

## PARI Interim Report 2017

<b>Grant recipient:</b>	<b>Zentrum für Entwicklungsforschung Universität Bonn</b>	<b>BMZ-Project number:</b> <b>201 4.0690. 9</b>
<b>Project description:</b>	<b>PARI “Program of Accompanying Research for Agricultural Innovation”</b>	
<b>Project duration:</b>	<b>December 01, 2014 – December 31, 2019</b>	
<b>Reporting period:</b>	<b>January 01, 2017 – December 31, 2017</b>	

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in cooperation with PARI Partners



## Table of Contents

<b>Zusammenfassung .....</b>	<b>2</b>
<b>Executive Summary.....</b>	<b>4</b>
<b>1 Project overview .....</b>	<b>6</b>
1.1 Objective of the Program of Accompanying Research for Innovation – PARI.....	6
1.2 Core partners.....	7
<b>2 Activities and achievements in 2017.....</b>	<b>8</b>
<i>WP 1: Innovation research with future-oriented impact analyses .....</i>	<i>8</i>
Activity I/1: Modeling and mapping direct and indirect impacts of potentially promising innovations.....	8
Activity I/2: Developing methodologies and concepts for strategic analysis of potentials and prospects.....	10
Activity I/3: Institutional analysis of the GICs in the context of their national agricultural innovation systems .....	12
<i>WP2: Identifying and stimulating technological and institutional innovations.....</i>	<i>14</i>
Activity II/1: Screening for promising innovations from research and innovation systems (“research proven top-down approach”) .....	14
Activity II/2: Soliciting innovations generated by farmers and other actors in the value chains (“farmer participation bottom-up approach”) .....	15
Activity II/3: Scaling of innovations.....	16
<i>WP3: Engaging with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security.....</i>	<i>18</i>
<b>3 Summary of PARI activities in 2017 and outlook for 2018.....</b>	<b>20</b>
<b>4 Publication List .....</b>	<b>22</b>
<b>5 Outlook for 2018-19.....</b>	<b>24</b>

## Zusammenfassung

Die *Begleitforschung für landwirtschaftliche Innovationen* (PARI) vereint Partner aus Afrika, Indien und Deutschland, um gemeinsam zu nachhaltigem landwirtschaftlichen Wachstum und Ernährungssicherheit in Afrika und Indien im Rahmen der deutschen Initiative „Grüne Innovationen in der Agrar- und Ernährungswirtschaft“ beizutragen. In 2017 konnten die folgenden Aktivitäten maßgeblich zur Umsetzung von PARIs Zielen beitragen:

### 1. Innovationsforschung mit zukunftsorientierter Wirkungsanalyse

- a) *Modellierung und Kartierung der direkten und indirekten Wirkungen von erfolgversprechenden Innovationen*: Die Auswirkungen verschiedener Innovationsszenarien auf Maiserträge wurden in Äthiopien, Ghana, Kenia, Malawi und Burkina Faso ermittelt. Diese Ergebnisse wurden genutzt, um die gesamtwirtschaftlichen Auswirkungen der erfolgversprechendsten Szenarien zu untersuchen. Im Fall von Ghana ergab die Forschung, dass signifikante Ertragssteigerungen und daraus resultierende Preissenkungen durch die Anwendungen von Innovationen im Maisanbau möglich sind, diese aber einer deutlichen Steigerung öffentlicher Investitionen bedürfen.

Zudem wurde mit einem Pflanzenwachstumsmodell für ganz Afrika erforscht, wie sich verschiedene Innovationen auf die Maiserträge in einzelnen Ländern und auf dem gesamten Kontinent auswirken. Die Studie zeigt, dass die Kombination von Innovationen, wie Dünger und Bewässerung, die Maiserträge Afrikas mehr als verdoppeln könnte.

- b) *Methoden- und Konzeptentwicklung zur strategischen Potenzialanalyse und Prognose*: Die Funktionen der GIS-basierten Plattform eAtlas wurden zur Anwendungsreife weiter entwickelt. Außerdem wurden für acht PARI Partnerländer ländliche Typologien kartiert, um Investitionsmöglichkeiten mit Bezug auf landwirtschaftliche Innovationen hervorzuheben. Diese wurden als Bericht veröffentlicht und im eAtlas zugänglich gemacht.

- c) *Institutionelle Analyse der Innovationszentren im Rahmen nationaler landwirtschaftlicher Forschungssysteme*: Die Länderdossiers, die ausführliche Informationen über das Innovationsumfeld in den 12 afrikanischen PARI Partnerländern zusammentragen, werden laufend aktualisiert. Die Dossiers haben in den jeweiligen Ländern als umfassende Informationsquelle zu landwirtschaftlichen Innovationen großen Anklang gefunden.

Forschung zu verschiedenen Querschnittsthemen befasste sich u.a. mit der Mechanisierung von kleinbäuerlichen Betrieben, Kompetenzentwicklung, Saatgut-Systemen, Ernährung und Beschäftigung. Studien zeigen, z.B., dass Mechanisierungsprogramme in Afrika häufig an mangelnden Kompetenzen für die Instandhaltung und Nutzung der Maschinen scheitern, da die Systeme für berufliche Bildung unzureichend entwickelt und nicht auf die Bedürfnisse des Privatsektors ausgerichtet sind.

### 2. Stimulierung und Identifizierung von technologischen und institutionellen Innovationen

- a) *Dokumentation von Innovationen aus dem Forschungs- und Innovationssystem („top-down“ Innovationsernte)*: Die PARI Innovationsdatenbank wurde mit Innovationen der Partnerorganisationen in Kenia und Äthiopien ergänzt. Die Datenbank umfasst ca. 200 wissenschaftliche

untersuchte Innovationen, die flächendeckend in tropischen und subtropischen Ländern angewandt werden könnten.

- b) *Dokumentation von Innovationen von Bauern und anderen Akteuren aus dem Agrar- und Ernährungssektor („bottom-up“ Innovationsernte):* Innovationswettbewerbe für Bauern fanden in Kamerun und Mali statt. Zudem analysiert eine Studie die Ergebnisse der vier Innovationswettbewerbe, die in 2016 durchgeführt wurden. Die Erfahrungen zeigen, dass Kleinbauern eine wertvolle, wenn auch häufig unterschätzte Quelle von lokal angepassten Innovationen darstellen. Die eingereichten Innovationen beinhalteten hauptsächlich technologische Anwendung, mit Schwerpunkt auf Innovationen für die Viehzucht, den Pflanzenanbau und Lagerung.
- c) *Verbreitung (scaling) von Innovationen:* Eine PARI-Studie dokumentiert und vergleicht Strategien für die flächendeckende Verbreitung von landwirtschaftlichen Innovationen. Eine Auswahl von Studien beschäftigt sich außerdem mit Innovationen und Investitionsmöglichkeiten in bestimmten Wertschöpfungsketten, mit Schwerpunkt auf die von den Grünen Innovationszentren unterstützen Ketten.

Zudem fand eine Dialogveranstaltung für afrikanische Agrarforscher aus den PARI Partnerländern in Indien statt (verbunden mit Besuchen bei Programmen), um sich über vielversprechende Innovationen auszutauschen. Die Forscher zeigten sich beeindruckt von den bereits vorhandenen technologischen Möglichkeiten in Indien, die sich auf Grund der Ähnlichkeiten der Betriebsstrukturen auch in der afrikanischen Landwirtschaft anwenden lassen könnten.

### **3. Politik-Dialog zur Förderung von Innovationsansätzen zur Verbesserung der Ernährungssicherheit**

Die Partner im PARI Konsortium nutzten verschiedene Veranstaltungen zum Austausch mit Stakeholdern, einschließlich der von PARI organisierten Politikworkshops in Ghana und Äthiopien sowie wichtige afrikanische, deutsche und internationale Veranstaltungen (z.B. mit afrikanischen politischen Entscheidungsträgern in Benin, Kenia und der Elfenbeinküste). Outreach Aktivitäten wurden auch durch IKT Anwendungen und Publikationen unterstützt.

#### **Ausblick für 2018-19**

In den kommenden zwei Jahren wird sich PARI zunehmend mit konkreten Investitionsmöglichkeiten im Agrarsektor und den ländlichen Räumen Afrikas befassen, mit dem übergreifenden Ziel, die Ernährungssituation zu verbessern und Arbeitsplätze und Einkommensmöglichkeiten zu schaffen. Hierfür wird die Forschung thematisch ausgerichtet. Schwerpunktthemen beinhalten: die Identifizierung vielversprechender Innovationen und nötige Rahmenbedingungen für deren Verbreitung; die Mechanisierung afrikanischer Wertschöpfungsketten; die Digitalisierung in der Landwirtschaft und Lebensmittelproduktion; und Förderung der ländlichen Jugend.

## Executive Summary

The *Program of Accompanying Research for Agricultural Innovation* (PARI) brings together partners from Africa, India and Germany to contribute to sustainable agricultural growth and food and nutrition security in Africa and India as part of the Green Innovation Centers (GICs) initiative by the German government. In 2017, the main achievements towards PARI's goals include:

### 1. Innovation research with future-oriented impact analyses

- a) *Modelling and mapping direct and indirect impacts of potentially promising innovations:* The modelling team further extended and applied a crop model to assess the impact of selected innovation scenarios on maize yields in Ethiopia, Ghana, Kenya, Malawi and Burkina Faso. The results were used to then assess the economy-wide impacts of the most promising innovation scenarios. In the case of Ghana, the research shows that significant yield increases and price reductions can be achieved when innovations are applied in maize production, but these impacts require substantial public investments to materialize.

In addition, an Africa-wide crop modelling exercise evaluated the yield impacts of innovations in maize cultivation for specific countries and across the continent. The study finds that the widespread adoption of innovation packages, including fertilizer and irrigation, could more than double maize yields for Africa as a whole.

- b) *Developing methodologies and concepts for strategic analysis of potentials and prospects:* The GIS-based eAtlas mapping tool was updated with new enhanced features. Rural typologies to identify investment opportunities and gaps at the subnational level were finalized for eight countries and made accessible via the eAtlas.
- c) *Institutional analysis of the GICs in the context of their national agricultural innovation systems:* The dossiers that provide in-depth information about the innovation environment in the 12 African PARI partner countries were updated. The dossiers were well received in the respective countries as valuable sources of information on the status of agricultural innovation.

Cross-cutting thematic research focused, inter alia, on smallholder mechanization, skill development, seed systems, nutrition and employment. Research shows, for instance, that initiatives for the mechanization of smallholders in Africa fail because the necessary skills to maintain and operate the machines is lacking due to poorly developed vocational training systems that are not adapted to the needs of the private sector.

### 2. Identifying and stimulating technological and institutional innovations

- a) *Screening for promising innovations from research and innovation systems:* The PARI Agricultural Innovation Database was expanded with innovations from the national partners in Ethiopia and Kenya. The database now contains around 200 scientifically tested agricultural innovations that could be applied in tropical and sub-tropical countries.
- b) *Soliciting innovations generated by farmers and other actors in the value chains:* Farmer innovation contests were implemented in Cameroon and Mali. In addition, a study reviewed the experiences and outcomes of the contests implemented in 2016. The research shows that smallholder farmers are a valuable, yet often underestimated source of locally adapted

innovations. The majority of innovations submitted to the contests dealt with technological applications in the areas of livestock production, crop management and storage.

- d) *Scaling innovations*: A PARI study documents and compares strategies for scaling agricultural innovations in Africa. Various studies also focused on innovations and investment opportunities in specific value chains in Africa, with a focus on value chains supported by the Green Innovation Centers.

In addition, a study tour of African researchers for PARI's partner organisations to India sought to foster Indian-African knowledge exchanges on promising innovations. The researchers were impressed with existing technological possibilities in India, which due to similarities in production systems could also be applied in Africa.

### **3. Engaging with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security**

Partners in the PARI consortium organized and participated in several events to engage key stakeholders, including national policy workshops organized by PARI in Ghana and Ethiopia, as well as major African, German and international events (for instance in Benin, Kenya and Côte d'Ivoire). Outreach activities were supported by several ICT tools and publications.

#### **Outlook for 2018-19**

In the coming two years, PARI will focus increasingly on the identification of investment opportunities in the agriculture sectors and rural areas of Africa with the aim of improving food security and creating employment and income opportunities. To this end, the research will be structured along key themes, including the identification of promising innovations and necessary framework conditions for their dissemination; mechanization along African value chains; digitalisation in food and agriculture; and engagement of the rural youth.

## 1 Project overview

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

PARI brings together partners from Africa, India and Germany **to contribute to sustainable agricultural growth and food and nutrition security in Africa and India**. PARI offers independent scientific advice to the German government's, "One World, No Hunger" Initiative (SEWOH). Among other activities, SEWOH seeks to achieve its objectives by establishing Green Innovation Centers (GICs) in 14 African countries as well as India.

The research-based information generated in PARI serves to strengthen the integration of the GICs into national, regional and continental institutional partner settings, in order to enhance value chains contributing to rural and agricultural development. The core topics and thematic research priorities of PARI are being identified in accordance with the African Union's CAADP as part of the New Partnership for Africa's Development (NEPAD) and the Indian partners. Specifically, the Program aims at:

1. promoting and supporting the **scaling of proven innovations** in the agri-food sector in collaboration and partnership with all relevant actors;
2. supporting and **enhancing investments in GICs** through research; and thereby
3. contributing to the development of the agri-food sector in Africa and India through the identification, **assessment and up-scaling of innovations**.

To achieve these objectives, PARI's collaborative work is divided into three main fields of accompanying research (work packages):

**WP 1:** Innovation research with future-oriented impact analyses, incl.:

- Activity I/1: modeling and mapping direct and indirect impacts of potentially promising innovations
- Activity I/2: developing methodologies and concepts for strategic analysis of potentials and prospects
- Activity I/3: institutional analysis of the GICs in the context of their national agricultural innovation systems

**WP2:** Identifying and stimulating technological and institutional innovations, incl.:

- Activity II/1: screening for promising innovations from research and innovation systems ("research proven top-down approach"),
- Activity II/2: soliciting innovations generated by farmers and other actors in the value chains ("farmer participation bottom-up approach"),
- Activity II/3: scaling of innovations.

**WP3:** Engaging with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security

## 1.2 Core partners

<b>Partner organizations</b>	<b>Focal point</b>
<ul style="list-style-type: none"> <li>• <b>ZEF</b> Center for Development Research University of Bonn</li> </ul>	<p>Prof. Dr. Joachim von Braun, Project Director Dr. Heike Baumüller, Project Coordinator</p>
<ul style="list-style-type: none"> <li>• <b>AGRODEP</b> African Growth and Development Policy Modeling Consortium (AGRODEP) International Food Policy Research Institute (IFPRI)</li> </ul>	<p>Dr. Ousmane Badiane, IFPRI Director for Africa</p>
<ul style="list-style-type: none"> <li>• <b>FARA</b> Forum for Agricultural Research in Africa</li> </ul>	<p>Dr. Yemi Akinbamijo, Executive Director Dr. Wole Fatunbi, Project Coordinator</p>
<ul style="list-style-type: none"> <li>• <b>TUM</b> School of Life Sciences Weihenstephan Technical University of Munich</li> </ul>	<p>Prof. Dr. Thomas Becker, Dean's office</p>
<ul style="list-style-type: none"> <li>• <b>UOH</b> University of Hohenheim</li> </ul>	<p>Prof. Dr. Regina Birner, Head of Social and Institutional Change in Agricultural Development</p>

The national partners in Africa (Benin, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Mali, Malawi, Nigeria, Togo, Tunisia and Zambia) and India include:

- National Agricultural Research Institute of Benin (INRAB)
- Institute de L 'Environment et de Recherches Agricoles (INERA), Burkina Faso
- Institut de Recherche Agricole pour le Development (IRAD), Cameroon
- Ethiopian Development Research Institute (EDRI)
- Council for Scientific and Industrial Research (CSIR), Ghana
- Kenya Agricultural and Livestock Research Organization (KALRO)
- Department of Agricultural Research Services (DARS), Malawi
- Institut d' Economie Rurale (IER), Mali
- Agricultural Research Council of Nigeria (ARCN), Nigeria
- Institut Togolaise de Recherche Agronomique (ITRA)
- Institut National de Recherche Agronomique de Tunis (INRAT)
- Zambia Agriculture Research Institute (ZARI)
- Indian Council for Research on International Economic Relations (ICRIER)



## 2 Activities and achievements in 2017

### WP 1: Innovation research with future-oriented impact analyses

PARI is evaluating contributions of innovations to sustainable agricultural growth and food and nutrition security, high potential areas for investments and the necessary framework condition to develop and scale promising technological innovations.

#### Activity I/1: Modeling and mapping direct and indirect impacts of potentially promising innovations

The modeling activities of PARI are aimed at assessing the impact of different crop-related technology packages on both yields and economic performance in selected PARI partner countries. In 2017, research activities launched in the previous year were developed further in different regions of Africa.

Continuing the work done in **crop modelling**, the teams at ZEF and INRES (Institute of Crop Science and Resource Conservation, University of Bonn) further extended and applied a crop model to assess the impact of selected innovation scenarios on maize yields in Ethiopia, Ghana, Kenya, Malawi and Burkina Faso (see Table 1 for an overview of scenarios). The modelling served to identify the most promising technology packages that resulted in the highest yield increases.

Table 1: Agronomic innovation scenarios for maize production in selected PARI partner countries

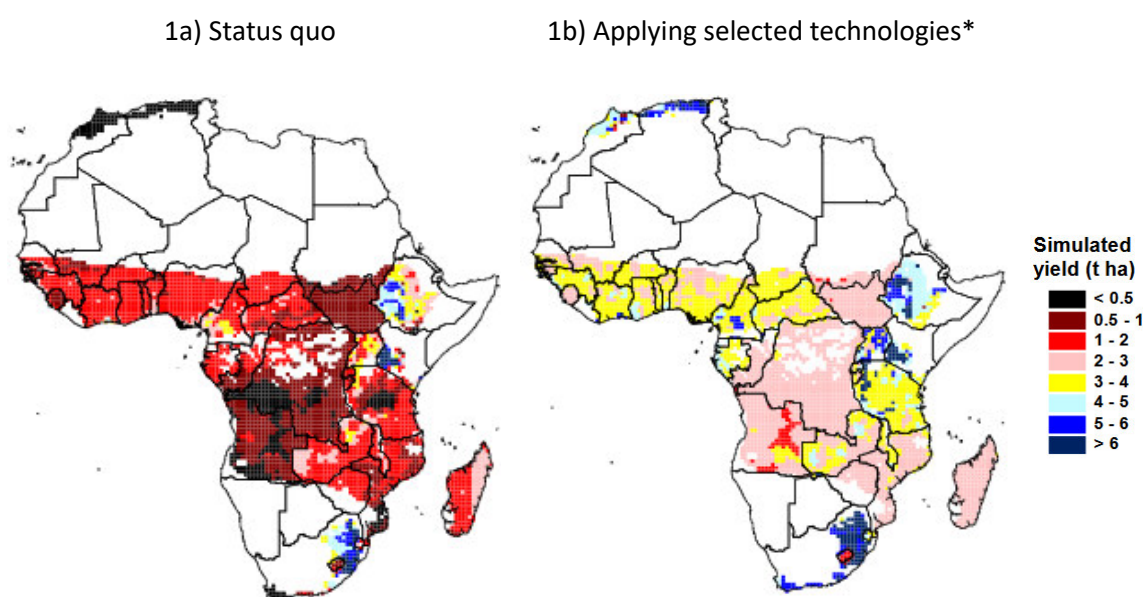
	Ghana	Nigeria	Malawi	Kenya	Ethiopia	Burkina Faso
Nitrogen scenarios	N1: 20 kg N ha <sup>-1</sup> N1: 40 kg N ha <sup>-1</sup> N1: 60 kg N ha <sup>-1</sup>	N1: current conditions (17 kg N ha <sup>-1</sup> ) N2: 30 kg N ha <sup>-1</sup> N3: 60 kg N ha <sup>-1</sup>	N1: current conditions (22 kg N ha <sup>-1</sup> ) N2: 60 kg N ha <sup>-1</sup>	N1: current conditions (17-34 kg N ha <sup>-1</sup> ) N2: 60 kg N ha <sup>-1</sup>	N1: current conditions (3-43 kg N ha <sup>-1</sup> ) N2: 60 kg N ha <sup>-1</sup>	N1: current conditions (5 kg N ha <sup>-1</sup> ) N2: 60 kg N ha <sup>-1</sup>
Cultivar scenarios	C1: 20% increase in grain filling rate C2: 20% increase in radiation use efficiency C3: C1 + C2	C1: current cultivar C2: 20% increase in grain filling rate and radiation use efficiency	C1: current cultivar C2: 20% increase in grain filling rate and radiation use efficiency	C1: current cultivar C2: 20% increase in grain filling rate	C1: current cultivar C2: 25% increase in grain filling rate	C1: current cultivar C2: 22% increase in grain filling rate
Sowing scenarios	S1: TSD-15 days S2: TSD S3: TSD+15 days	Typical sowing date (TSD)	S1: TSD S2: TSD-25 days	TSD	TSD	TSD
Irrigation scenarios	rainfed	rainfed	rainfed	rainfed	IR1: rainfed IR2: supplementary irrigation when soil water content <50% of field capacity	rainfed

Source: Rezaei and Gaiser (2018)

The results of the country-level crop modelling were used as an input into the **economic modeling** undertaken by AGRODEP/IFPRI. This modelling assesses the economy-wide impacts of introducing the most promising technology packages while also considering the costs. The country-level modelling was carried out by the AGRODEP members based in the countries or regions who participated in training to ensure that the methods and results are comparable.

An economic analysis of potential innovations was successfully implemented for **Ghana**. This study was used as a pilot to finalize the model specifications and cost parameters. Therefore, additional time was invested in the finalization. The modelling results for the other countries will be forthcoming in 2018. The study in Ghana shows that the introduction of agricultural innovations in the maize sector could increase maize production by 40% and reduce the maize price by 35% with positive spillover effects for the poultry sector. However, to trigger the productivity increases implied by the different scenarios, public spending on the maize sector would need to be significantly adjusted upward and at least 1.6% of public expenditure would need to be spent on the maize sector.

In addition to the country-level crop modelling, an **Africa-wide maize modelling study** was conducted. Maize is still one of the most important staple crops across Africa and a source of livelihood for the continent's smallholder farmers who produce three-quarters of the harvest. However, at 2 tons per hectare, average maize yields in sub-Saharan Africa are much lower than the global average yields of 5.6 tons. The crop modelling results suggest that by implementing improved crop management practices, i.e. supplementary irrigation schemes and fertilizer use, current yields in Africa could potentially double across the continent (Figure 1).<sup>1</sup>



\* 60 kg nitrogen/ha, supplementary irrigation, cultivar with 20% higher radiation use efficiency

Figure 1: Impacts of selected technologies on maize yields in Africa

Source: Rezaei & Gaiser (2017)

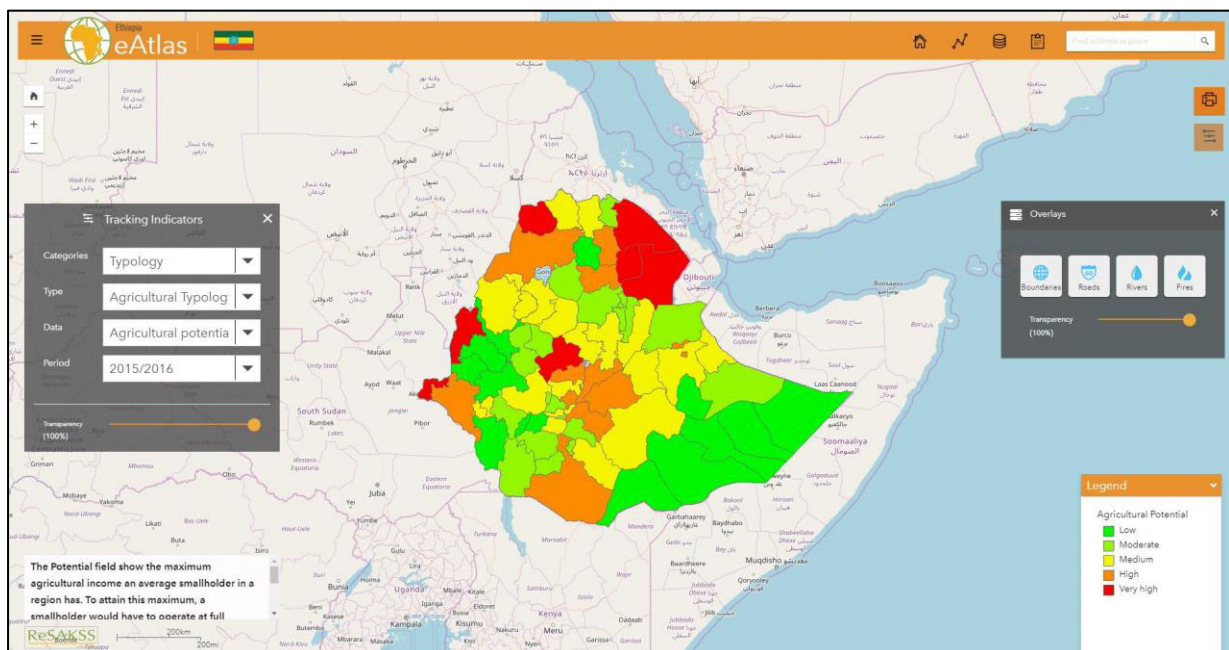
<sup>1</sup> Published in ZEF-Discussion Papers on Development Policy No. 239: Change in crop management strategies could double the maize yield in Africa (2017)

## Activity I/2: Developing methodologies and concepts for strategic analysis of potentials and prospects

### Mapping agricultural, socio-economic and biophysical indicators for policy-making

Development and updating of the country **eAtlases**<sup>2</sup> was a priority in order to facilitate clear and robust multi-lingual presentation of qualitative and quantitative data with newly enhanced features. To this end workshops were held in Tunisia, Ethiopia and Kenya and representatives from all of the PARI partner countries included in the eAtlas (Benin, Burkina Faso, Ghana, Kenya, Mali, Malawi, Rwanda, Togo and Tunisia) were invited to the eAtlas annual meeting in Dakar in October 2017 to share their experiences in managing and maintaining respective sections. The gatherings also provided a prime opportunity to provide training in the proficient use of GIS and other remote sensing tools, in fulfilment of the goal of sustainably handing over the management and maintenance of the eAtlas tools.

The eAtlas has the potential to serve all state and non-state actors involved in policy planning, implementation, and monitoring; policy analysis, review and dialogue; and design and targeting of agricultural and other investments. Generally, these groups will find this system useful: (i) government ministries and agencies, (ii) academic institutions, research institutions and policy analysts, (iii) civil society organizations and farmer organizations, and (iv) agribusiness and other private sector firms.

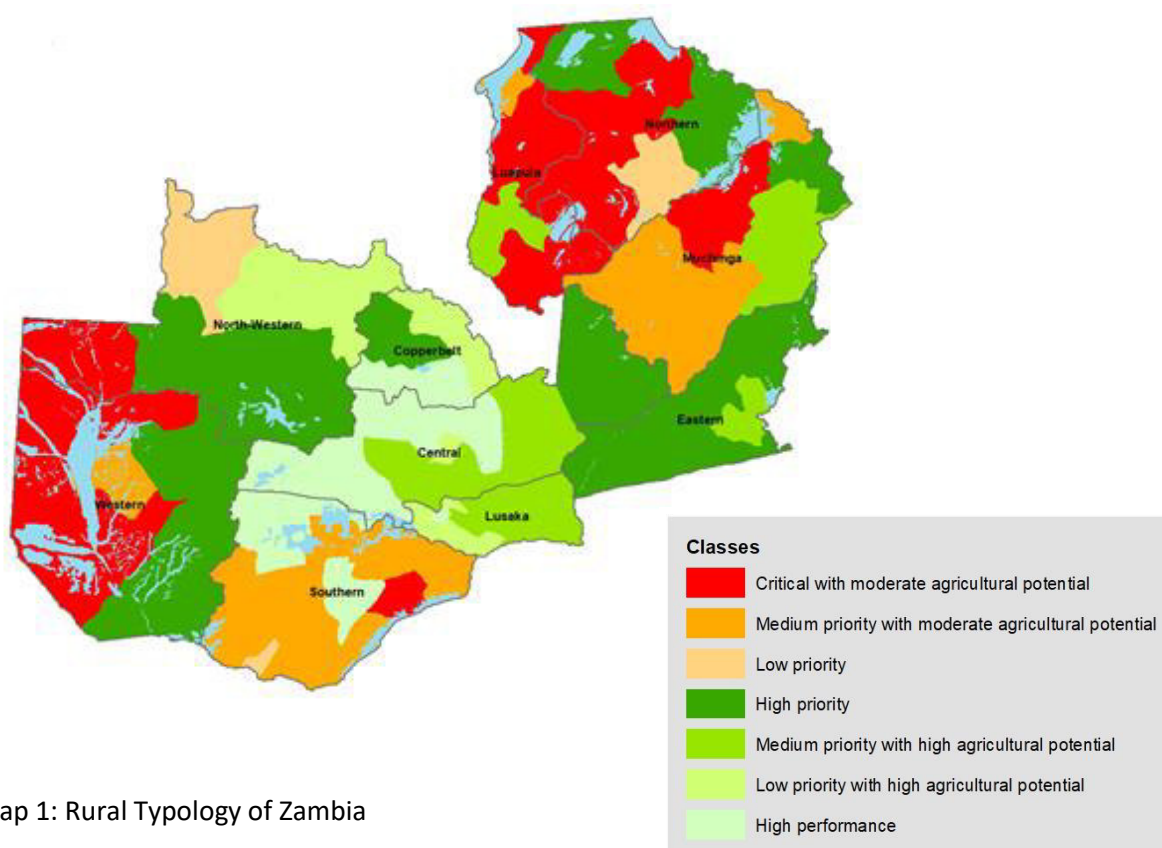


Picture 1: Screenshot from eAtlas Ethiopia

<sup>2</sup> <http://eatlas.resakss.org/index.html>

## Mapping the agricultural production frontier

PARI is developing a **Rural Typology** of micro-regions in selected African PARI partner countries to identify micro-regional level opportunities, bottlenecks and investment gaps for agricultural innovation. Map 1 offers an example of the Rural Typology for Zambia. The favorable agroecological conditions for maize and livestock in the Eastern region combined with the good access to urban markets explain the high agricultural potential of the Eastern region. The Central provinces also possess high potential resulting from a combination of high soil quality and an intermediate amount of rainfall. Comparatively, the Northern Province has high rainfall and humidity, but problems with soil acidity explain its overall lower agricultural potential.



Map 1: Rural Typology of Zambia

Source: Maruyama et al. (2018)

Rural Typologies were completed for eight countries, including Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Togo and Zambia. The final maps were published in a report that also outlines the methodology.<sup>3</sup> In addition, the typologies as well as the component maps are available on the respective country pages of the eAtlas where they can be viewed online and downloaded as shapefiles. Typologies for the remaining four PARI partner countries could not be completed because of lack of data. Feedback received from policy stakeholders on a draft typology for Benin showed that the originally planned “light” version of the typology using less data did not yield satisfactory results.

<sup>3</sup> Published in ZEF-Discussion Papers on Development Policy No. 251: Frontier analysis and agricultural typologies (2018)

### Activity I/3: Institutional analysis of the GICs in the context of their national agricultural innovation systems

#### Assessing opportunities and constraints in national innovation environments

In 2017, updates of the 12 country dossiers originally compiled in 2015 were published.<sup>4</sup> The dossiers provide insight into areas of innovation for agricultural growth within the countries, including a general background and overview of each of their unique agricultural sectors, the most relevant value chains as well as suggestions of key partners for collaboration. Policy Brief 9 provides a summary of the 12 country dossiers.



#### Cross-cutting thematic research

##### *Supporting smallholder mechanization*

Research on smallholder mechanization led by the University of Hohenheim in collaboration with local partners focused on **institutional innovations for creating a conducive environment for mechanization** in Africa. This research is motivated by the fact that in many African countries labour, rather than land, is a limiting factor and mechanization can help to fill this labour gap. One study in Ghana identifies a series of governance challenges that undermine progress in mechanization on the continent, including lack of skills to operate and maintain the machines, a poorly developed servicing infrastructure, market failures and a continued focus on state- rather than private sector-led mechanization efforts.<sup>5</sup> A second study sought to identify strategies for developing the necessary knowledge and skills for agricultural mechanization by looking at historic examples from the United States and Germany.<sup>6</sup> The comparative analysis shows that different strategies can be used towards this goal, such as primarily private sector-run training efforts favoured in the US or public-private vocational training initiatives offered in Germany.

##### *Enhancing skills for agricultural development*

A **review of the Agricultural Technical and Vocational Education and Training (ATVET) systems** in selected Sub-Saharan Africa countries showed that there are far too few training opportunities for young people and that currently, training offered does not match the needs of the private sector or local administrations.<sup>7</sup> The research also concluded that ATVET focuses too heavily on production skills with limited attention paid to skills needed along the entire agricultural value chain. The study

<sup>4</sup> Available at [https://research4agrinnovation.org/publication/country\\_dossiers\\_2017](https://research4agrinnovation.org/publication/country_dossiers_2017).

<sup>5</sup> Published as: The neglected governance challenges of agricultural mechanisation in Africa – insights from Ghana (2017) and summarized in PARI Policy Brief No. 5

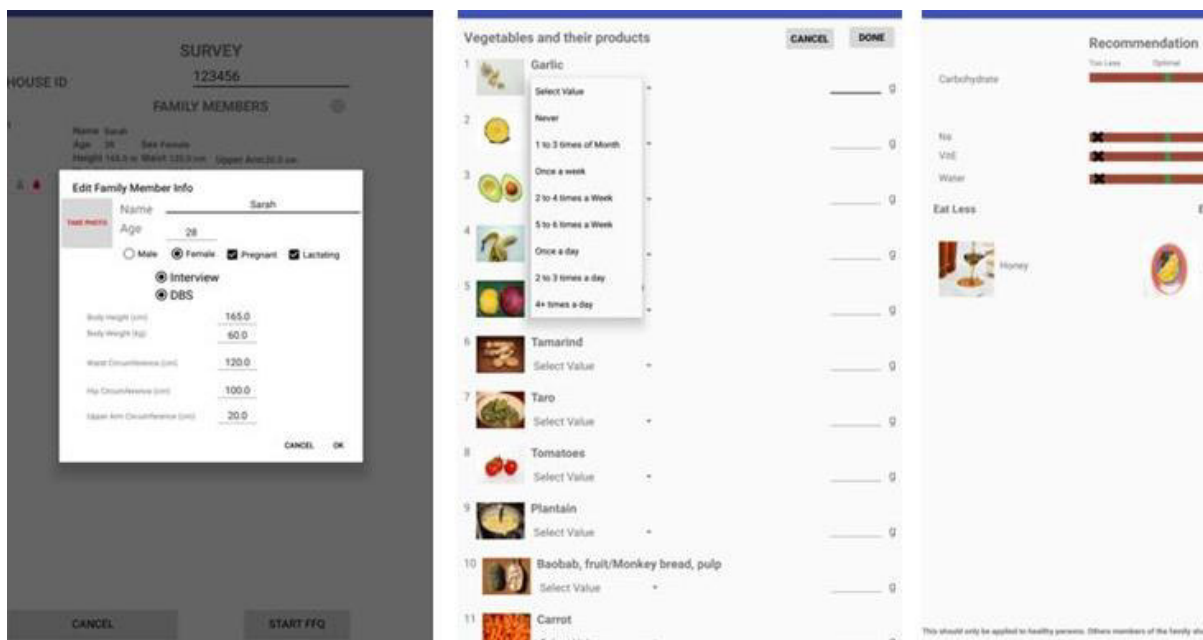
<sup>6</sup> Summarized in Policy Brief No. 7

<sup>7</sup> Published in ZEF Working Paper 164: Vocational Education and Training for Farmers and Other Actors in the Agri-Food Value Chain in Africa (2017)

suggests that ATVET systems across Africa need to be fundamentally transformed into entrepreneurial and professional systems that will improve the skills of farmers and other value chain professionals through a combination of theoretical and practical training.

### **Improving nutrition**

In order to study the **impact of offering personalized nutrition advice to rural households**, researchers at TUM developed and applied a smartphone app, the Food-Recommender. This Android-based application provides food recommendations based on an analysis of anthropometrics and food intake. The app determines the optimal nutrient intake based on a variety of personal characteristics entered into the app and compares it to the actual intake. The app then provides recommendations for dietary changes in the usual diet to reduce malnutrition in the household.



Picture 2: Screenshot of the Food-Recommender application

TUM in collaboration with the Institut National des Recherches Agricoles du Bénin (INRAB) is piloting the app in Benin using experimental research which includes extensive data collection through food frequency questionnaires, household surveys, anthropometrics and dried blood spot analysis. Three survey rounds were completed in 2017 and a final round was held in early 2018. To be able to carry out the DBS analysis, INRAB was supplied with the necessary equipment and two scientists received training in Munich.

### ***Generating employment along agricultural value chains***

The potential for generating employment through agricultural value chain development was assessed for the cotton and rice value chains in Benin and Senegal.<sup>8</sup> Agriculture in West Africa is overwhelmingly informal i.e. own-account or family-based, and therefore mainly generates highly vulnerable and little formal employment in rural areas. The research shows that job patterns and income generation greatly vary across sub-national regions. Household farms operating in areas where the value chains are organized are much better off than their counterparts. Constraints in the business environment often hamper value chain expansion, including limited access to financing, lack of training, property rights issues, limited mechanization, and weak access to an affordable and effective source of energy. To improve employment prospects, policy interventions should aim at removing these bottlenecks, in particular for small and nano-enterprises that are the most prevalent businesses in these areas.

### ***Building sustainable seed systems***

A study was undertaken to identify possible elements of sustainable seed systems in Africa.<sup>9</sup> The study compared and contrasted experiences from two Sub-Saharan countries, Kenya and Mali, to gain insights into existing seed systems and the different actors who contribute to various functions and operate at different scales. The study finds that differences in the size and the structure and organization of the market played a significant role in terms of quality, access, and availability of seeds. It concludes that sustainable seed system development requires more actor-orientation, with a central focus on farmers' capacities and needs. Furthermore, strengthening actors' capacities to collect, share and assess information about varieties and their comparative performances will contribute to dynamic and responsive seed systems. Plant breeding, as the source of value creation, needs to be regarded as an integral component of functioning seed systems and requires joint consideration of what demands for innovations actually exist in order for seed systems to advance. Decentralized seed production and marketing enterprises can serve as nuclei for an emerging locally-based seed industry where market opportunities are limited and preferences diverse.

## **WP2: Identifying and stimulating technological and institutional innovations**

This component of PARI identifies promising innovations for the agricultural and food sector along value chains and markets in the respective national and regional context of the GICs and assesses strategies for scaling these innovations.

### **Activity II/1: Screening for promising innovations from research and innovation systems (“research proven top-down approach”)**

The **PARI Agricultural Innovation Database** launched in 2016 includes technological, managerial and institutional innovations that could be applied and scaled up along agricultural value chains, in

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<sup>8</sup> Published in ZEF-Discussion Papers on Development Policy No. 254: Generating Employment and Increasing Income in Agricultural Value Chains and thereby Fostering Food Security (2018)

<sup>9</sup> Published in ZEF Working Paper 165: Identifying Options for the Development of Sustainable Seed Systems (2018)

particular in tropical and sub-tropical countries. The database has the purpose of facilitating information exchange and documenting promising innovations in agriculture and the wider food sector. Further inputs were made to the database from PARI partners in Kenya and Ethiopia. Topics range from varietal types of sweet potatoes to tillage management for soil conservation.

### **Activity II/2: Soliciting innovations generated by farmers and other actors in the value chains (“farmer participation bottom-up approach”)**

The **farmer innovation contests**<sup>10</sup>, which were held in four African countries in 2016, were continued in **Cameroon and Mali**. The FARA team together with the Institute of Rural Economics (IER, Mali) and the Institute of Agricultural Research for Development (IRAD, Cameroon) prepared the ground for the launch of the contests in the two countries. This consisted of training ‘farmers innovations scouters’ as well as contest facilitators. Part of the preparation also involved composing radio jingles to garner publicity on the contests. These contests aim at identifying and stimulating high-potential farmer innovations which lend themselves to easy adaptation and dissemination.

The identified innovations were mainly technological in nature. Using the example from Cameroon, the contest attracted 162, mostly male, competitors for a first-place award of 1000 USD. The winning innovations were primarily related to processing and post-harvest management (33%), crop production and protection (26%), animal production and health (15%), followed by mechanization (6%). Examples from the contest are a soap made from snail shells, a processing method to turn yams into ‘gari’ flour, and a multi-fuel power source egg incubator which can be used in rural areas.

In addition, a **study analyzing the first four contests** finds that farmers are active experimenters who continuously generate remarkable and locally adapted innovations, which can indirectly contribute to efforts to achieve sustainable agricultural intensification or to make agriculture climate smart.<sup>11</sup> In the four countries, the majority of innovations dealt with livestock production (40%), crop management (26%) and storage (10%). The study concludes that farmers possess valuable ethnobotanical knowledge and innovation-generating potential that need to be harnessed and supported. A contest is an effective means to scout and acknowledge farmer innovators while simultaneously raising awareness of the farmer innovation approach among relevant stakeholders.

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<sup>10</sup> Further information about all contests can be found at <https://research4agrinnovation.org/farmer-innovation-contests>

<sup>11</sup> Published in ZEF Working Paper 166: Recognizing and rewarding farmers’ creativity through contests: experiences and insights from four African countries (2018)





Picture 3: Farmer Innovation Scouters trained in Segou Region, Mali Republic

Source: IER

### Activity II/3: Scaling of innovations

A research report was published that outlines and reviews various strategies to scale agricultural innovations.<sup>12</sup> Scaling up of agricultural innovations is necessary for any truly robust developments which are capable of reaching a large number of people. The report discusses the different routes from which up-scaling of technology is likely to occur in Africa, described as either ‘sporadic’ or ‘systematized’ pathways. Sporadic describes scaling without interventions or active dissemination which are usually novel solutions to problems that are significant barriers to productivity. These technologies tend to find easy acceptance due to many stakeholders having actively searched for solutions to the problems the new technology addresses. In contrast, systematized pathways require stepwise interventions to facilitate its scaling of an innovation beyond the environment in which it was generated. In this study FARA and its partners have proved, on a pilot basis, that the Integrated Agricultural Research for Development (IAR4D) approach using the Integrated Platforms can produce positive results for scaling innovations within a very short time.

### Fostering Africa-India learning on scaling innovations

A group of agricultural researchers from PARI’s partner institutions in Africa traveled to India to connect to key local stakeholders, engage in inter-continental learning on issues of mutual interest to Africa and India, and identify joint research activities between the African and Indian partners. Participants during the visit included representatives from the lead organizations in the 12 African partner countries, FARA and ZEF. The delegation was led by Dr. Yemi Akinbami, the Executive Director of FARA and the study visit was coordinated by Indian Council for Research on International Economic Relations (ICRIER), under the leadership of Professor Ashok Gulati. Companies and organisations visited along the way included, among others, the Indian National Bank for Agriculture

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<sup>12</sup> Published by FARA and ZEF as a book “Strategies for Scaling Agricultural Technologies in Africa” (2018)

and Rural Development (NABARD); Jain Irrigation Systems Limited (JAINS), the second largest micro-irrigation company in the world; the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) which is working closely with grassroots innovators in India; and the dairy processing company Amul, India's largest food brand.<sup>13</sup>

In addition, a study was undertaken to map **agricultural innovations at the technology frontier that were developed or applied in India**, including in the areas of biological innovations, biofortification, digitization, agricultural finance, logistics and vertical farming.<sup>14</sup> The study also looks into the policy and institutional reforms that can catalyze the introduction and adoption of the advanced technology solutions in the context of Indian agriculture.

### Value chain-related research at the country level

Facilitated through the work of the National Partners, several studies were published during 2017 and early 2018 that outline innovation opportunities in selected value chains:<sup>15</sup>

- Innovation Opportunities in Irish Potato Value Chain in Mali
- Innovation Opportunities in Mango Value Chains in Mali
- Innovation Opportunities in the Rice Value Chain in Nigeria
- Innovation Opportunities in Sweet Potato production in Kenya
- Innovation Opportunities in the Small Ruminants livestock sector in Benin
- Agricultural Mechanization in Kenya: rice and banana value chains
- Development and Analysis of Rice Value Chains in Ghana
- Value Chain Assessment of Sidi Bouzid Sheep Production and Marketing in Tunisia
- Impact of Climate Change on Rice Farmer Income in Togo
- Analysis of the Dynamics and Obstacles to the Adoption of Technological Innovations: the Case of Rice Farming in Togo

### Scaling innovations in the dairy sector

Research undertaken by the University of Hohenheim in collaboration with national partners assessed dairy value chains and supported innovations in milk cooling in Kenya and Tunisia, as well as in feeding. Kenya was selected as representative of a dairy sector supported by the Green Innovation Center project. Here, a **solar-based milk cooling system** developed by the University of Hohenheim was tested and its socio-economic impacts assessed (Picture 4).

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<sup>13</sup> A trip report is available at [https://research4agrinnovation.org/publication/study-visit\\_india](https://research4agrinnovation.org/publication/study-visit_india).

<sup>14</sup> Published in ZEF Working Paper 159: Innovations spearheading the next transformations in India's agriculture (2017); summarized in Policy Brief No. 4.

<sup>15</sup> Country-level studies are available on the respective country page on the PARI website: [https://research4agrinnovation.org/pari\\_countries/](https://research4agrinnovation.org/pari_countries/)



Picture 4: Solar-based milk cooling system

Source: University of Hohenheim

The system consists of many commercially available components. A single smart freezer can store 60 liters of milk for an entire year. The system allows small dairy farmers to overcome the challenge of safely storing and transporting milk in the short-term, thereby enabling them to properly maintain cool temperatures and meet hygiene standards. The system involves innovative insulated milk-cans that have the capacity to cool down and store milk using ice compartments. For Kenya, the team developed a new version of the milk cans out of plastic to reduce the weight. A strong component of the strategic aim of their work was the ability to upscale the technology through e.g. cooperatives.

Another study was conducted by the University of Hohenheim which tested **innovations for improved feeding of African dairy cattle** during the dry season and conducted research on the resilience of individual animals to conditions of undernutrition. The study sought to better characterize the nutritional value of tropical roughages offered to dairy cows in Africa. To this end, the researchers collected *in vivo* data on dietary effects on nutrient conversion efficiency and partitioning in tropical dairy cows and developed a simulation model to predict nutrient conversion efficiency. A database was built populated with the data for basic and advance nutritional characteristics of about 90 important feedstuffs used in dairy feeding in Africa. Based on the study a prototype for a farmer-friendly mobile phone-based diet formulation tool is being developed which seeks to better inform African dairy farmers about optimizing animal nutrition through dietary composition choices.

### **WP3: Engaging with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security**

In 2017 there was a significant effort to continue drafting policy briefs, with four more created in order to aid the on-going communications policy (available in English and partly in French):

- PARI Policy Brief No. 3: Sustainable Intensification Strategies for The Rural Poor
- PARI Policy Brief No. 4: Agricultural Innovations at the Technological Frontier in India
- PARI Policy Brief No. 5: Smallholder agricultural mechanization in Africa
- PARI Policy Brief No. 6: Improving Employment Prospects for Africa's Rural Youth

During 2017, PARI hosted or participated in several policy-relevant conferences in Germany, Africa and India to share research insights and policy recommendations and network with partners:

In Germany, PARI engaged with policy stakeholders and the general public in several high-profile events. Early in the year, PARI was in attendance for the **International Green Week** in Berlin where together with partner researchers from the UOH the milk cooling system was presented in the ‘One World No Hunger’ special exhibition hosted by the BMZ. PARI also contributed substantially to the preparations of the **“ONE WORLD – No Hunger. Future of the Rural World” conference** in April in Berlin organized in the lead-up to the G20 meetings. As a co-chair of an international advisory committee, PARI Director Prof. Joachim von Braun together with Dr. Agnes Kalibata, the president of the Alliance for a Green Revolution in Africa (AGRA), led the preparation of the Berlin Charter adopted at the conference.

In Africa, PARI organized two **National Policy Roundtables**, first in Ghana in collaboration with the Science and Technology Policy Research Institute (STEPRI) of the Council for Scientific and Industrial Research (CSIR), and later in Ethiopia together with the Ethiopian Development Research Institute (EDRI). These meetings serve the purpose of presenting and discussing research findings and recommendations with stakeholders to promote agricultural development. In Ghana, participants agreed that technological and institutional innovations are crucial for advancing agricultural growth through the e.g. development of the entire value chain, collection and dissemination of agricultural statistics and data, improve financing and seed development along the value chain as well as protect and promote farmer innovations. In Ethiopia emphasis was placed on e.g. building collaborations and partnerships, the need for more reliable data, and value chains which move beyond cereals.

PARI also hosted a side-event at the **African Green Revolution Forum** in Abidjan in September. The AGRF is the most important annual gathering of policy stakeholders engaged in African agriculture. Leading researchers and policy makers from FARA, AGRODEP/IFPRI, ICRIER, Ghana, Côte d'Ivoire and ZEF presented their ideas on how and where to best target innovation investments for sustainable agricultural growth and rural development.

In November, the UNFCCC **COP-23** was hosted in Bonn where PARI presented at a side-event in the German pavilion. Researchers presented a session on Climate and Development in West and East Africa linking the themes of agricultural innovation to climate resilience in Africa.



Picture 5: Dr. Oliver Kirui presenting on the “Drivers of Sustainable Land Management in Eastern Africa”

Listed chronologically, the highlights from 2017 include:

- 20-29.01.: 82<sup>nd</sup> International Green Week
- 27.-28.4.: input into the BMZ Food security conference and adoption of the Berlin Charter
- 31.7-1.8.: PARI National Policy Roundtable in Ghana
- 5.9.: Side-event at the African Green Revolution Forum 2018 in Côte d'Ivoire
- 20.-22.9.: Presentations at the Tropentag conference on tropical & subtropical agriculture 2017
- 12-13.10.: PARI National Policy Roundtable in Ethiopia
- 22-29.10.: Study-tour of African agricultural researchers to India
- 9.11.: Side-event at UNFCCC COP-23 Conference in Bonn

### 3 Summary of PARI activities in 2017 and outlook for 2018

Deliverable	Status by end-2017	Outlook for 2018	Lead organization(s)
<b>Work package I: Innovation research with future-oriented impact analyses</b>			
<b>Activity I/1: Modelling and mapping direct and indirect impacts of potentially promising innovations</b>			
Modeling of the impacts of agricultural innovations on yield and economic performance	Crop modeling completed for maize in Ethiopia, Ghana, Kenya, Malawi and Burkina Faso. Economic modelling implemented for Ghana. An Africa-wide crop model for maize completed.	Economic analyses will be completed for the remaining countries: Ethiopia, Kenya, Malawi, Nigeria, and Burkina Faso	ZEF, INRES AGRODEP/IFPRI
<b>Activity I/2: Developing methodologies and concepts for strategic analysis of potentials and prospects</b>			
eAtlas platform	Updates, training, dissemination	Continuous updates and dissemination	AGRODEP/IFPRI
Rural typologies	Published for 8 countries & available digitally on eAtlas		AGRODEP/IFPRI
<b>Activity I/3: Institutional analysis of the GICs in the context of their national agricultural innovation systems</b>			
African Country Dossiers	Updated version of 12 country dossiers published including a summary		ZEF, FARA, national partners
Study on governance options for mechanization	Completed and published in a journal		UOH
Study on the historical development of mechanization in US & Germany	Policy brief completed	Publication forthcoming	UOH
Study on the status of agricultural vocational education and training in Africa and globally	Published as ZEF Working Paper 164		ZEF

Study on personalized nutrition advice in Benin	Smartphone app developed and pilot testing	Ongoing testing, report forthcoming	TUM, INRAB
Study on employment generation in agricultural value chains in Benin and Senegal	Published as ZEF Discussion Paper 254		UCAD
Study on sustainable seed systems	Published as ZEF Working Paper 165	Policy Brief forthcoming	ZEF
Study on the impact of mechanization on the intra household labour allocation	Draft finalized	Publication forthcoming	UOH
Thematic research at country level	Several studies published	Remaining studies forthcoming	National partners
<b>Work package II: Identifying and stimulating technological and institutional innovations</b>			
<b>Activity II/1: Screening for promising innovations from research and innovation systems</b>			
PARI Agricultural Innovation Database	Database updated with further inputs from Kenya and Ethiopia	To be further updated	ZEF (online platform), all partners (input)
<b>Activity II/2: Soliciting innovations generated by farmers and other actors in the value chains</b>			
Farmer innovation contests	Completed in Cameroon and Mali		FARA, national partners, ZEF
Study of first four contests	Published as ZEF Working Paper 166	Study on farmers' perception on intellectual property rights forthcoming	ZEF, FARA, national partners
<b>Activity II/3: Scaling of innovations</b>			
Study on the scaling of agricultural innovations	Published in early 2018		FARA, ZEF
Africa-India Study Visit	Completed	Study on Indian grassroots innovations forthcoming	ICRIER, FARA, ZEF, national partners
Value chain-related research at the country level	Several studies published	Remaining studies forthcoming	National partners, FARA
Solar-powered milk cooler	Tested in Kenya and Tunisia	Study forthcoming	UOH, national partners
Feed options for African cattle	Tested	Study forthcoming	UOH, national partners
<b>Work package III: Engaging with food and agriculture policy making to enhance approaches for innovation that improve food and nutrition security</b>			
Formal and informal input into policy debates	National policy roundtables held in Ghana and Ethiopia; engagement in African, German and international fora	To be continued	All partners
PARI policy briefs	4 briefs completed	Additional briefs forthcoming	All partners
PARI website	Online with minor updates	Updates ongoing	ZEF (online platform), all partners (contributions)

## 4 Publication List

During 2017, PARI has seen a significant growth in research outputs, including journal articles, studies and policy briefs. Below contains an exhaustive list which also includes outputs published in 2018, but for which most of the work was undertaken in 2017:

Publication Title	Lead organisation(s)	Geography	Year
<a href="#">Enhancing resilience to climate shocks through farmer innovation: evidence from northern Ghana</a>	ZEF	Ghana	2017
<a href="#">Recognizing and rewarding farmers' creativity through contests: experiences and insights from four African countries</a>	ZEF	Ethiopia, Kenya, Malawi, Zambia	2018
<a href="#">Farmers' adaptation to weather extremes in the Sudan Savanna</a>	ZEF	Burkina Faso, Ghana	2017
<a href="#">Identifying Options for the Development of Sustainable Seed Systems – Insights from Kenya and Mali</a>	ZEF	Kenya, Mali	2018
<a href="#">Vocational Education and Training for Farmers and Other Actors in the Agri-Food Value Chain in Africa</a>	ZEF	General	2018
<a href="#">The Neglected Governance Challenges of Agricultural Mechanization in Africa</a>	UOH	Ghana	2017
<a href="#">Innovations spearheading the next transformations in India's agriculture</a>	ZEF, ICRIER	India	2017
<a href="#">Weather impacts on crop yields - searching for simple answers to a complex problem</a>	ZEF, INRES	General	2017
<a href="#">The uncertainty of crop yield projections is reduced by improved temperature response functions</a>	ZEF, INRES	General	2017
<a href="#">Change in crop management strategies could double the maize yield in Africa</a>	ZEF, INRES	Benin, Ethiopia, Kenya, Malawi, Mali, Nigeria, Togo, Zambia	2017
<a href="#">The uncertainty of crop yield projections is reduced by improved temperature response functions</a>	ZEF, INRES	General	2017
<a href="#">Physical robustness of canopy temperature models for crop heat stress simulation</a>	ZEF, INRES	General	2017
<a href="#">Generating Employment and Increasing Income in Agricultural Value Chains and Thereby Fostering Food Security: Case Studies of Rice and Cotton in Benin and Senegal</a>	UCAD, ZEF	Benin, Senegal	2018
<a href="#">From Agricultural to Economic Growth: Targeting Investments Across Africa</a>	ZEF, EDRI	General	2018
<a href="#">Frontier Analysis and Agricultural Typologies</a>	AGRODEP / IFPRI, ZEF	Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Togo and Zambia	2018
<a href="#">Strategies for Scaling Agricultural Technologies in Africa</a>	FARA	General	2018
<a href="#">Status of Smallholders Agricultural Mechanization in Sub-Saharan Africa</a>	FARA	General	2018

Publication Title	Lead organisation(s)	Geography	Year
<a href="#">Functions and Impacts of Multi-Stakeholder Platforms in Benin</a>	INRAB, FARA	Benin	2017
<a href="#">Impact of Climate Change Adaptation Strategies on Farm Yields and Income in Benin</a>	INRAB, FARA	Benin	2017
<a href="#">Innovation Opportunities in the Small Ruminants livestock sector in Benin</a>	INRAB, FARA	Benin	2018
<a href="#">Socio-Economic Analysis of Promising Innovations in Benin</a>	INRAB, FARA	Benin	2018
<a href="#">Development and Analysis of Rice Value Chains in Ghana</a>	CSIR-STEPRI, FARA	Ghana	2017
<a href="#">Factors Influencing Scaling-up of Agricultural Innovations: Lessons from Ghana</a>	CSIR-STEPRI, FARA	Ghana	2017
<a href="#">Agricultural Mechanization in Kenya: rice and banana value chains</a>	KALRO, FARA	Kenya	2017
<a href="#">Innovation Opportunities in Sweet Potato production in Kenya</a>	KALRO, FARA	Kenya	2018
<a href="#">Impact of Agricultural Innovation Platforms on Smallholder livelihoods in Eastern and Western Kenya</a>	KALRO, FARA	Kenya	2018
<a href="#">Innovation Opportunities in Sweet Potato production in Kenya</a>	KALRO, FARA	Kenya	2018
<a href="#">Innovation Opportunities in Irish Potato Value Chain in Mali</a>	IER, FARA	Mali	2017
<a href="#">Innovation Opportunities in Mango Value Chains in Mali</a>	IER, FARA	Mali	2018
<a href="#">Coping strategies with Climate Variability effects: The case of the village of Zignasso in Mali</a>	IER, FARA	Mali	2018
<a href="#">Scaling Strategies for Agricultural Innovation in Nigeria</a>	ARCN, FARA	Nigeria	2018
<a href="#">Innovation Opportunities in the Rice Value Chain in Nigeria</a>	ARCN, FARA	Nigeria	2018
<a href="#">Documentation of Selected Outstanding Innovations in Nigeria</a>	ARCN, FARA	Nigeria	2018
<a href="#">Impact of Climate Change on Rice Farmer Income in Togo</a>	ITRA, FARA	Togo	2018
<a href="#">Analysis of the Dynamics and Obstacles to the Adoption of Technological Innovations: the Case of Rice Farming in Togo</a>	ITRA, FARA	Togo	2018
<a href="#">Value Chain Assessment of Sidi Bouzid Sheep Production and Marketing in Tunisia : Challenges and Opportunities of Linking Breeders to the Markets</a>	INRAT, FARA	Tunisia	2018

Policy Briefs published in 2017:

- [PARI Policy Brief No. 3: Sustainable Intensification Strategies for the Rural Poor](#)
- [PARI Policy Brief No. 4: Agricultural Innovations at the Technological Frontier in India](#)
- [PARI Policy Brief No. 5: Smallholder agricultural mechanization in Africa](#)
- [PARI Policy Brief No. 6: Improving Employment Prospects for Africa's Rural Youth](#)



## 5 Outlook for 2018-19

The conclusion of PARI's first three years afforded the opportunity to re-evaluate the scope and mission of the project and align the PARI strategy with the future direction of the One World, No Hunger Initiative (SEWOH). The goal of PARI's research was refined and focused on **identifying investment opportunities in the agriculture sectors and rural areas of Africa with the aim of improving food security and creating employment and income opportunities.**

The strategic focus of PARI research will move **beyond country-specific value chains** and shift towards those which are of importance across Africa or its sub-regions. This approach will ensure that innovations applied in one country or location (e.g. a GIC) can be scaled more easily across the continent. Moreover, activities will increasingly target the **later stages of the value chain, creation of good jobs, and people's wellbeing, incl. nutrition.** Engagement with the private sector will play an important role here. In addition, PARI will respond to the growing recognition that the context in which value chains function also needs to be strengthened. Thus, more emphasis will be placed on promoting **rural development and rural-urban linkages**, with a particular focus on youth employment combined with skill development. Improved access to agricultural finance may also be one of the priority measures in this context. Finally, as part of the effort to improve the framework conditions for agricultural and rural development through innovation, additional efforts will be made to support the **formulation and implementation of conducive policies** at national, African and international levels.

To this end, in the next phase PARI will endeavour to:

- integrate PARI research under key **themes** of particular relevance to PARI's overarching goal in order to scale research findings across Africa,
- strengthen linkages and **cooperation** between existing partners and broaden partnerships, esp. with the private sector, and
- more effectively **engage policy stakeholders** in the research process and **communicate** research findings (with the involvement of all partners).

Research will be organized in the following **thematic research 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 the youth in the rural economy
5. Improving the policy context and contributing to evidence-based policy processes