African strategic directions and policy documents to ensure its alignment with African priorities. Accordingly, PARI was initiated based on BMZ suggestions and in accordance with the CAADP strategy, Agenda 2063, STISA-2024, Dakar 1 and 2, the Feed Africa strategy, as well as several regional and national priority areas. In general, PARI was launched to build upon the African continent's established priorities, which include:

1. **Sustainable productivity in major farming systems.** Examples include crops, livestock, aquatic and fisheries, and agro-forestry;
2. **Food systems, value chains, nutrition, and health.** Examples include food security, food processing, food safety, and their nutritional and health improvement effects.
3. **Agricultural biodiversity and natural resource management.** Examples include conserving and enhancing biodiversity, sustainable land and soil management, managing water resources and irrigation, and energy systems;

⁷ Available at <https://sc-fss2021.org>.

4. **Challenges for agriculture and food security.**

Examples include climate change adaptation and mitigation policies, prevention of volatility, and risks.

In particular, the CAADP core thematic priority research areas have been of great relevance for the determination of PARI's research focus areas. Of course, the relevance of PARI's main research themes differs in weight and sub-regional importance and are case-specific depending on location. However, more focus is given to those areas that are relevant for other countries or agricultural ecologies and food systems in Africa and India.

3.2. PARI's Relevance to BMZ's Strategy

PARI was aligned with the German government's Africa Strategy, as reflected in the concept note prepared by the Federal German government in 2011 (Federal Republic of Germany, 2011). The German Africa Policy is based on a realistic assessment of the situation on the African continent and is guided by universal values and interests of the parties. Currently, Germany's relationship with Africa is based on "Shaping the Future with Africa", a strategy that was issued by the Federal Ministry for Economic Cooperation and Development (BMZ) in 2023. This strategy outlines Germany's policy guidelines for Africa.

The "Shaping the Future with Africa" strategy continues to emphasize the importance of fostering a close economic and political partnership between Germany and African countries, based on shared values due to close historical, geographical and cultural ties (BMZ, 2023). The BMZ strategy for Africa also supports the African Union's Agenda 2063, setting out its vision for the continent. Within the framework of German and European policy on Africa, the BMZ Africa strategy pursues the following overarching goals:

- To lend structural support to the achievement of the development goals—as set by the AU and its member states—to enable the continent to unlock its huge potential and become more resilient;
- To work with African partners for a global transformation to ensure that everyone can live with dignity and security in an intact environment; and
- To address crises jointly and visibly with Europe's neighbouring continent in a spirit of solidarity.

According to BMZ's Africa Strategy, there are six main areas of cooperation of which at least two are directly related to the activities of PARI. While all six areas of cooperation are tangentially linked with PARI interventions, PARI's research and policy dialogues have a particularly strong connection to the goals of (i) trade, employment, migration, and digital transformation and (ii) overcoming poverty and hunger and building social protection. The former goal is realized through BMZ's support for African Common Free Trade Area (AfCFTA) and ensuring trade agreements, for public and private investments in infrastructure, for the digitalization of the African economy, and other interventions. Meanwhile, the latter goal is achieved through BMZ's intervention in promoting the development of sustainable and resilient agriculture and food systems, stepping up sustainable consumption and sustainable supply chains, expanding social protection systems, and access to education. All these areas have been among the focus research areas of PARI.

The EU-Africa cooperation on Science, Technology, and Innovation (STI), which intends to strengthen knowledge-based systems and enhance the development of effective solutions for challenges, such as climate change, food and nutrition insecurities, also provides support for innovations in the food and agriculture sector.

Food security, movement towards a world without hunger, agriculture, and rural development are key areas of Germany's development cooperation in which the "One World – No Hunger" initiative plays an active role. Launched in 2014, the "One World – No Hunger" initiative is active in countries where the majority of the population suffers from a high level of hunger and malnutrition (BMZ, 2014). The main goals of the initiative focus on improving the nutrition of children and other vulnerable groups and improving the living conditions of people through the GICs. It aims to accomplish this by sustainably increasing productivity, managing natural resources, and financing agricultural development. In 2021, the "One World – No Hunger" initiative was renamed to become the "Special Initiative for the Transformation of Agricultural and Food Systems". A number of core intervention areas for 2021-2026 that were prioritized in this initiative are directly linked to the main activities of PARI, including Sustainable Agri-Food Systems, Food and Nutrition Security, Rural Development, and Agriculture (BMZ, 2021).

Africa is the focus of the "One World – No Hunger" initiative, as the continent is home to the majority of least-developed countries. India plays an important role in sharing innovations and experiences in policy reform through a triangular partnership with Germany and Africa. This special initiative offers an opportunity to support African countries' commitment to develop domestic food and agricultural sectors and contribute to efforts to reduce poverty- and nutrition-related internal and external migration flows.

Thus, the PARI project complements both the goals of the BMZ Africa strategy as well as the special initiatives of "One World – No Hunger" and the Transformation of Agricultural and Food Systems. The information generated by PARI can assist the BMZ in defining the long-term strategic orientation of innovation centres and help to guide future

investment decisions related to innovation for food security. PARI research has shown that investments in the agricultural sector and food security interventions supported by such initiatives can significantly contribute to the overall economic growth and transformation in Africa. Hence, PARI strongly supports the promotion of Africa-Germany exchanges on innovation and investment for agricultural and rural development and nutrition.

4. PARI's capacity and network building, policy relevance and sustainability

The preceding sections have demonstrated that PARI took form in the wake of a careful assessment of the needs, priorities and development aspirations of African countries, as reflected in various continental strategies, Germany's Africa strategy, and the "One World– No Hunger" initiative. Indeed, PARI has produced several research outputs that have been crucial in addressing core agricultural development challenges on the continent. In this section, we briefly review some of PARI's achievements, the policy relevance of project outputs and capacity building efforts. In addition, we briefly reflect on the sustainability challenges of the project.

4.2. Research outputs of PARI and their policy relevance

PARI has planned and undertaken several research and innovation activities to accomplish the goals set during the different phases of the project's life. Several outputs related to overarching project objectives were produced during this time, including research reports, books, working papers, synthesis reports, policy briefs, and journal articles. In this section, we review some of these major research outputs.

In terms of innovation research activities, PARI has undertaken several thematic research projects under different work packages. In the process, it has generated useful information on the contribution of innovations to sustainable agricultural growth and food and nutrition security. Furthermore, it has helped to assess the state of technology generation and innovation in the target African countries and India. The analysis-based information is supplied to all project stakeholders for potential target-orientated adaptation and policy interventions. Some of the thematic research undertakings of the program and its partners are presented in Table 1.

Studies focusing on food and agriculture policies, production and mechanization dominate the list of studies undertaken by the project over the years. During the first three years, PARI research focused primarily on identifying promising innovations for the agricultural and food sector along the value chains in the respective partner countries, producing several research reports and policy briefs

in the process. PARI also continued work on the identification of promising innovation investments to improve the productivity and resilience of the agriculture and food sector. For example, the project produced several research outputs on employment and income opportunities in rural areas for youth and women, digitalization in food and agriculture, input use and finance for smallholder farmers and small businesses, mechanization, and agroforestry. Table 2, below, presents the number of publications produced by the PARI project on the above and many other topics over the years. As can be observed from Table 2, an impressive 278 publications were produced between 2015 and 2023. Some 70 percent of the publications were in the form of research reports, such as working papers, discussion papers, and other research reports. FARA has published several research reports, which primarily focus on national issues while ZEF, AKADEMIYA2063 and University of Hohenheim published several working and discussion papers, addressing mostly thematic, cross-country and regional issues.

Table 1: Thematic areas covered by PARI studies undertaken between 2015 and 2023

	Number of studies	Share of all studies
Agricultural production (multi-sectoral)	27	10
Agricultural production (crops)	24	9
Agricultural production (livestock and aquaculture)	20	7
Markets and supply chains	18	6
Mechanization	30	11
Digitalization	25	9
Women and youth	20	7
Skill development	18	6
Infrastructure	6	2
Food and agriculture policies	63	23
Climate change	27	10

Source: PARI publications.

While studies commonly address several of these themes simultaneously, only the main theme is indicated here.

Table 2: Types of publications produced between 2015 and 2023

Type	Number	Share
Books	3	1
Journal Articles	43	15
Policy Briefs	35	13
Research Reports ¹	194	70
Others	3	1
Total	278	100

Source: PARI publications

¹ This includes several working papers, discussion papers and other research reports.

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Looking at the publication trend over time, it can be observed that generally the number of publications produced by the project has been increasing steadily. Close to 50 percent of the publications were produced between 2018 and 2020 (Figure 2).

Policy briefs are often prepared to meet the needs of policymakers who may not be familiar with sophisticated analytical procedures and who are faced with shortages of time to read long documents. Accordingly, a significant number of policy briefs focused on different thematic areas and targeted to policymakers were produced by the project (see Table 3). A full list of policy briefs is available in the Annex.

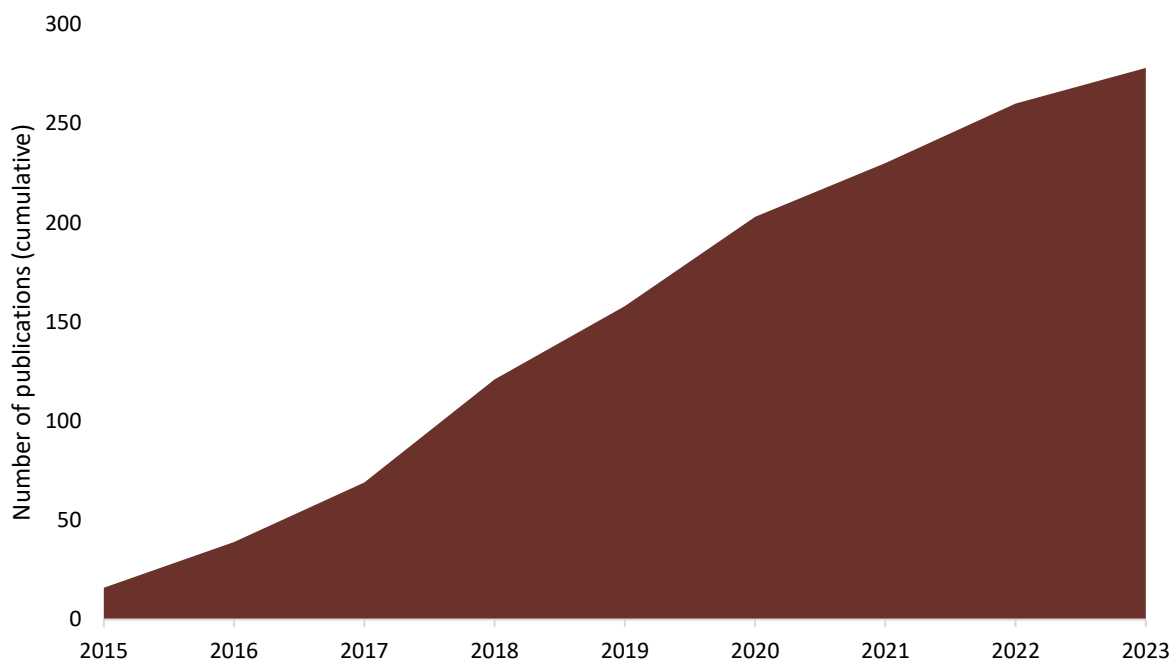


Figure 2: PARI publication by year (cumulative), 2015-2023

Source: PARI publications

Table 3: Themes covered by PARI policy briefs between 2015 and 2023

Themes	No. of policy briefs
Agricultural production (multi-sectoral)	6
Agricultural production (crops)	3
Agricultural production (livestock and aquaculture)	2
Markets and supply chains	8
Mechanization	7
Digitalization	8
Women and youth	4
Skill development	5
Infrastructure	3
Food and agriculture policies	6

Note: Some policy brief cover more than one theme.

As shown in Table 4, some 68 percent of the publications were based on single country studies, while around 32 percent were based on multiple countries. As the focus of the project is on Africa, some 70 studies focused on the continent as a

whole. These scientific publications were produced in collaboration with a range of experts from several countries involved in the project. All the publications were published after going through a rigorous review process to ensure quality.

Table 4: Country coverage of PARI publications

Coverage countries	Number of studies	Share of all studies
Single country	234	68
Multiple countries	41	12
Relevant to all Africa	70	20

Source: PARI publications

4.3. Network and capacity building effects

4.3.1. Strengthening partnerships and networks

From the outset, PARI was established and embedded as a collaborative project with different stakeholders within Africa, India and Germany, building on existing innovation platforms in the selected countries. The program started its operations with the establishment of a core team consisting of German and African partners to lead and coordinate the accompanying research as a consortium, in collaboration with other partners in Africa, India and Germany. Accordingly, a consortium consisting of three German university

departments (ZEF, University of Hohenheim, and TU Munich) and FARA and AGRODEP was formed. The consortium is supported by several regional and national partners from the selected countries.

Initially, PARI started with a strong focus on collaboration with national agricultural research institutes (NARIs), but the network diversified over time due to constraints in research capacities, limited policy reach, and a broadening of the research agenda toward topics where NARIs do not have a comparative advantage. To this end, pan-African/regional research partners as well as universities were added to the network (see Table 5). The list of collaborating institutions is presented in the Annex.

Table 5: Core partners by type of institutions and region (2014-2023)

Type of institution	No. of partners	Region/country	No. of partners
NARI	13	West Africa	11
University	9	East Africa	6
National research institute	5	Southern Africa	3
Regional research institute	4	North Africa	1
Int. research institute	2	Central Africa	1
Network	3	Regional (Africa)	7
		India	2
		Germany	3
		International	2

Source: PARI website

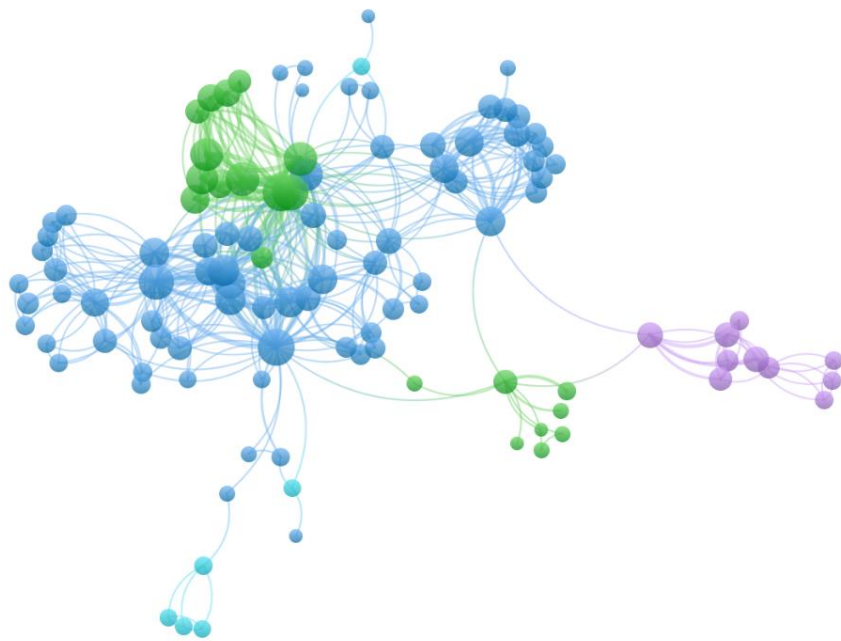
Country-specific research topics and concepts were developed through extensive discussion with partners. These dialogues took into account country-specific innovation research issues in accordance with the BMZ's objective and the various Africa-wide strategies, such as CAADP and S3A. In this way, the process demonstrates a strong partnership framework, with some of the most capable national and sub-regional food and agriculture-related African knowledge networks engaged in agricultural innovation and research across national borders. Hence, the program is relevant for the entire continent.

In fact, during the first few years the primary focus of the project centred on building a productive network among the African, German, and Indian partners, with the aim of facilitating mutual learning and knowledge exchanges on innovation opportunities. PARI achieved good results, particularly with regard to the creation of, and engagement with, a good network in the respective countries and the region at large, where research has been undertaken.

PARI has also engaged with practitioners in the African agriculture and food systems in order to gather their views and share research results. In particular, PARI has organized a series of six farmer

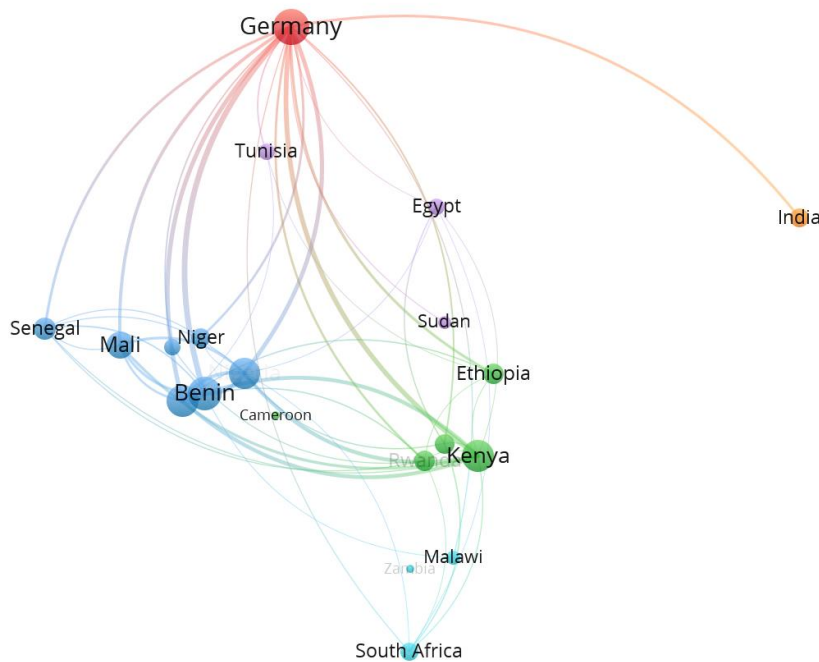
innovation contests where promising, locally-adapted innovations developed by farmers were presented and awarded. PARI has also engaged with farmers' organizations in several research activities. In addition, insights from farmers, agricultural intermediaries, agribusinesses, processing companies, technical training institutes, youth and policy-makers were attained through surveys, focus group discussions, interviews and national policy dialogue. This process offered direct insights into these stakeholders' aspirations, challenges and impacts of innovations.

One of the main strengths and achievements of PARI is the creation of networks between country teams. As Figures 3 and 4 clearly show, the project not only established a solid partnership between Germany, Africa and India, but also facilitated the formation of strong partnership networks within Africa itself. The partner organizations had been given much flexibility when designing their research agendas based on their national development priorities. However, they were encouraged to follow similar or comparable outlines to allow for comparability across countries.



Note: Collaborative research activities among African authors for all publications 2015-2023 (as of December 2023). Dot = author. Size of the dot = number of publications by the respective author.

Figure 3: Research collaboration among African partners



Note: Collaborative research activities between German, African and Indian authors for all publications 2015-2023 (as of December 2023). Authors clustered by countries. Size of the dot = number of authors in each country. Thickness of connections = number of collaborative publications.). Countries arranged by geographical location.

■ Europe
 ■ East Africa
 ■ West Africa
 ■ Central Africa
 ■ North Africa
 ■ Southern Africa
 ■ South Asia

Figure 4: Research collaboration facilitated by German partners

Source: PARI publications. Generated using VOSViewer. Cartography: Heike Baumüller.

Coordinating Partners:



Research Partners:



Figure 5: Core PARI Partners 2014-2023

Source: PARI Annual Reports. A full list of partners is provided in the Annex.

PARI has established a far-reaching network of partners in Africa, India and Germany and has continued to strengthen collaborative engagements to enhance agricultural development and ensure food security throughout all phases of the program (see Figure 5). In addition to the national research partners who have regularly engaged in PARI activities, other experts and institutions are brought in where needed to complement the network’s capacities. New networks have also joined the program, which has further strengthened the research partnership. Between 2014 and 2023 the PARI network of regional and Pan-African institutions that are engaged in research for agricultural innovation and food security has grown significantly; around 75 organizations in 25 countries have directly or indirectly collaborated. In addition, many researchers are not financially supported by PARI, but have actively supported PARI activities by providing advice and institutional support, infrastructure, information, and data sources, as part of PARI’s long-standing networks. This network provides a strong basis to facilitate impact through cooperation and dissemination

across countries. Some of these collaborations have only been on a single or a few studies, but many of the partnerships have persisted over the course of the project, showing long-term engagement.

In addition to collaboration with country partners, some sub-regional organizations, national and continental farmers’ organizations, private operators engaged in input and output markets, and organizations providing extension services are among PARI’s network members. Efforts were also made to link and network members through workshops and joint research development. Moreover, FARA’s extensive network of policy actors in Africa has enabled the program to disseminate its research findings widely and create awareness of PARI’s activities among key stakeholders. The network has also engaged new researchers in PARI activities and fostered linkages between the research community and policymakers.

The expanded and strengthened pan-African research partnerships outlined above have enabled

partner organizations and PARI to produce several comparable research outputs, which have wider relevance beyond national boundaries. The network of researchers from Africa, Germany and India engaged more than 300 researchers between 2014 and 2023 to conduct collaborative research and produce 278 publications by the end of 2023. Table 6 shows the regional distribution of the authors of these publications. Details on the number of researchers from participating countries can be found in the Annex.

As can be seen in Table 6, of a total of 318 researchers—with some 70 percent being from Africa (primarily West and East Africa)—participated in the production of PARI research outputs between inception and 2023. Authors from national agricultural institutes from Benin, Kenya, Nigeria, Ghana, and Senegal constitute the largest number of authors. Over 80 percent of the outputs were published by a core research group consisting of ZEF, FARA, AKADEMIYA2063, and UHO.

4.3.2. Capacity-building interventions

Capacity building was not a primary focus of PARI at the outset. Nevertheless, the project has contributed directly or indirectly to improving the capacity of individual researchers who have participated in the project, as well as the capacity of partner institutions. PARI has engaged extensively

both with senior and junior (i.e., early career) researchers, thus enabling them to share and acquire experience and knowledge by undertaking applied research in the food and agriculture system. Hence, PARI has significantly contributed to the capacity-building of African policy research experts.

PARI has encouraged African research partners to set their own research agenda under the project’s overarching thematic research areas and created a framework for joint collaboration between research partners and members of the core team at ZEF, UHO, AGRODEP and, later, AKADEMIYA2063. This has created an excellent opportunity for senior researchers to share their experience with young researchers and help them to develop their research skills. Interactions between African researchers and their colleagues in German universities and other African countries have enhanced the capacity of these researchers through discussions during meetings, joint implementation of activities, and exchange of literature. PARI has also encouraged and supported a culture of joint publications, including technical reports, policy briefs, refereed journals, and conference papers. The responses from the Key Informant Interviews indicated that the capacity of African research partners has been significantly increased through their participation in rigorous data collection, analysis, and output preparation. Some trainings were also organized on these issues.

Table 6: Distribution of authors of PARI research outputs (2015-2023)

	Number of authors	% of authors
Africa	222	70
<i>East Africa</i>	48	15
<i>West Africa</i>	132	42
<i>Central Africa</i>	12	4
<i>North Africa</i>	11	3
<i>Southern Africa</i>	19	6
South Asia	17	5
Europe	79	25
Total authors	318	

Source: PARI publications (as of December 2023)

In addition, research capacity was also indirectly strengthened in partner African countries through PARI's creation of an enabling environment for conducting research. The NARIs in African countries have weaknesses owing to institutional, infrastructural, and organizational arrangements of the research system. PARI has helped these institutes undertake quality research through the financial grants the program provided and through mentoring interventions. In most African countries, research equipment is not available, individual capacities are weak due to a lack of hands-on-practice, and a lack of access to new knowledge and methods. Thus, sharing resources through linkages and exchange programs is an important capacity-enhancement mechanism.

PARI's capacity-building contribution can also be seen in its collaboration with the African Economic Research Consortium (AERC), since 2019/2020. PARI strengthened research capacity in Africa through

the support it provides to PhD and MSc graduate students who were undertaking thesis research, a key component of research capacity-building. Through this collaboration, PARI aims to contribute to AERC's long lasting efforts to enhance capacity for economic policy research and graduate training in Sub-Saharan Africa. Several AERC-PARI seminars were also organized in which Master's and PhD students from Africa were able to present and discuss their research findings and broaden their network of students working on related topics. The collaboration with AERC has also enabled PARI to build a network of researchers working on issues related to agriculture in Africa.

In addition, the UHO supported a number of Master's students from Africa to conduct their field research related to the PARI key themes.

Table 7 provides the number of students supported by PARI from different African countries.

Table 7: African Students Supported by PARI

	Masters	PhD
Ethiopia	6	3
Cameroon	0	1
Ghana	2	2
Kenya	5	5
Lesotho	1	0
Liberia	1	0
Malawi	3	0
Nigeria	6	1
Rwanda	0	1
Sudan	1	0
Tanzania	3	0
Togo	1	0
Tunisia	0	1
Uganda	3	3
Zimbabwe	2	1
Total	34	18

Source: PARI annual reports

Since 2014, many ZEF doctoral students from Africa were connected with PARI in their applied field research, although their stipends were not financed by PARI. Most of these students have returned to Africa, while others have moved on to international development agencies, such as the World Bank. Financial and academic support has been provided to postgraduate students to undertake research within the thematic areas of PARI. PARI researchers have also been directly engaged with students and faculty members to provide input into research activities, co-publish articles, and participate in training activities.

In addition, PARI has helped the capacity-building efforts on the continent through its engagements with other partners beyond its own core activities. For instance, its engagement in the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) project—in which more than 30 doctoral students were co-coached by African and ZEF staff and professors and supported partly through PARI networks—is a case in point.

4.4. PARI engagement in food and agriculture policy-making

For research outputs to be useful, dissemination to stakeholders (primarily policymakers) through workshops, policy briefs, conferences, and print media is of paramount importance. Policy consultations are important for disseminating research findings and encouraging evidence-based policy reforms on food and agriculture. Reaching out to policymakers engaged at the global, national, sub-regional, and continental levels is expected to contribute to policy reforms related to food and agriculture. PARI promotes and supports evidence-based political dialogues through its own policy dialogue forums, through its participation in existing

processes, and through the dissemination of research findings.

Engaging and organizing policy forums with the African and global food and agriculture policy making system has always been one of PARI's core strategies for enhancing innovation approaches to help improve food and nutrition security. In order to help influence policy reforms and enhance future policy leadership for rural transformation, PARI focuses on close engagement with policymakers, private sector service providers, entrepreneurs, civil society, farmer organizations, and advisory services, through outreach strategies such as organized roundtables and IT-based communications.

Accordingly, PARI has organized several events such as policy dialogue forums, conferences, workshops, and seminars in partnership with its network members. It has also participated in various events in Africa, India, and globally and provided policy advice and input into policy processes based on the research findings of the program. PARI members have taken part and contributed to policy-relevant events in many African countries and at the Pan-African level. Tables 8 and 9 show the number and type of events organized by PARI over the years. The events include side-events, seminars, project meetings, roundtable discussions, and scientific conferences. PARI research results were also disseminated through presentations by PARI team members at external events and through bilateral meetings with German, Indian, and African stakeholders in food and agriculture.

Table 8: Number of events organized by PARI between 2015 and 2023

Year	Number of events	Countries
2015	5	Kenya, Ethiopia, Germany
2016	4	Germany Rwanda, Kenya, Ethiopia
2017	6	Germany, Ghana, India, Côte d'Ivoire, Ethiopia
2018	8	Germany, Benin, Malawi, Canada, Rwanda
2019	4	Ghana, Nigeria, Senegal
2020	2	Online
2021	7	Online
2022	6	Online, Rwanda, Germany
2023	2	South Africa
Total	44	

Source: PARI website

Table 9: Type of events organized by PARI between 2015 and 2023

Event type	No. of events
Side-event to policy forum	17
Research & Dissemination Seminar	14
Project meeting	5
National policy roundtable	4
India-Africa exchange	2
Youth Townhall	1
Scientific conference	1

Source: PARI website

PARI has also participated in and organized side-events at different international meetings between 2015 and 2023. These events focused on different agriculture and food security issues, which aim to advance agricultural growth and food and nutrition security (see Table 10). Some of the high-level events in which PARI actively participated include the annual Africa Food Systems Forum (formerly African Green Revolution Forum), the African Association of Agricultural Economists (AAAE), International Green Week, the International

Conference of Agricultural Economists, as well as relevant African Union meetings. These forums have enabled PARI to engage key stakeholders, including high-level policymakers, development partners and academics, to discuss research activities and develop PARI's work plans. In this way, PARI has also benefited from its multi-actor partnerships with regional and Pan-African institutions that have organized policy forums and platforms in different countries.

Table 10: Side events organized by PARI at international events

Year	Event
2015	29 th International Conference of Agricultural Economists ReSAKSS Annual Conference 2015
2016	International Green Week 7th Africa Agriculture Science Week 5th International Conference of African Agricultural Economists
2017	International Green Week African Green Revolution Forum 2017 COP23 Conference in Bonn
2018	International Green Week 30th International Conference of Agricultural Economists African Green Revolution Forum 2018
2019	African Green Revolution Forum 2019 6th International Conference of African Agricultural Economists
2020	Cultivate Africa
2021	UNFSS – Science Day
2022	African Green Revolution Forum 2022
2023	Africa Agribusiness and Science Week 7 th African Conference of Agricultural Economists

Source: PARI website

PARI's consortium members are often invited by decision makers to share their insights on innovations in the agri-food sector. Since its inception, PARI has continuously engaged policymakers and experts involved in the "One World – No Hunger" initiative and provided significant advice and recommendations to BMZ on the focus of German investments in food and agriculture. PARI staff have regularly engaged with BMZ through participation in the SEWOH initiative advisory body (which meets several times a year), monthly meetings with BMZ and GIZ/GIC senior management (in the early years of the SEWOH), and regular bilateral communication with BMZ senior management. PARI has also provided insights to inform the development of BMZ's programmatic strategy through the submission of strategy documents. This close engagement also facilitated high-level involvement of BMZ in the African Green Revolution Forum 2018, including a speech during

the opening plenary by the BMZ Commissioner of the "One World – No Hunger" initiative and an MOU signed with AGRA on the sidelines of the event.

PARI has also participated in the GIC network meetings while the GICs were being formed. In addition to participating in these events, PARI researchers visited several countries with GICs in Africa and India to better understand the reality on the ground and to link the crucial organizations of the innovation systems of the countries with the GICs.

PARI research was cited in most reports of the Malabo-Montpellier Panel (the leading agricultural think tank in Africa) and PARI team members were often actively engaged in the development the reports (see list of References). Through the PARI director, the project's research regularly flowed into the MaMo discussions and events.

4.5. Outreach and media engagements

Having proper communication channels is also critical to disseminating research findings to stakeholders, including policymakers. Both print and electronic communication channels are important to reach out to intended audiences. PARI's outreach activities use a multi-pronged communication strategy, which includes dissemination of key research findings via the publication of study reports, policy briefs, press releases, and opinion pieces, which are also published on partner websites and distributed through social media channels. Zoom meetings, emails, and personal physical meetings are frequently used to communicate with partners.

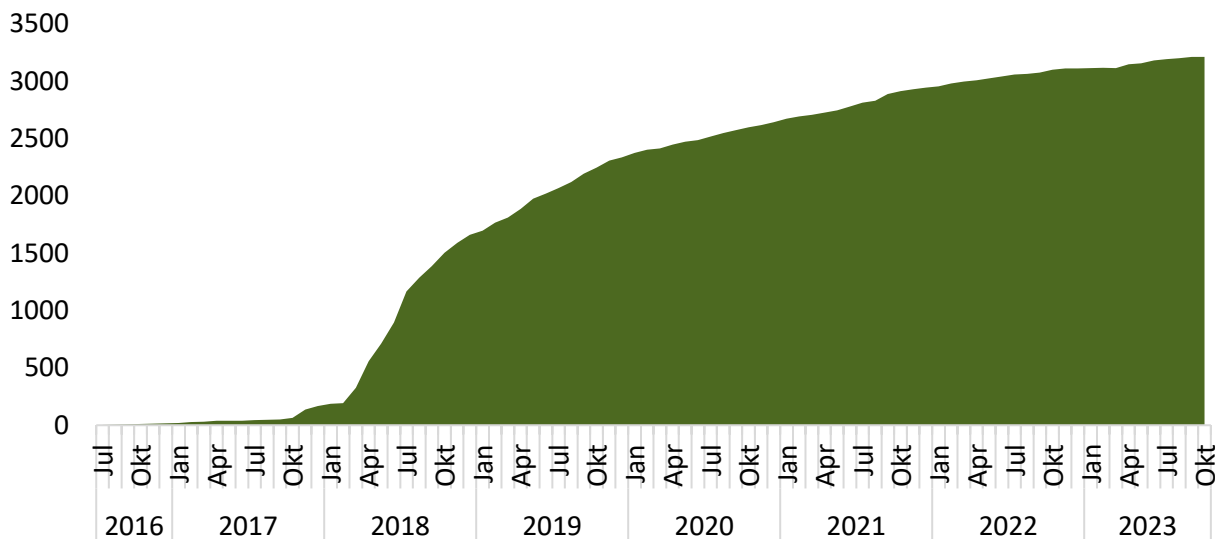
As pointed out earlier, PARI has produced several publications and printed materials and disseminated them through its different communications channels. Various communication channels have been used in this project, including project inception workshops, midterm and end term project workshops, and other meetings within and between key stakeholders. In addition, side events

at international conferences were also organized to help communicate research results.

Web-based communications are also actively utilized by the project. The PARI website (research4agrinnovation.org) is a modern platform that hosts a large number of publications, events and news. The website was re-designed in 2022 to increase usability and facilitate access to the PARI research findings. The website was optimized for use on mobile phones, which is the main channel for accessing the internet in Africa and India. The homepage was modernized and re-structured to highlight recent publications and tweets, upcoming events, and the PARI Newsletter. The filter was improved to allow users to more easily search by theme, author, or date. Additionally, an interactive map was included where users can access all PARI research related to a particular country.

In addition to the PARI Website, PARI has used its own X/Twitter account to disseminate research outputs and advertise events. The number of followers of PARI X/Twitter accounts has grown exponentially over the years due to the development and implementation of an engagement strategy with posts (see Figure 6).

Figure 6: PARI followers on Twitter (2016-2023, cumulative)



Source: Twitter statistics

PARI also enlists the help of partner organizations to support the dissemination of its findings through their social media channels in order to reach a wider audience. In particular, FARA's X/Twitter account, Facebook account, and DGroups played a critical role in reaching out to key African stakeholders. FARA's DGroups have almost 40,000 members across Africa, while its X/Twitter account is followed by over 33,500 users. Meanwhile, FARA's Facebook page and LinkedIn page had around 77,000 and 27,000 followers in 2023, respectively. The FARA website provides another important avenue for dissemination, attracting over half a million visitors ever year.

4.6. Project management

Having a sound management system is an important component of any project. The project is managed by a project director and an overall project coordinator on the part of ZEF as well as a project coordinator for Africa based at FARA. Overall, it is ZEF which has been the major initiator of the program and has provided the leadership services during much of the program's lifetime. Since several African countries are involved in this project, the activities in each country are coordinated by FARA. Contractual agreements with partners in each country are mainly initiated by ZEF, FARA and to a lesser extent UHO and AKADEMIYA2063. In addition to the institutional partners of ZEF, there are several country-based researchers, as well as researchers from the consortium partners who are actively involved in the project. In general, research agenda setting based on PARI's thematic focus areas is usually done collaboratively between ZEF and the African partner institutions. Since the NARIs in Africa are the main partners in this project, the country's priorities could easily be aligned with the national priorities.

There has also been a division of labour in terms of who should lead research clusters. For instance, ZEF

was leading the digitalization cluster, while FARA led the youth cluster, and the University of Hohenheim led the mechanization cluster during phase three of the project. The thematic issue within each cluster is developed in consultation with each cluster member. In this way, better integration of objectives and thematic research areas has been created.

With regard to required staffing at the different locations, it can clearly be seen that there has been adequate financial provision for technical and administrative staff as well as for operational activities. Thus far, funds have been properly utilized for the intended purposes. Out of the total budget, more than 52 percent was disbursed for African and Indian partners while the remaining balance (48 percent) was spent to support the German partners. Well experienced full-time researchers as well as administrative experts were recruited for this project within each partner organization.

4.7. Policy relevance and sustainability of PARI

PARI is an innovative and a highly relevant intervention for the African continent. The goal of the project is to improve the productivity of the agriculture and food sector, thereby providing healthy, safe and nutritious food for a growing population. At the same time, the project aims to provide helpful information to supply feed for farm animals and furnish fibre, fuel, and other bio-based products for a range of industrial uses. In addition, agriculture must also use resources more sustainably to preserve available land, water, and biodiversity resources, and respond to climate change. To meet these challenges and respond to opportunities, the sector will need to embrace new and innovative approaches to improve productivity in a sustainable manner, including agro ecological practices which PARI is responding to.

Innovation is key to improving productivity, sustainability, and resilience in the food and agriculture sector. The future of food and agriculture in Africa depends on the capacity of agricultural innovation systems to provide farmers with innovations that address an increasingly diverse and complex range of needs. This includes improving farm productivity and environmental performance, as well as better responses to climate change. Investments in research and innovations in the agricultural sector are needed to sustainably increase productivity and ensure food security, while maintaining environmental quality and resources. However, despite the strong and growing political support for innovations in agriculture through, for instance, the STISA-2024, investments in R&D have not increased sufficiently. Therefore, PARI, which focuses on innovation investments, is an extremely relevant and timely intervention for Africa.

The selection of PARI's thematic research areas is based on the needs of African countries engaged in the project. The project was initiated as partnership initiative between the African countries and Germany and harmonized with Africa's own development agenda. A strategic area of collaboration focuses on results-oriented investments that have a high potential for scale up, as they can achieve maximum impact when harmonized with the existing African initiatives. PARI mostly works on contemporary topics with major policy implications; it follows a value chain and food systems approach. The project identified partner countries based on their past track record of political commitment to foster agricultural production as well as the actual progress they made; selection was also based on a country's commitment to reduce malnutrition and hunger in their respective countries. Most of the partners in Africa are either research institutes with a strong agricultural component or national research organizations. Selecting these types of partners

enabled the creation of a sense of cooperation and understanding between the partners and facilitated outreach to policymakers. Thus, one of the unique strengths of the PARI project is the establishment of a strong collaborating framework (network) between Africa, India, and Germany. The work plans are prepared in consultation with national and regional partners in order to be in line with national and global priorities. In this way, PARI is highly relevant from these perspectives.

Another strength of PARI is its collaboration with existing institutions on the ground such as FARA, a pan-African institution and the technical arm of the African Union, and NARIs. This has significantly reduced the transaction cost of finding new partners. Because FARA operates in collaboration with NARIs in different African countries, it is well positioned to identify the needs of African partners. While ZEF can focus on global and strategic issues, FARA can focus more on national and continental issues. This is another advantage that the project brings.

The project's analytical capacity created by the collaboration is a unique strength of the program, as demonstrated by the number of countries involved, the kind of institutions it engages, and the quality of its outputs. The project outputs are relevant and are, in most cases, of good quality, since they undergo an internal and external review process to ensure quality. Core project staff in all partner organizations are highly educated, have good research experience, and are people who have been collaborating with ZEF on many previous occasions.

Sustainability of a project after the project funding is exhausted is an important measure of the success of any project. The fact that this project has been so collaborative is illustrated by the fact that the agenda setting was done by the partner countries, based on their own specific needs. This would mean that the project will build the capacity of

participating organizations to undertake similar research on the topic of innovation in the future, either on their own or in collaboration with new partners. The KII indicated that partner's participation in the PARI project has contributed to their research capacity and enabled them to acquire new research projects and partners (funders). Thus, PARI will have a long-lasting impact as it has strengthened the capacities of the involved researchers (both German and African), thus enabling them to contribute applied research on sustainable agriculture in Africa in the future. The KII indicated that PARI will also have a long-lasting impact as it has strengthened collaboration between German and African partners, which will continue even after the end of PARI.

Because PARI involves several agricultural industry stakeholders—such as ministries of agriculture, NARIs, and universities—which are responsible for agricultural innovation and diffusion, it helps to push the research and development agenda initiated by the project. Again, the information obtained from the KII clearly showed that collaboration interests between researchers and policymakers have increased. The project has increased the appetite for evidence in the policymaking process and, in so doing, created stimulus for further research in the future. PARI has demonstrated the need for a collaborative engagement between research and policymaking and ensured ownership sentiment beyond the life of the program by involving the implementing institutions.

One of the aims of PARI is to scale up promising innovations developed in one context to other similar cross-country contexts. There is an increasing demand for such information as continental strategies, such as the African Continental Free Trade Area (AfCFTA), begin to be implemented. Thus, the stimulus created by PARI will be highly relevant, which ensures its sustainability.

Finally, some partner institutions have indicated that they will continue working on some of the thematic research areas initiated by PARI. For instance, AKADEMIYA2063 indicated that the results will continue to be used for policy engagement and dialogues in all its events. AKADEMIYA2063 would like to continue working in the same areas where PARI used to provide support through other options and opportunities.

Overall, PARI accomplished most of the goals it set out to achieve.

- First, the commitment of most of the partner organizations is highly commendable. It clearly shows that a partnership agreement works well in most cases.
- Secondly, most of the staff involved in the project have the necessary background and relevant competence for the project. They are all well trained and committed to deliver results.
- Thirdly, the support of the funding body has been instrumental in achieving the goals and is extremely appreciated by all stakeholders.
- Finally, the project is, in general, well managed and the necessary logistical support has been provided by the project leadership. Some also feel that PARI has a multiplier effect on other activities undertaken by partners.

4.8. Areas for further consideration

The preceding sections have clearly presented the achievements of PARI over the last several years. Examples of the projects outputs include the provision of support for the African food and agriculture system through applied research interventions, capacity building, networking and policy recommendations. While the achievements of the program are indeed commendable, there are some areas that require more careful attention when planning follow-up activities. In this section we will try to point out and enumerate some of the issues that require further consideration:

- a. Initially PARI started its operations in 12 countries with the collaboration of national partners, particularly the NARIs. However, some of these countries were dropped from the project as they did not produce the expected results on time and with the right level of commitment, partly because they have weak institutional capacity. Finding a good research partner with the required capacity and commitment is critical for the success of such projects. Many NARIs in Africa are known to have serious systemic challenges in terms of human, financial and physical capacity. They are underfunded and understaffed and project staff often have too many commitments and assignments in addition to their commitments to PARI. Naturally, this reduces their effectiveness and efficiency. Thus, in the future a careful assessment of the capacities of partner organizations should be seriously considered before including them in the project.
- b. Working with continental and sub-regional organizations would be useful, as this will reduce transaction costs and have significant political implications. However, the capacity of African continental institutions is not very strong, as they do not have much analytical capacity or the political power to enforce their messages across the different countries. As pointed out earlier, FARA is the anchor organization that coordinates the activities of PARI on the African continent. Since FARA is a continental organization responsible for agricultural research, it is well positioned to provide technical advice when sub regional and continental policy issues are formulated. Indeed, FARA has played a significant and catalytic role in fostering research and innovation in the agricultural and food systems, as well as facilitating the operations of PARI on the continent. Nevertheless, like any other organization in Africa, FARA's capacity to coordinate are also limited. Its coordination capacity with national organizations and its supervision role have been excessively overstretched. Some coordination challenges are also visible between project leaders in Germany and FARA and country teams as well. If country teams are not delivering the results on time, then FARA will be put in a difficult situation. Accordingly, it might have been better to also engage more sub-regional organisations, universities and think tanks rather than depending only on FARA to play a coordinating and catalytic role. Thus, a proper balance between working directly with country teams and regional and sub-regional organizations need to be designed. Engaging continental organizations will have significant symbolic value and political implications, but working directly with country teams could be more effective in delivering results (although that might increase transaction costs). In short, broadening the scope of engagement with other innovation centres, such as universities, academies of sciences, think tanks and sub-regional organisations would be more useful.
- c. As reflected in the project title, PARI is an "accompanying" project to expand and support the Green Innovation Centres in Africa as they could have been among the channels to reach out to national stakeholders. In fact, one of the overarching objectives of PARI was to scale up promising innovations. However, there has been very little interaction between PARI and the Green Innovation Centres, partly because of weak commitment on the part of the Centres. Nevertheless, PARI coordinators have argued that the project has been working on most of the thematic areas of the Centres although the formal engagement was weak. Whenever research topics are identified within the PARI program, reference is usually made to the thematic areas of the GICs. Therefore, in terms

of content, PARI has addressed most of the thematic focus areas of the Green Innovation Centres. In addition, they indicated that PARI has considered a broader scope in its engagement with NARIs, to which the GICs belong. Thus, PARI aimed to reach out to the GICs through the NARIs rather than restricting itself to only value chain-based Green Innovation Centres.

- d. Informing and encouraging policy-makers in Africa to use evidence produced by PARI in their policy formulation process has been among the main objectives of PARI. The idea of partnering with FARA was also to enable PARI to reach out to sub-regional and continental policymakers in Africa. In order to facilitate this process, some roundtable discussions and side-events have been undertaken and several policy briefs were produced. However, it is not clear whether they have made significant differences in the policy process in Africa. The efforts made thus far to use PARI outputs in the discussion of sub-regional and continental agendas is not yet visible. Indeed, several efforts were made to create awareness about PARI research outputs to African policymakers at different African scientific community forums. Examples of these outreach initiatives include activities with the Malabo-Montpellier Panel and African contributions to the UNFSS (as noted above). The project assumed that the African partners, including FARA and the NARIs, would be well positioned to disseminate the results of PARI research outputs and touch base with national policymakers. However, the KIIs show that some feel that this effort has not been very satisfactory. FARA and country teams could have been more proactive in engaging African policymakers including African Union Commissioners, in a more sustained and institutionalized manner. But it should be noted that it would be inappropriate for the PARI

leadership to take a more aggressive role in the African policy communication endeavour. Similarly, the efforts to engage German policymakers were also inadequate, although engagements with BMZ were effective. Thus, more sustained efforts could have been made to reach out to African and German policymakers by the PARI project leadership. In this regard, developing a well-developed and targeted communication strategy would have been more effective.

- e. In addition to having strong science capacity, the success of any project like PARI depends on the presence of a favourable and conducive social and political environment. In addition, unwavering support for national agricultural development is also very important. In this regard, PARI has been challenged in some cases because of unstable and weak political support for agricultural development, internal conflicts and challenges associated with the COVID-19 pandemic. The adverse economic effects of COVID-19 hampered some of the opportunities. Thus, mitigation strategies for such risks need to be considered in the future.

5. Suggested themes for PARI 2.0

As repeatedly indicated in the preceding sections, the agriculture and food sector is at the heart of the economies of almost all African countries. This strategic role of the sector is well articulated in the various continental documents and agriculture is prioritized as an integral part of the development process on the continent. Indeed, there are growing opportunities for accelerating growth of the agriculture sector through innovations, investments and market developments, which are now increasingly supported by African governments, development partners, and the private sector. Vibrant agri-food-systems and institutions engaged in the production and consumption of food, are key

to the delivery of the continent's development agenda and the UN Sustainable Development Goals (SDGs).

While the various continental strategies have well documented the importance and strategic role of the agriculture and food sector, progress towards meeting the goals set in the various strategies need acceleration. Although the various programs and policies have led to some progress in the fight against food and nutrition insecurity, Africa continues to depend heavily on food imports, worth about US\$60 billion per year (UNCTAD, 2020). This shows that the African market holds great potential for the agriculture and food industries. The prevalence of undernourishment and food insecurity is also still at an unacceptable level and the expansion of food production helps to reduce the high costs related to malnutrition. Hence, continuing the focus on food and agriculture and an explicit targeting and consideration of hunger and malnutrition in the continent is an imperative.

The African food and agriculture system is also transforming, inducing changes in the demand for food and dietary habits, due to many factors including a rising income, rapid population growth, urbanization, as well as digitalization effects. These factors will have significant impact on food production, distribution, and allocation efforts. These shifts are influenced by a variety of external challenges including climate change, environmental degradation, low adoption of new technologies, a growing energy deficit, rising resource-scarcity, limited financial resources, socio-economic shocks, migration, and youth unemployment (Badiane et al, 2023). New initiatives like the AfCFTA offer additional opportunities for the development of food systems, including diverse livelihoods across the food system and the provision of safe and nutritious food to all on the continent using its own resources and reducing the reliance on imports and development assistance. Hence, there is a need to

refocus the broader agricultural development agenda in Africa, such as the CAADP framework and Agenda 2063, to adopt a food systems lens. Science, technology, and policy innovations offer many promising opportunities for food system transformation in Africa in ways that could protect resources, provide livelihood opportunities, and improve incomes across the system, while delivering more nutritious and healthy diets. For Africa to realize its full agricultural potential to bolster its food systems, there is a need for increased investments in key productivity-enhancing innovations to harness science solutions for growth. This is an area in which PARI has made immense contributions.

It has been well documented in the preceding sections that PARI had added significantly to our understanding of the agriculture and food system in Africa. While the contributions are immense and commendable, there are still several challenges that confront the food and agriculture sector in Africa. Hence, a renewed and continued engagement with African partners is imperative. Moreover, new challenges and issues affecting the African food and agriculture sector are emerging. The increasing appetite for Africa's arable land to produce and contribute to global food security is one such important trend. This potential is threatened by climate change, which is already impacting the fragile agri-food system, demonstrating a need for increased investment in the agriculture and food sector. There is still a need for strengthening production fundamentals such as research and innovation to direct how Africa should leverage its production resources.

The experience gained in the previous project period with regard to collaboration and partnership research has shown that this model is indeed useful for bringing about meaningful results in an efficient manner. Accordingly, PARI 2.0 might need to continue working on some of the issues that have

been started in the current phase to further strengthen and cement their scientific contribution and also embark on few selected new research areas. The key informants in this study were requested to propose the themes they would like to see addressed in the next phase of PARI. The following are some of these suggested themes. The list is categorized into two groups: (i) themes from the current phase that PARI needs to continue working on and (ii) themes that may be new.

Themes to be continued from the current phase

- Mechanization along the value chain;
- Inputs (seed, fertilizer) and finance for smallholders and rural small businesses;
- Digitalization in food and agriculture/ artificial intelligence, and robotics as drivers of change in agriculture;
- Socio-economic aspects of animal husbandry;
- Agroforestry;
- Employment/income, skills, youth and women;
- Food security, resilient systems, and climate adaptation and mitigation;
- Market integration and smallholder commercialization;
- Gender and women empowerment; and
- Nutrition and livelihood security.

Potentially new themes

- Conflict and governance in rural areas;
- Policy reform in agriculture;
- Sustainability / climate change adaptation/ climate smart agriculture;
- Impact evaluation studies;
- Green energy and innovations in climate smart agriculture/ harnessing of solar and wind energy for agricultural production;

- Rural infrastructure investments; and
- Operationalization of African regional trade integration initiatives.

Indeed, the list of topics that need to be addressed is extensive. As the capacity of PARI, like any other project, is limited, it will be difficult to address all the above issues. Nevertheless, some priority areas must be identified, given the scope and limitations of the project. Accordingly, we would like to propose that special attention be given to issues such as agricultural production for food and nutrition security, climate change and agriculture, natural resources management, rural green energy, and digitization in agriculture. Clearly, the African agricultural sector must play a key role if the food security and nutrition targets are to be met. This is both because of its function in the supply of raw food products and because it still employs a large share of the African population. To realize its potential, the sector must aim beyond merely increasing production and productivity, to capture synergies (and reduce trade-offs) between nutrition, health, and food production—including intersections with the fields of health, water, and sanitation (Gerber et al., 2019). In the context of climate change, rapid demographic growth, youth unemployment, migration, urbanization and international pandemics, as well as technological advancements, resilience in the agriculture and food system is particularly relevant for Africa. PARI 2.0 could support and significantly contribute to the efforts to strengthen capacity platforms including universities, NARIs, public, private and civil society actors, as well as producers and consumers.

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Annexes

Annex I: List of Key Informants

Joachim von Braun, ZEF, Germany
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Felister Makini, KALRO, Kenya
Alpha Kergna, IER, Mali
Mark Koir, AERC, Kenya
Aly Mbaye, UCAD, Senegal
Regina Birner, Uni Hohenheim, Germany
Thomas Daum, Uni Hohenheim, Germany
Tigabu Getahun, PSI, Ethiopia
Stefan Schmitz, Former BMZ Commissioner One World – No Hunger, Germany

Annex II: Key Informant Interview Questions

Dear -----,

As you know the Program of Accompanying Agricultural Research for Innovation (PARI in short) has been initiated and implemented since 2014 with the aim of contributing to sustainable agricultural growth and food and nutrition security in Africa and India. Over the last few years, in collaboration with partners like you, the project has undertaken several innovative research projects, organized different policy workshops and conferences and actively engaged policy makers and researchers in several African countries and India. With the aim of taking stock of what it has achieved during the current phase, the project is now interested to review its past performance. The outcome of the review will also be used as a critical input for the development of a proposal for the next phase of the project.

As an active partner who has been actively participating and closely following the activities of the project, we feel that your opinion and reflections on the successes and challenges as well as the areas on which the next phase should focus are critically important. To that effect we have prepared few questions to get your reflections and suggestions. Given your rich experience in the project and insights, we strongly believe that your suggestions and feedbacks will be highly relevant and useful.

We thank you in advance

1. In your opinion, to what extent is the PARI project aligned to African priorities? Please explain.
2. Is the overall project design and research topics relevant to the specific needs of African agricultural and food system as reflected for example in CAADP, Science Agenda, Agenda 2063, Dakar 1 and 2 conferences of the AU etc.? Do you see any gaps? Please explain

3. In your opinion, did the research focus and project activities changed over time? Please explain
4. Are the PARI research activities aligned with changing policy priorities over time?
5. In your opinion, did the PARI project strengthened research capacities in Africa? Please explain
6. In your opinion, what were the challenging factors that have constrained PARI's effectiveness?
7. What are the prospects for the sustainability of the results produced by PARI activities? Do you see any risks? Please explain
8. What lessons can be learned from policy-focused, partnership-based research projects like PARI?
9. In the context of Africa, which research areas should be the focus of the next phase of the project?

Annex III: PARI core research partners

Organisation	Location	Focus of engagement			Type of institution
		Research	Policy outreach	Capacity building	
Coordinating partners 2014-2024					
Center for Development Research (ZEF), University of Bonn	Germany	x	x	x	University
Forum for Agricultural Research in Africa (FARA)	Ghana (pan-African)	x	x	x	Reg. research institute
AKADEMIYA2063	Rwanda (pan-African)	x	x	x	Reg. research institute
Indian Council for Research on International Economic Relations (ICRIER)	India	x	x	x	Nat. research institute
University of Hohenheim	Germany	x	x	x	University
Regional / international research partners					
African Growth and Development Policy Modeling Consortium (AGRODEP) by AKADEMIYA 2063	Rwanda (pan-African)	x			Network
African Economic Research Consortium (AERC)	Kenya (pan-African)	x	x	x	Network
Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle (AGRHYMET)	Niger (West African)	x	x		Reg. research institute
BioInnovate Africa	Kenya (East African)	x			Reg. research institute
World Aquaculture Society Africa Chapter	South Africa (pan-African)	x			Network
International Food Policy Research Institute	International	x	x	x	Int. research institute
International Livestock Research Institute	International	x	x	x	Int. research institute
National research partners in Africa, India and Germany					
Agricultural Research Council of Nigeria (ARCN)	Nigeria	x	x		NARI
Centre de Suivi Ecologique (CSE)	Senegal	x	x		Nat. research institute

CSIR Science and Technology Policy Research Institute (CSIR-STEPRI)	Ghana	x	x		NARI
Department of Agricultural Research Services of Malawi (DARS)	Malawi	x	x		NARI
Initiative Prospective Agricole et Rurale (IPAR)	Senegal	x			Nat. research institute
Institut d'Economie Rurale (IER)	Mali	x	x		NARI
Institut de L'Environnement et de Recherches Agricoles (INERA)	Burkina Faso	x			NARI
Institut de Recherche Agricole pour le Development (IRAD)	Cameroon	x			NARI
Institut National des Recherches Agricoles du Bénin (INRAB)	Benin	x			NARI
Institut National de Recherche Agronomique de Tunis (INRAT)	Tunisia	x			NARI
Institut Sénégalais de Recherches Agricoles (ISAR)	Senegal	x	x		NARI
Institut Togolaise de Recherche Agronomique (ITRA)	Togo	x			NARI
Kenya Agricultural and Livestock Research Organization (KALRO)	Kenya	x	x		NARI
Lilongwe University of Agriculture & Natural Resources (LUANAR)	Malawi	x		x	University
Makerere University – College of Agricultural & Environmental Sciences	Uganda	x		x	University
National Agricultural Research Organisation (NARO)	Uganda	x			NARI
Policy Studies Institute (PSI)	Ethiopia	x	x		Nat. research institute
Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)	India	x			Nat. research institute
Université Cheikh Anta Diop de Dakar (UCAD)	Senegal	x		x	University
University of Addis Ababa	Ethiopia	x			University
University of Ghana – Institute of Statistical, Social and Economic Research (ISSER)	Ghana	x		x	University
University of Nairobi – School of Computing and Informatics	Kenya	x		x	University
Zambia Agriculture Research Institute (ZARI)	Zambia	x			NARI
Technische Universität München	Germany	x		x	University

Annex IV: Number of authors by country of origin

Country	no. of authors	% of authors
Germany	72	23
Benin	30	9
Kenya	30	9
Nigeria	22	7
Ghana	22	7
India	17	5
Senegal	20	6
Ethiopia	14	4
Cameroon	12	4
Mali	11	3
Burkina Faso	10	3
Tunisia	10	3
Niger	10	3
Togo	8	3
USA	0	0
Rwanda	8	3
Zambia	4	1
Malawi	4	1
South Africa	3	1
Uganda	2	1
Austria	2	1
Netherlands	2	1
Sudan	2	1
Finland	2	1
United Kingdom	1	0
Egypt	1	0

Annex V: Countries covered in the publications (numbers)

Relevant to all Africa	71
Benin	24
Burkina Faso	13
Cameroon	6
Chad	1
Côte d'Ivoire	2
Djibouti	1
Egypt	2
Eritrea	1
Ethiopia	31
The Gambia	1
Ghana	30
India	18
Kenya	41
Malawi	11
Mali	27
Mauritania	1
Mozambique	2
Niger	4
Nigeria	31
Rwanda	2
Senegal	7
South Africa	2
Sudan	3
Tanzania	6
Togo	7
Tunisia	10
Uganda	6
Zambia	24
Zimbabwe	1

Note: Some studies cover multiple countries.

Annex VI: List of PARI Policy Briefs

- No. 1: Strategic Directions for Development Collaboration for Food Security and Agricultural Growth in Sub-Saharan Africa
- No. 2: Farmer Innovation Contest. Tapping the Innovative Potential of Smallholder Farmers
- No. 3: Sustainable Intensification Strategies for the Rural Poor
- No. 4: Agricultural Innovations at the Technological Frontier in India
- No. 5: Smallholder Agricultural Mechanization in Africa – Addressing governance challenges of state- and market-led mechanization efforts
- No. 6: Improving Employment Prospects for Africa's Rural Youth – Harnessing the potential of the agriculture sector for long-term job creation
- No. 7: How to develop Knowledge and Skills for Mechanization in Africa – Historical examples from the United States and Germany
- No. 8: Doubling the Maize Yield in Africa Through Better Crop Management – Results from a crop simulation model to inform policy and research
- No. 9: Innovation for Sustainable Agricultural Growth in Africa – Insights from Research Dossiers on 12 PARI Partner Countries
- No. 10: Innovations to Overcome Increasingly Complex Problems of Hunger
- No. 11: Realizing the Potential of Digital Technologies for Agricultural Development in Africa
- No. 12: Small-Scale Irrigation Potential In Sub-Saharan Africa – Targeting investments in technologies, locations and institutions
- No. 13: How to Keep Tractors Running in Africa? – Lessons for knowledge and skills development from Zambia
- No. 14: Foreign Direct Investments In Africa's Food And Agriculture Sector – How understanding and channeling FDI better could unlock a powerful development tool
- No. 15: Seed System Development: Fertile Grounds in Sub-Saharan Africa – Identifying Options for Sustainable Development
- No. 16: Improving Energy Access in Rural Areas – How to incentivize the transition to modern energy solutions in rural India
- No. 17: Improving Protein Nutrition of Dairy Cattle in the Tropics – The case of East Africa
- No. 18: Mechanizing African Agriculture – Drivers, Barriers and Benefits
- No. 19: Leveling the Playing Field for Women in African Agriculture – Interventions to address gender-based inequalities
- No. 20: What are the Effects of Agricultural Mechanization? A case study from Zambia
- No. 21: The Forgotten Agriculture-Nutrition Link– Estimating the energy requirements of different farming technologies in rural Zambia
- No. 22: Can Mobile Money Facilitate Cash Transfers to Farmers and the Rural Poor in the COVID-19 Context?
- No. 23: Like Uber for Tractors? How to strengthen the rural sharing economy in India and Africa
- No. 24: Emerging Impacts of COVID-19 on the South African Food and Beverage Manufacturing Sector
- No. 25: Emerging Impacts of COVID-19 on the Nigerian Food and Beverage Manufacturing Sector
- No. 26: Emerging Impacts of COVID-19 on the Kenyan Food and Beverage Manufacturing Sector
- No. 27: Covid-19 causes unprecedented Migrant Crisis in India – Assessing the impact of lockdown measures on migrant workers during the first wave of Covid-19
- No. 28: Resilience of Africa's Food and Beverage Manufacturing Sector – Evidence from the Covid-19 Pandemic
- No. 29: Towards a Digital One-Stop-Shop for African Producers? Strategic Decisions of Digital Agricultural Platform Providers
- No. 30: Comparing African Countries and Indian States. Lessons for promoting agricultural growth, employment and food security
- No. 31: Made in Africa - How to make local agricultural machinery manufacturing thrive?
- No. 32: Building digital bridges in African value chains. Use and impact of digital technologies among agricultural intermediaries
- No. 33: Mechanization and automation in Africa's agroprocessing sector: Implications for employment and skill needs
- No. 34: Farming for Fish – Success factors for expanding Africa's aquaculture sector