PARI Interim Report 2019

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submitted by

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in cooperation with PARI Partners

Program of Accompanying Research for Agricultural Innovation

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Zusammenfassung

Die *Begleitforschung für landwirtschaftliche Innovationen* (PARI) vereint Partner aus Afrika, Indien und Deutschland, um zu nachhaltigem landwirtschaftlichen Wachstum und Ernährungssicherheit im Rahmen der deutschen Initiative *Eine Welt Ohne Hunger* beizutragen. 2019 konnten die folgenden Aktivitäten maßgeblich zur Umsetzung von PARIs Zielen beitragen:

Arbeitspaket 1: Investitionen in Innovationen zur Verbesserung der Produktivität und Resilienz von Agrar- und Ernährungssystemen

In diesem Arbeitspaket entwickelt die PARI-Forschung Ansätze und wendet diese an, um die kosteneffizientesten technologischen und institutionellen Innovationen für bestimmte Standorte, Zielgruppen, Rohstoffe und Stufen der Wertschöpfungskette in ganz Afrika zu identifizieren, die im Hinblick auf die Ziele von PARI / SEWOH / GIC die größte Wirkung haben:

Mechanisierung: Die Forschung konzentrierte sich auf die Auswirkungen der Mechanisierung auf Kleinbauern und auf verschiedene Ansätze zur Steigerung des Einsatzes von Landmaschinen. Studien zeigten, dass die Mechanisierung auf Betriebsebene die Anbaufläche, das Einkommen, den Einsatz von Betriebsmitteln und die Nachfrage nach Arbeitskräften erheblich steigern kann. Beispielsweise haben sambische Bauern, die Traktoren einsetzen, 25% höhere Maiserträge und bearbeiten 75% mehr Land, wodurch sich ihr Einkommen verdoppelt. Vor allem Frauen profitieren von der Mechanisierung auf Betriebsebene durch Zeitersparnisse bei der Bodenbearbeitung. Die Mechanisierung wirkt sich auch auf die notwendige Nahrungszufuhr aus, da sie den Kalorienbedarf für landwirtschaftliche Tätigkeiten senkt. Digitale Technologien sind eine vielversprechende Möglichkeit, Kleinbauern die gemeinsame Nutzung von Maschinen zu erleichtern, vorausgesetzt dass die derzeitigen Rahmenbedingungen verbessert werden, z.B. durch Investitionen in Infrastruktur, digitale Kompetenz und institutionelle Strukturen.

Produktionsmittel und Finanzen: Die Forschung konzentrierte sich auf eine Reihe von landwirtschaftlichen Betriebsmittel, die für Kleinbauern und ländliche Kleinunternehmen notwendig sind z.B. Bewässerung, Elektrizität, Finanzen und Produktionsmittel. Studien zur Analyse des Potenzials für Investitionen in kleine Bewässerungsanlagen und erneuerbare Energien verdeutlichen, dass die Investitionen auf bestimmte Gebiete und Stufen der Wertschöpfungskette ausgerichtet werden müssen. In Benin fanden Forscher zum Beispiel heraus, dass in der Wertschöpfungskette von Mais hybride Diesel-Solar-Energiesysteme, die während des Mahlens eingesetzt werden, eine vielversprechende Investition für die Stromerzeugung und die Reduzierung von Treibhausgasemissionen sind. In Indien lieferte die Forschung wertvolle Erkenntnisse über die Nutzung institutioneller Kredite für Landwirte. Die Studie ergab, dass Finanzinnovationen in den Bereichen Agrarkreditpolitik, Kreditinstrumente, Organisationen und Mikro-ATMs wesentlich dazu beigetragen haben, den Zugang der Landwirte zu institutioneller Finanzierung zu verbessern.

Digitalisierung: Die Forschung konzentrierte sich auf die Ermittlung der notwendigen Rahmenbedingungen, die die Entwicklung, Skalierung und Wirkung von Informations- und Kommunikationstechnologien (IKT) gestützten Diensten in der Lebensmittel- und Landwirtschaft stimulieren können. Der gleichberechtigte Zugang zu mobilen Diensten, die Förderung digitaler Kompetenz, die Verfügbarkeit mobiler Zahlungssysteme und ein unterstützendes Innovationsumfeld für Unternehmer gehören zu den wichtigsten Faktoren zur Förderung der Digitalisierung. Diese müssen von Investitionen zur Bewältigung von strukturellen Zwängen im gesamten Lebensmittel- und Agrarsektor begleitet werden. Digitale Plattformen entwickeln sich zu einem vielversprechenden Ansatz, um landwirtschaftliche

Lösungen zu sammeln und anzuwenden, um Akteuren im Agrarsektor einen ganzheitlicheren digitalen Werkzeugkasten zur Verfügung zu stellen.

Sozioökonomische Aspekte der Tierhaltung: Die Forschung konzentrierte sich auf die Identifizierung von Ländern und Innovationen in der Tierhaltung, die das größte Potenzial für zukünftige Investitionen bieten. Zu den vielversprechenden technologischen Innovationen gehören Brachiaria-Futter, verbesserte Futterkonservierung und künstliche Besamung. Außerdem werden Masterpläne für die Viehzucht, Vermögenstransferprogramme und index-basierte Viehversicherungen als politische Innovationen mit hohem Potenzial hervorgehoben. Darüber hinaus haben Fallstudien über digitale Lösungen im afrikanischen und indischen Viehzuchtsektor ergeben, dass solche Anwendungen Viehzüchter mit Wissen und Fähigkeiten ausstatten, ihnen ein besseres Management ihrer Herden ermöglichen und den Zugang zu Produktionsmitteln und Dienstleistungen erleichtern können.

Nachhaltigkeit / Anpassung an den Klimawandel: Der wissenschaftliche Beitrag zu einer vom PARI unterstützten Konferenz bot Einblicke in die Auswirkungen des Klimawandels auf die Ernährungssicherheit in Westafrika. Die Teilnehmer der Konferenz forderten eine stärkere interdisziplinäre Forschungszusammenarbeit und eine aktivere Kommunikation zwischen Forschern und politischen Entscheidungsträgern. Im Anschluss an diese Veranstaltung werden laufende Forschungsarbeiten Investitionsmöglichkeiten zur Förderung von Beschäftigung, Wirtschaftswachstum und Ernährungssicherheit in der Sahelzone durch Maßnahmen an der Schnittstelle von nachhaltigem Landmanagement, Klimawandel und Energie identifizieren.

Arbeitspaket 2: Beschäftigungs- und Einkommensmöglichkeiten in ländlichen Gebieten, insbesondere für Jugendliche und Frauen

In diesem Arbeitspaket identifiziert die PARI-Forschung Optionen zur Schaffung von Arbeitsplätzen und anderen Einkommensmöglichkeiten in der ländlichen Wirtschaft im Allgemeinen und speziell für Jugendliche und Frauen in ländlichen Gebieten:

Beschäftigungsmöglichkeiten: Die Forschung konzentrierte sich auf Beschäftigungsmöglichkeiten in der Verarbeitung von landwirtschaftlichen Produkten. Studien in Ghana und Äthiopien zeigten, dass der Sektor durch eine hohe Arbeitsintensität, ein niedriges Qualifikationsniveau und weitgehend informelle Lieferketten gekennzeichnet ist. In Ghana beschäftigt der Sektor beispielsweise fast ein Drittel aller Arbeitskräfte und ist damit der größte Arbeitgeber im verarbeitenden Teilsektor. Die Beschäftigungsmöglichkeiten von Mann und Frau sind jedoch verschieden; in Äthiopien sind zum Beispiel mehr als zwei Drittel der Arbeitsplätze von Männern besetzt. Insgesamt bleibt ein Großteil des Beschäftigungspotenzials ungenutzt und die Produktivität der Industrien ist gering. Zwar dürfte die Mechanisierung längerfristig die Produktivität und die Qualität der Produktion steigern, doch werden dringend zusätzliche Investitionen in die Qualifikation von Arbeitnehmern erforderlich sein, um sicherzustellen, dass durch die Einführung von Maschinen Arbeitsplätze geschaffen und nicht ersetzt werden.

Kapazitätsaufbau und Bildung: Die Forschung untersuchte jeweils die Auswirkungen allgemeiner und spezifischer Bildung für Kleinbauern. Eine Studie ergab, dass Investitionen in die postprimäre Bildung (d.h. in die Sekundar-, Berufs- und Hochschulbildung) das größte Potenzial haben, den Einsatz von verbessertem Saatgut und Dünger sowie den Pro-Kopf-Verbrauch und den Zugang zu Krediten zu steigern - und zwar wesentlich mehr als die Alphabetisierung und die Grundschulbildung allein. So lagen beispielsweise bei den Personen mit postsekundärer Bildung je nach Land die Pro-Kopf-Ausgaben 14-45 % und der Zugang zu Kreditdienstleistungen 49-128 % höher. Eine Analyse der Maßnahmen zum Aufbau der Fähigkeiten von Kleinbauern in Indien zeigte, dass die Regierung als Katalysator bei der Konzeption, Umsetzung und Finanzierung solcher Programme einige Veränderungen herbeigeführt hat.

Engagement für die Jugend: Die Forschung analysierte groß angelegte Jugendinitiativen und bewertete die Auswirkungen der größten Interventionen auf Beschäftigung und Einkommensmöglichkeiten. Am erfolgreichsten bei der Schaffung von Arbeitsplätzen sind Initiativen, die bei der Gestaltung von Interventionen die einschlägigen Herausforderungen Jugendlicher während ihrer Entwicklung berücksichtigen und den Aufbau von Kapazitäten sowie den Zugang zu Startkapital, Produktionsmitteln und Mentoren vorsehen.

Arbeitspaket 3: Beteiligung an der Gestaltung der Ernährungs- und Agrarpolitik, um Ansätze für Innovationen zu fördern, die die Ernährungssicherung und Lebensmittelsicherheit verbessern

Dieses Arbeitspaket identifiziert und implementiert Strategien zur Unterstützung politischer Reformen im Zusammenhang mit landwirtschaftlichen Innovationen, ländlicher Entwicklung und Ernährungssicherheit in Afrika. Diese Forschung zu Reformen und dem politischen Kontext ist auch für den potenziellen Erfolg der Grünen Innovationszentren sowie für private Investitionen von entscheidender Bedeutung. Zu den Zielgruppen gehören politische Entscheidungsträger, die auf nationaler, subregionaler und kontinentaler Ebene in Afrika tätig sind, sowie globale politische Prozesse, die die Rahmenbedingungen für die afrikanische Landwirtschaft bilden.

Die Forschung ermittelte spezifische politische und institutionelle Rahmenbedingungen, die zum Erfolg oder Misserfolg der Einbindung politischer Entscheidungsträger in Innovationsprozesse beitrugen. Zu den ermittelten Schlüsselfaktoren gehören die Kompetenzen von politischen Interessenvertretern sowie die Identifizierung der Bedürfnisse politischer Entscheidungsträger und die Ausrichtung der Interventionen auf diese Bedürfnisse.

Zur Verbreitung der Ergebnisse und des Inputs in politische Prozesse organisierten und beteiligten sich die Partner des PARI-Konsortiums an mehreren Veranstaltungen, um wichtige Interessengruppen einzubeziehen, darunter sind afrikanische, deutsche und internationale Veranstaltungen (z.B. in Ghana, Nigeria und den USA). Die Öffentlichkeitsarbeit wurde durch soziale Medien und Publikationen, darunter Policy Briefs, Studien und Stellungnahmen unterstützt. Online-Statistiken zeigen, dass es PARI gelingt, ein breites Publikum afrikanischer Interessenvertreter zu erreichen und einzubeziehen.

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 as part of the *One World No Hunger* initiative by the German government. In 2019, the main achievements towards PARI's goals include:

Work Package 1: Innovation investments to improve the productivity and resilience of agricultural and food systems

In this work package, PARI research develops and applies approaches to identify the most cost-effective technological and institutional innovations for specific locations, target audiences, commodities and value chain stages across Africa that have the highest impact with regard to the PARI / SEWOH / GIC goals.

Mechanization: Research examined the impacts of mechanization on smallholders and on different approaches to increase take-up of farm machinery. Studies showed that farm-level mechanization can significantly increase cropping area, input use, demand for hired labour and incomes. For instance, Zambian farmers using tractors have 25% higher maize yields and cultivate 75% more land, thereby doubling their income. Women saved relatively more time during land preparation as a result of farm-level mechanization. Mechanization also impacts nutritional outcomes by reducing caloric requirements for farming. Digital tools offer a promising avenue to facilitate the sharing of farm-level machinery among smallholders, provided that the enabling environment is improved, e.g. through investments in infrastructure, digital literacy and institutions.

Inputs and finance: Research focused on various agricultural inputs necessary for smallholders and rural small businesses, including irrigation, electricity, finance and production inputs. Studies mapping the potential for small-scale irrigation and renewable energy investments highlighted the need for targeting investments to specific areas and value chain stages. Research in Benin, for instance, identified hybrid diesel-solar energy systems employed at the milling stage as the most promising investment for electricity generation and greenhouse gas reduction in the maize value chain. Research in India offered valuable insights on access to credit for farmers. The study found that financial innovations in agri-credit policies, credit instruments, organizations, and micro-ATMs have greatly helped to improve farmers' access to institutional finance.

Digitalization: Research assessed the necessary framework conditions that can stimulate the development, scaling and impact of ICT-enabled services in food and agriculture. Equitable access to mobile services, digital literacy, availability of mobile payment systems and a supportive innovation environment for entrepreneurs are among the main enabling factors, accompanied by investments to address broader structural constraints in the entire food and agriculture sector. Digital platforms are emerging as a promising approach to aggregate and integrate agricultural solutions to offer a more holistic digital toolbox to agricultural actors.

Socio-economic aspects of animal husbandry: Research identified countries and livestock innovations that offer the greatest potential for future investments. Promising technological innovations include Brachiaria forages, improved fodder conservation and artificial insemination, while livestock master plans, asset transfer programs and index-based livestock insurance are high-potential policy innovations. In addition, case studies of digital solutions in the livestock sector found that such applications can empower livestock farmers with knowledge and skills, allow them to better manage their herds and facilitated access to production inputs.

Sustainability / climate change adaptation: Scientific input into a PARI-supported conference offered insights on impacts of climate change on food security in Western Africa. Conference participants called for stronger interdisciplinary research collaborations and more active communication between researchers and policymakers.

Following on from this event, ongoing research will identify investment opportunities to advance economic growth, employment and food security in the Sahel region through actions at the nexus of sustainable land management, climate change and energy.

Work Package 2: Employment and income opportunities in rural areas, especially for youth and women

In this work packages, PARI research identifies options for generating jobs and other income opportunities in the rural economy in general and specifically for the rural youth and women.

Employment opportunities: Research focused on employment opportunities in the agroprocessing sector. Assessments in Ghana and Ethiopia showed that the sector is characterized by high labour intensity, low skill levels and largely informal supply chains. In Ghana, for instance, the sector employs close to a third of the total workforce, making it the largest employer in the manufacturing subsector. Employment opportunities are not gender-equal, however; in Ethiopia more than two thirds of the jobs are held by men. Overall, much of the employment potential remains untapped, and the productivity of the industries is low. Additional investments in skills will be urgently needed to ensure that the introduction of machines creates rather than replaces jobs.

Capacity building and education: Research assessed the impacts of general education on smallholders as well as specific skill training for farmers. Investments in post-primary education (i.e. secondary, vocational and university education) have considerably more potential for increasing the use of inputs, access to credit and per capita consumption than primary education. For instance, among those with post-secondary education, per capita expenditure was 14-45 % and access to credit services 49-128 % higher (depending on the country). An analysis of measures to build the skills of smallholders in India showed that the government has been a catalyst of change in this area in terms of designing, implementing and financing of such programs.

Youth engagement: Research mapped large-scale youth initiatives and assessed the impact of the largest interventions on employment and income opportunities. Initiatives that consider pertinent youth development challenges in the design of the interventions and provide capacity building, access to production assets, start-up capitals and mentorship are most successful in job creation.

Work Package 3: Engaging with food and agriculture policy making to enhance food and nutrition security

This work package identifies and implements strategies to support policy reforms related to agricultural innovation, rural development and food security in Africa. This research on policy context and reforms is of critical importance also for the potential success of the Green Innovation Centers as well as private investments. The target audience includes policy-makers engaged at national, sub-regional and continental levels in Africa as well as global policy processes that shape the framework conditions for African agriculture

Research identified specific political and institutional framework conditions that contributed the success or failure of engaging policy makers in innovation processes. Key factors include the competencies of involved policy stakeholders, appropriate identification of policymakers' needs and alignment of interventions to their needs.

To disseminate PARI findings and input into policy processes, partners in the PARI consortium organized and participated in several events to engage key stakeholders, including African, German and international events (for instance in Ghana, Nigeria and USA). Outreach activities were supported by social media and publications, including policy briefs, studies and opinion pieces. Online statistics show that PARI is reaching and engaging a wide audience of African policy stakeholders.

1. Project overview

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. 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**.

Specific PARI research themes have evolved over time, reacting to the needs and questions of BMZ's SEWOH initiative and the innovation research challenges and needs in the partner countries in Africa and India. In his sense, PARI's collaborative work in the third phase (2019-21) is re-organized around the following research areas:

WP 1: Investments in innovations to improve the productivity and resilience of agricultural and food systems

Activity I/1: Accompanying **impact analyses to identify cost-effective innovations** for particular agro-ecological conditions, target groups, agricultural products and value chains, which can have the most wide-ranging impact for achieving the SEWOH goals.

Activity I/2: Development and testing of **strategies for scaling** promising innovations that strengthen rural areas, i.e. seed systems, fertilizer, finance

Activity I/3: Development and application of indicators and methods for **monitoring and evaluation of investments** with regard to impacts on employment generation, food and nutrition security and the wider economy.

Thematic focus areas in this work package include:

- Mechanization along value chains
- Inputs (seed, fertilizer) and finance for smallholders and rural small businesses
- Digitalization in food and agriculture
- Socio-economic aspects of animal husbandry
- Sustainability / climate change adaptation
- Agroforestry

WP 2: Employment and income opportunities in rural areas, especially for youth and women

Activity II/1: Ex ante impact analyses of the **direct and indirect employment effects of investments and policy reform** for target groups, regions and the wider economy.

Activity II/2: Research will assess options for developing the necessary **capacities to enable productive employment and income generation** along agricultural value chains.

Activity II/3: Specific studies regarding the impacts of innovations and policy reforms on **employment and capacity development of youth and women.**

Activity II/4: Research will investigate options for linking rural development with **social security** systems (productive safety nets) and **infrastructure investments** (including for transport, water, electricity and mobile connectivity).

WP 3: Policy Consultation and Policy Reform Theme

Activity III/1: Ex ante and accompanying impact analyses to assess **conducive political and institutional framework conditions** for the development, adaptation and scaling of innovations.

Activity III/2: Support **multi-actor partnerships** for the accompanying research and implementation of investment projects by strengthening pan-African networks for rural and agricultural transformation and capacity building.

Activity III/3**:** Evidence-based input into **high-level policy fora** in Africa, e.g. the Malabo-Montpelier Forum the African Green Revolution Forum, the Conference of the African Association of Agricultural Economists and the FARA Science Week.

Core partners

Partner organizations	Focal point
• **ZEF** Center for Development Research University of Bonn	Prof. Dr. Joachim von Braun, Project Director Dr. Heike Baumüller, Project Coordinator
• **AGRODEP** African Growth and Development Policy Modeling Consortium (AGRODEP) International Food Policy Research Institute (IFPRI)	Dr. Ousmane Badiane, IFPRI Director for Africa
• **FARA** Forum for Agricultural Research in Africa	Dr. Yemi Akinbamijo, Executive Director Dr. Wole Fatunbi, Project Coordinator
• **UHO** University of Hohenheim	Prof. Dr. Regina Birner, Head of Social and Institutional Change in Agricultural Development

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

- Agricultural Research Council of Nigeria (ARCN), Nigeria
- Council for Scientific and Industrial Research (CSIR), Ghana
- Department of Agricultural Research Services (DARS), Malawi
- Policy Studies Institute (PSI, formerly Ethiopian Development Research Institute EDRI), Ethiopia
- Indian Council for Research on International Economic Relations (ICRIER)
- Institut de Recherche Agricole pour le Development (IRAD), Cameroon
- Institut d'Economie Rurale (IER), Mali
- Institut de L'Environment et de Recherches Agricoles (INERA), Burkina Faso
- Institut National de Recherche Agronomique de Tunis (INRAT)
- Institut Togolaise de Recherche Agronomique (ITRA)
- Kenya Agricultural and Livestock Research Organization (KALRO)
- Lilongwe University of Agriculture & Natural Resources (LUANAR)
- National Agricultural Research Institute of Benin (INRAB)
- Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)
- University of Nairobi, School of Computing and Informatics
- Université Cheikh Anta Diop de Dakar, Senegal (UCAD)
- Zambia Agriculture Research Institute (ZARI)

2. Activities and achievements in 2019

WP 1: Innovation investments to improve the productivity and resilience of agricultural and food systems

In this work package, PARI research seeks to develop and apply approaches to identify the most cost-effective technological and institutional innovations for specific locations, target audiences, commodities and value chain stages across Africa that have the highest impact with regard to the PARI / SEWOH goals.

Specifically, research focuses on three inter-related strands:

a) Accompanying impact analyses to identify cost-effective innovations

b) Development and testing of strategies for scaling promising innovations that strengthen rural areas, i.e. seed systems, fertilizer, finance.

c) Development and application of indicators and methods for monitoring and evaluation of investments

Related research activities were undertaken with regard to different thematic focus areas:

a) Mechanization along value chains

Research under this theme focused on mechanization at the **farm level** as well as in the **food processing sector**. Information on the former is provided in this section, while research related to the food processing sector is described under WP2.

Are private- or state-led initiatives more effective in improving access to tractors for smallholders?

What skills are required?

Farm level mechanization was studied by a consortium consisting of researchers from the University of Hohenheim, ZEF, FARA, ARCN (Nigeria), KARLO (Kenya), INRAB (Benin) and IER (Mali). Using the same survey methodologies and tools in the four African countries, the research sought to (1) compare the effectiveness of **state-led and private sector-led mechanization** (with a focus on tractors), (2) the status of **skill levels and training institutes** related to mechanization and (3) the **attitude of policy makers** towards farm-level mechanization. Country studies[1] were completed and a cross-country analyses will be published in 2020.

How has agricultural mechanization changed the productivity of African smallholders?

Another study led by ZEF assessed the **state, drivers and effects of farm-level mechanization in Africa**.[2] The study found that agricultural mechanization significantly increases the amount of cropland cultivated (extensification) and is also accompanied by input intensification, especially in countries where land expansion is naturally limited. Furthermore, agricultural mechanization significantly raised the productivity of maize and rice in all cases.

How is mechanization impacting the use of labour and energy among smallholders?

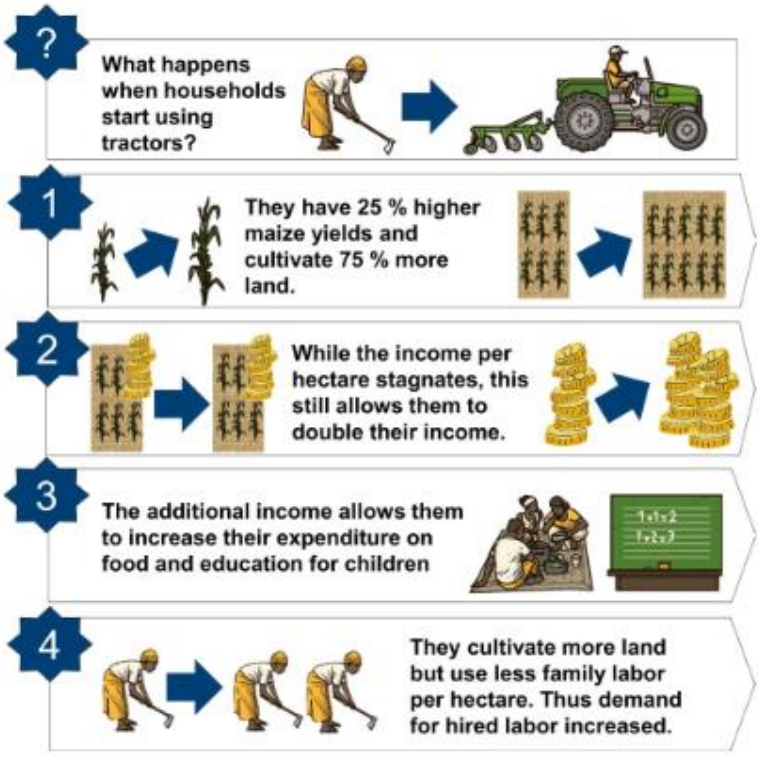
How the **introduction of tractors is impacting labour and caloric energy requirements** at the farm was examined by several studies led by the University of Hohenheim. The study on labour impacts found that women benefit relatively more from mechanization with regard to time-use

[1] The country studies are vailable at https://library.faraafrica.org/research-reports/.

[2] Published as ZEF-Discussion Papers on Development Policy No. 272: The Agricultural Mechanization in Africa: Micro-level Analysis of State Drivers and Effects (2019) and PARI Policy Brief No. 18

during land preparation (see also **Fehler! Verweisquelle konnte nicht gefunden werden.**).[3] The second study reported that farm technologies affect nutritional outcomes substantially. Overall, energy required for farming largely determines daily energy requirements. Transportation and domestic chores further contribute significantly to energy needs. Mechanizing these activities therefore greatly reduces caloric requirements.[4]

Figure 1: Labour impacts of tractor use



Source: PARI Policy Brief No. 20

How effective are digital technologies to facilitate sharing of farm machinery?

Research led by the University of Hohenheim also assessed the **utility of information and communication tools to improve access to tractors** (also referred to as Uberization of farm machinery) using India and Nigeria as case studies. A comparative study published in early 2020[5] notes the potential of ICT-based tractor hire but finds that many of the thornier challenges of agricultural markets – which urban ride-hailing markets do not face – have yet to be addressed which undermines the effectiveness of ICT-enabled services. The enabling environment for such services would need to be improved, e.g. through investments in infrastructure, digital literacy and institutions.

[3] Published as ZEF-Discussion Papers on Development Policy No. 262: Can Big Companies' Initiatives to Promote Mechanization Benefit Small Farms in Africa? A Case Study from Zambia (2019) and Policy Brief No. 20

[4] Published as ZEF Working Paper: 182: The forgotten agriculture-nutrition link: Estimating the energy requirements of different farming technologies in rural Zambia (2019) and PARI Policy Brief No. 21

[5] Published as Hohenheim Working Papers on Social and Institutional Change in Agricultural Development, 001-2020, Uber for tractors? Opportunities and challenges of digital tools for tractor hire in India and Nigeria

Finally, PARI findings to date as well as related research were summarized in a study on **African agricultural mechanization: Myths, realities and an emerging research agenda**.[6] The paper finds that some of the commonly held beliefs about mechanization are accurate, but many are too simplistic and some are plainly wrong or "myths". Such popular myths can mislead policies and programs to promote mechanization and lead to adverse effects on farmers.

What do we really know about the impact of agricultural mechanization on Africa's smallholder farmers?

In addition, country-specific studies on mechanization published in 2019[7] include:

- Study of Mechanized Agricultural Services Needs in the Rural Communities of Béréba and Koumbia in the Cotton-Growing Region of Western Burkina Faso, FARA Research Report Volume 4 No. 7
- Suitability of Different Processing Techniques and Sales Options for Irish Potato (Solanum Tuberusum) Cultivars in Cameroon, FARA Research Report Volume 4 No. 4
- A Comparative Study on the Determinants of the Level of Mechanization in Kenya: The Case of Rice and Banana Value Chains, FARA Research Report Vol. 4 No. 15

Moreover, research was launched in 2019 to assess the status of **mechanization/automation in the African food and beverage industry**, as well as related impacts on jobs and skill requirements. Further details are provided in WP 2 below.

b) Inputs (seed, fertilizer) and finance for smallholders and rural small businesses

Irrigation: AGRODEP members contributed to PARI's research on irrigation by assessing the potential for small-scale irrigation investment in Niger and Mali based on a combination of biophysical and socioeconomic factors using IFPRI's ex-ante irrigation potential assessment framework.[8] The types of small-scale irrigation technologies under study included (1) motor pumps, (2) treadle pumps, (3) communal river diversion, and (4) small reservoirs. Data collection and processing was completed in 2019 and the final study will be published in 2020.

Where should we invest in small-scale irrigation for agricultural production in Africa?

Electricity: The University of Hohenheim in collaboration with INRAB (Benin) explored the potentials of using photovoltaic systems for agricultural development in different farming systems in Africa. The study aims at geographically mapping the potentials of using photovoltaic applications in agriculture. The results are expected in 2020. Preliminary results identified hybrid diesel-solar energy systems employed at the milling stage to be the most promising investment for electricity generation and greenhouse gas reduction in the maize value chain in Benin.

Where should we invest in solar energy across different farming systems and value chain stages in Africa?

[6] Published as ZEF Working Paper No. 189: African agricultural mechanization: Myths, realities and an emerging research agenda (2019)
[7] Available at https://library.faraafrica.org/research-reports/
[8] See PARI Policy Brief No. 12.

Finance: A study led by Ashok Gulati from ICRIER reported on the evolution, innovativeness and effectiveness of the agricultural credit system for Indian farmers.[9] The study showed that the share of institutional credit to farming households in overall credit increased from about 10 percent in 1951 to 63 percent in 1981. Innovations in agri-credit policies, credit instruments, organizations, business correspondents and micro-ATMs, have greatly helped to improve farmers' access to institutional finance.

What can we learn from India's experience in providing credit to its smallholders?

Post-harvest technologies: Using vegetable value chains in Senegal as a case study, an AGRODEP-led study examined where and to what extent post-harvest losses occur on the farm and what potential economic benefits could be obtained by reducing these losses. The results suggest that on average 30% of vegetable production is lost on farm and is therefore unavailable for sale or consumption. Eliminating these losses could increase the total value of supply by US $72 million per year and reduce imports by 127,000 tons per year. The study will be published in 2020.

Where do most losses occur on the farm and how much could be gained by introducing suitable innovations to reduce losses?

Production inputs: Several country-specific studies coordinated by FARA addressed issues related to production inputs for selected GIC-supported value chains:

What are the challenges and opportunities for increasing input use in selected value chains?

- ITRA (Togo) evaluated challenges related to the **production and conservation of peanut**, such as the absence of selected seeds adapted to agro-ecological conditions and resistant to diseases; lack of commercial seed multipliers; disease infestation of the peanut plants; and insufficient extension workers or technology transfer for peanut cultivation.[10] The researchers proposed multiple solutions, such as facilitating the creation of peanut producer groups, training extension workers on the technical routes of peanut farming, and subsidizing the price of seed of improved varieties.
- Another study led by PSI (Ethiopia) focused on the **productivity of wheat and faba bean cultivation** in Ethiopia.[11] The results suggest that production constraints could be addressed through the release of new agricultural technologies adapted to diverse agroecologies and resistant to crop diseases, adoption of existing technical and management innovations, and supply of improved inputs.
- Two additional studies by PSI examined the **determinants for adoption of chemical fertilizer and improved seed and the role of information in this regard.**[12] Important determining factors for adoption include household size and education as well as institutional factors. Community gatherings and on-farm visits by extension workers were found to be important sources of agricultural information that could encourage farmers to use more inputs.

[9] Published as ZEF Working Paper: 184: Agricultural Credit System in India: Evolution, Effectiveness and Innovations (2019)

[10] Published as FARA Research Report Volume 4 No: 10: Evaluation of the Inventory of Endogenous Knowledge on the Production and Conservation of Peanut in Togo (2019)

[11] Published as FARA Research Report Volume 4 No: 5: Innovation Opportunities for Wheat and Faba Bean Value Chains in Ethiopia (2019)

[12] Published as FARA Research Report Volume 4 No: 3: Evaluation of Modern Agricultural Technologies Adoption and Impact of Adoption on Productivity (2019)

c) Digitalization in food and agriculture

What framework conditions are needed to speed up digitalization in African food and agriculture?

A consortium of PARI partners consisting of ZEF, KALRO (Kenya), ARCN (Nigeria) and CSIR-STEPRI (Ghana) undertook research to assess the status of information and communication technologies (ICTs) in the three countries, map digital services in the agriculture sector, and examine the elements of the enabling environment that have hindered or helped the emergence of the ICT sector and related agricultural services in the respective country. Based on these analyses, the research seeks to identify the **necessary framework conditions that can stimulate the development, scaling and impact of ICT-enabled services in food and agriculture**. A cross-country review of the country-specific research findings[13] will be published in 2020.

Can SMS-based crowdsourcing be used to monitor the food security situation of rural households?

In addition, ZEF in collaboration with GeoPoll is using an SMS-based survey tool to collect monthly data on the current food security status of the responding households in Uganda and Sierra Leone over the course of one year. This research will help to assess the suitability of **SMS-based crowdsourcing of data to monitor food security indicators** as in input into timely and accurate early warning systems. In addition, the collected data can be overlaid with other indicators to assess the impact of shocks, such as the spread of locusts in East Africa or the corona pandemic across Africa. The survey will continue throughout 2020.

What could a digital platform look like that aggregates different digital services in agriculture?

Research implemented jointly by ZEF and the University of Nairobi continued to assess the technological and economic feasibility of **aggregating ICT services in a single platform**. In 2019, qualitative data was collected on the technical and economic feasibility of an aggregator platform from the perspective of service providers through key informant interviews and focus group discussions. In addition, an online survey assessed the demand for a mobile services aggregation platform among agricultural value chain actors. The results will be published in 2020.

Are African governments and digital service providers protecting the data privacy rights of users?

Research got underway in 2019 to map the regulatory landscape with regard to **data privacy and protection** across Africa. In addition, the data privacy provisions of digital agricultural services are being reviewed to assess whether they conform with national regulations and international best practice. The research results will be published in 2020.

d) Socio-economic aspects of animal husbandry

What are the opportunities and challenges for innovation in dairy value chains?

As part of a series of studies that seek to identify innovation opportunities in selected GIC-supported value chains, FARA released a report compiled by KALRO which maps innovation opportunities in **dairy livestock in Kenya**, including value chain analyses for dairy cattle, goats and camels.[14] The findings suggest that although there is an upward trend in production for all three value chains, productivity remains low due to several challenges including poor access to improved breeds, high cost of manufactured animal feed, inadequate and in some cases nutrient-poor fodder, diseases and pests, droughts, underdeveloped extension services and lack of veterinary services.

[13] The country studies are available at https://library.faraafrica.org/research-reports/.
[14] Published as FARA Guide Book 2019: Innovation Opportunities in Dairy Livestock in Kenya (2019)

Which countries and livestock innovations offer the greatest potential for future investments?

Building on the research undertaken in Kenya, **comprehensive livestock studies** were undertaken in Mali (IER)[15], Kenya (KARLO)[16] and Ethiopia (ILRI)[17]. The studies outline the constraints and opportunities of the sector in their countries and identify promising technical and institutional innovations that have helped to advance its development. Promising technological innovations include Brachiaria forages, improved fodder conservation and artificial insemination, while livestock master plans, asset transfer programs and index-based livestock insurance are highlighted as among the policy innovations. A synthesis study will be published in 2020 which will identify **high priority countries and innovations for investment** in Africa's livestock sectors.

Where should livestock investments be targeted within countries?

Researchers from AGRODEP initiated studies in late 2019 to identify **high-potential areas for livestock sector development** in Mali and Ethiopia, using a methodology to generate rural typology maps of micro-regions applied in the first phase of PARI.[18] To this end, the research seeks to identify the key factors that influence the potential of sub-national geographical regions for livestock production in consultation with African policy makers and other livestock sector stakeholders (e.g. availability of water and feed, market access, veterinary services, prevalence of livestock diseases etc.); and collect and overlay related geospatial data to develop rural typology maps for the two countries. The research will be published in 2020.

How can digital tools be used to improve livestock production in Africa and India?

The University of Hohenheim undertook a review and assessment of **digital tools in the livestock sector**. To this end, the researchers mapped relevant digital tools in Africa. Case studies in India and Africa of selected digital services were conducted to assess the function, organization, governance challenges as well as the potential effects of the applications (Picture 1). The studies showed that such applications can empower male and female livestock farmers with knowledge and skills, allow them to better manage their herds and facilitated access to production inputs and services. The research will be published in 2020.

In addition, the University of Hohenheim in collaboration with Fodjan GmbH continued to further develop the **diet formulation app for cattle** - a precision farming tool for smallholder dairy farmers that assists in optimizing energy and protein supply and balancing milk yields against feeding costs (Figure 2). In 2019, the feed app user interface was improved by implementing suggestions made by Kenyan farmers collected in 2018.

[15] Published as FARA Research Report Vol. 5 No. 7: Potential and drivers of livestock production in Mali (2020)

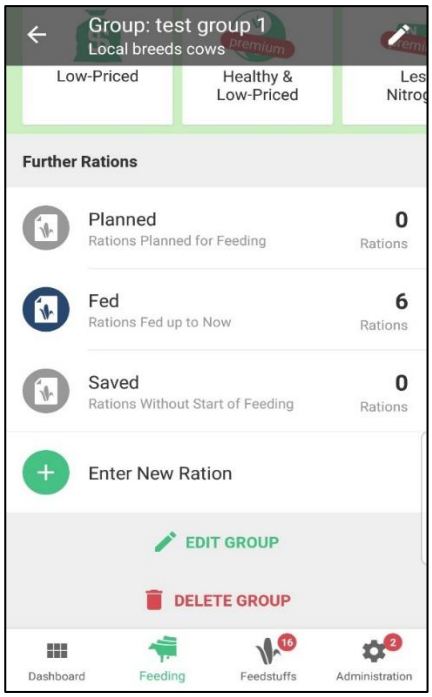
[16] Published by FARA as Mose et al. (2020) An Appraisal of Selected Innovation Cases in the Livestock Sector in Kenya.

[17] forthcoming in 2020

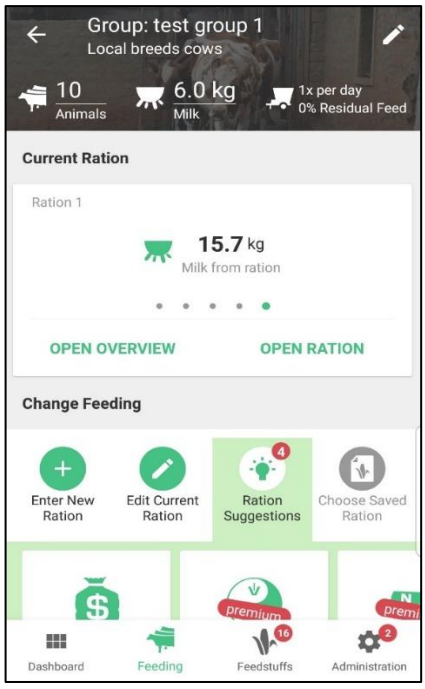
[18] Maruyama et al. (2018) Frontier Analysis and Agricultural Typologies. ZEF Discussion Papers on Development Policy No. 251.

Picture 1: PARI researchers meet ICT stakeholders in India

Figure 2: Screen shots of the diet formulation app



A: interface for creating a new ration



B: using an existing ration within the user's database

e) Sustainability / climate change adaptation

How will climate change impact food security in Western Africa and how can impacts be mitigated?

The Université Cheikh Anta Diop de Dakar (UCAD) and ZEF co-hosted a scientific **Conference on Climate Change and Food Security in West Africa** on 17-18 November 2019 in Dakar, Senegal. In particular former and current students of the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) Program submitted innovative papers on different aspects of the nexus between climate change and food security. In total, more than 250 full research papers were submitted, of which 35 outstanding papers were competitively selected by leading climate change academics from the region. Conference participants stressed that enhancing food security under climate change in Western Africa calls for stronger interdisciplinary research collaborations and more active communication between researchers and policymakers across the region. A selection of the best papers was published in the conference proceedings.[19]

How can measures to combat climate change and land degradation promote economic growth in the Sahel region?

In late-2019, a collaborative research effort was launched that brings together leading authors from the Sahel region to identify **investment opportunities to advance economic growth, employment and food security in the Sahel region** through actions at the nexus of sustainable land management, climate change and energy. Country studies are being prepared for Burkina Faso, Ethiopia, Mali, Niger, Nigeria, Senegal and Sudan, as well as a synthesis study that will draw out lessons for the entire region. The research outputs will be published in 2020.

WP 2: Employment and income opportunities in rural areas, especially for youth and women

In this work packages, PARI research is examining options for generating jobs and other income opportunities in the rural economy in general and specifically for the rural youth and women. The focus is on employment along agricultural value chains (e.g. logistics, processing, retail) as well as supporting businesses (e.g. financial services, machinery operators, mechanics).

Specifically, research focuses on three inter-related strands:

a) ex ante impact analyses of the direct and indirect employment effects of investments and policy reform

b) Assessment of options for developing the necessary capacities to enable productive employment and income generation along agricultural value chains.

c) Examine impacts of innovations and policy reforms on employment and capacity development of youth and women

d) investigate options for linking rural development with social security systems and infrastructure investments

[19] Available at https://research4agrinnovation.org/publication/proceedings-wascal-conference/

a) Employment opportunities

PARI research seeks to estimate the **potential of the agroprocessing sector to create employment** and assess how investments and other interventions in the food sector affect the quantity, quality and inclusiveness of jobs. The research project is composed of two components.

What is the state of employment in the agroprocessing sector in Africa?

The first component of the project, which is implemented by ZEF, PSI (Ethiopia)[20], CSRI-STEPRI (Ghana)[21] and INRAT (Tunisia)[22], involves **mapping employment in the agroprocessing sector** in each of the countries based on selected sectoral indicators; as well as primary data collection at the firm level, i.e. key informant interviews with owners and/ or managers, and, whenever possible, focus group discussions with workers. The research showed that the agro-processing sector is characterized by high labour intensity, low skill levels and largely informal supply chains. In Ghana, for instance, the sector employs close to a third of the total workforce, making it the largest employer in the manufacturing subsector. Employment opportunities are not gender-equal, however; in Ethiopia more than two thirds of the jobs are held by men. Overall, much of the employment potential remains untapped and the productivity of the industries is low. A synthesis of the research findings from the countries will be published in 2020.

How can mechanization and automation of food processing create rather than replace jobs?

The second component led by ZEF and implemented in collaboration with the SADC Research Centre and PSI (Ethiopia) is investigating **where and under what conditions mechanization and automation in the African food and beverage industry will generate employment and lead to equitable income gains.** To this end, the study will assess the status and potential of mechanization/automation in the African food and beverage industry; evaluate the skill needs, availability of skilled labour and the status of related education opportunities; and assess the labour impacts of mechanization/automation to identify the most promising entry points for investments for employment generation. The research was launched in late 2019 and will focus on South Africa, Nigeria, Kenya and Ethiopia.

b) Capacity building and education

In which levels of education should we invest to raise productivity and incomes of smallholder farmers?

A study led by ZEF assessed the extent to which **different levels of education influence the use of productive inputs and overall economic outcomes** (consumption, expenditure and poverty) **among smallholder farmers** in four African countries (Ethiopia, Malawi, Nigeria and Tanzania)[23]. The findings suggest that post-primary education (i.e. secondary, vocational and university education) significantly increases the use of improved seed varieties and fertilizer, access to credit services, and per capita consumption expenditure – considerably more so than mere introductory literacy and primary education. For instance, among those with post-secondary education, per capita expenditure was 14-45 % and access to credit services 49-128 % higher (depending on the country).

[20] Published as FARA Research Report Vol. 5 No. 13: Employment Potential of the Agro-processing Manufacturing Sector in Ethiopia (2020)

[21] Published as FARA Research Report Vol. 5 No. 14: Employment Potential of the Food and Beverage Sector in Ghana (2020)

[22] Forthcoming in 2020

[23] Published as ZEF-Discussion Papers on Development Policy No. 277: The complementarity of education and use of productive inputs among smallholder farmers in Africa (2019)

To foster South-South learning, research in this area reviewed policies and institutions that are operational in the context of **skill formation in the Indian agriculture and food sector**.[24] The focus is on quality of training, assessment and certification, which are prerequisites for investments in skills to bring higher returns in terms of remunerative jobs. The government has been a catalyst of change in this area in terms of designing, implementing and financing of such programs. The role of private players including both as potential employers as well as global partners (government, business and nongovernmental organizations) has been widely recognized in upgrading the scope, target and outcomes as well as ensuring sustainability of the national skill development program.

What can we learn from India's experience in building the skills of its smallholders?

As part of PARI's collaboration with the African Economic Research Consortium (AERC), PARI aimed to contribute to AERC's effort at **enhancing the capacities for economic policy research and graduate training in sub-Saharan Africa**. Within this, financial and academic support is being provided to postgraduate students to undertake research within the thematic areas of PARI. Overall, 15 master thesis and 5 PhD dissertations will be funded.

c) Youth engagement

A consortium of PARI partners, including FARA, ZEF, INRAB (Benin), PSI (Ethiopia), CSIR-STEPRI (Ghana), DARS (Malawi) and LUANAR (Malawi), undertook a series of country[25] and cross-country studies to examine **large-scale youth employment initiatives** implemented in the rural areas of the four countries between 2000 and 2018 and assess the impact of the identified initiatives. A desk review was initially carried out to identify four major initiatives in each country, followed by qualitative surveys to better understand the initiatives targeting strategy, implementation details, outcomes, and monitoring and evaluation mechanism. A survey of 2380 youth spread across the four countries was subsequently carried out to assess the overall impact of the interventions. A first synthesis of the qualitative data concluded that those youth employment initiatives that considered relevant youth development challenges in their design and provided capacity building, access to production assets and technology, start-up capitals and mentorship were most successful in job creation.[26]

How can large-scale youth employment initiatives generate employment and income opportunities for the youth in the long-run?

d) Infrastructure investments

Research led by AGRODEP seeks to identify regions within countries that offer the best opportunities for further **investments in integrated infrastructure development**, with a focus on water, electricity and transport infrastructure. To this end, the researchers are combining GIS layers and middle-resolution satellite data on existing infrastructure (irrigation, rural electrification, and roads) with the agricultural typology work developed for PARI 1.0. Thereby, the researchers can assess where smallholder agricultural productivity can be significantly increased through different public and private investments such as electric pumps and examine

Where will investments in integrated infrastructure development yield highest productivity gains among smallholders?

[24] Published as ZEF Working Paper 183: Skill Development in Indian Agriculture and Food Processing Sectors: A Scoping Exercise (2019)

[25] Available at https://library.faraafrica.org/research-reports/.

[26] Published as FARA Research Report No. 5 No. 16, Characteriziation of Youth Employment Initiatives in selected African Counties: A Synthesis Report. The country studies are available at https://library.faraafrica.org/research-reports.

how the existing road network layout can be improved to better connect those and other areas with high agricultural potential to local, regional, and national markets. The research results for Senegal and Burkina Faso will be published in 2020.

WP 3: Engaging with food and agriculture policy making to enhance food and nutrition security

This work package focuses on identifying and implementing strategies to support **policy reforms related to agricultural innovation, rural development and food security in Africa**. The target audience includes policy-makers engaged at national, sub-regional and continental levels in Africa as well as global policy processes that shape the framework conditions for African agriculture, such as trade, investment and climate change policies. In addition to the cluster leaders, key African players to engage in this context will include the African Union, NEPAD, the regional economic communities, national policy think tanks and the Malabo-Montpellier Panel.

Specifically, research and outreach activities focus on three inter-related strands:

a) impact analyses to assess conducive political and institutional framework conditions for the development, adaptation and scaling of innovations

b) support multi-actor partnerships for the accompanying research and implementation of investment projects by strengthening pan-African networks for rural and agricultural transformation and capacity building

c) evidence-based input into high-level policy fora in Africa

a) Political and institutional framework conditions

What determines the success or failure of engaging policy makers in innovation processes?

Research led by FARA in collaboration with the PARI country partners assessed factors that have contributed to **the success or failure of engaging African policy makers in agricultural innovation processes** in the past to draw out lessons for effective engagement in the future.[27] Key factors identified include the competencies of involved policy stakeholders as well as an appropriate identification of policymakers' needs and alignment of interventions to their needs. The study therefore calls for the engagement of competent researchers in policy processes, adequate financial supply, adequately capacitated technical partners, and smart engagement with target beneficiaries as a key to a successful agricultural innovation process.

Are African policies on track to meet continental and global agricultural development targets?

AGRODEP researchers from Cote d'Ivoire, Ethiopia, Malawi, Mozambique, Niger and Rwanda assessed to what extent their **governments' policies are likely to achieve their agricultural development commitments**. Specifically, the research analysed the countries' national agricultural investment plans (NAIPs) to assess whether they are sufficient to meet the Malabo targets, selected Sustainable Development Goals (SDGs) and Agenda 2063. An economic modelling framework was developed in order to assess the investments and agricultural transformation requirements to achieve the multiple goals simultaneously. Modelling activities were completed in 2019 and the results will be published in 2020.

[27] Published as FARA Research Report Vol. 4 No. 6: Understanding the Engagement of Policymakers in the Success or Failure of Agricultural Innovation Processes: Lessons from Africa Countries (2019)

b) Strengthening multi-actor partnerships and pan-African networks

PARI continued to strengthen its existing pan-African networks in the second phase of PARI:

- Particular emphasis was placed on linking and building the capacities of **AGRODEP members** through joint workshops and research development as well as mentoring by senior IFPRI researchers.
- Widespread outreach activities and dissemination of PARI research findings among **FARA's extensive network of policy actors** in Africa served to raise awareness of PARI among key stakeholders, engage new researchers in PARI activities and foster linkages between the research community and policy makers.

Research and capacity building initiatives outlined above also sought to strengthen and expand pan-African research partnerships:

- The **ZEF-UCAD conference on climate change and food security** in November 2019 brought together former and current WASCAL students working on these issues to foster academic exchange and long-term engagement (**Fehler! Verweisquelle konnte nicht gefunden werden.**).
- The **collaboration with AERC** serves to build a network of researchers working on issues related to agricultural and rural development in Africa. PARI researchers will directly engage with students and faculty members to provide input into the research activities, co-publish articles and participate in training activities. Efforts will be made to maintain linkages with students after graduation to further expand the network of researchers and policy makers for future collaborative activities and outreach.

Picture 2: Participants at the ZEF-UCAD Conference on climate change and food security in Senegal

c) Evidence-based input into high-level African policy fora

Download statistics show that PARI publications are attracting much attention among policy stakeholders. In particular studies published and circulated through the FARA network are reaching a large audience of primarily African readers (Table 1).

Table 1: Download statistics for selected PARI publications published by FARA

Title	Online Access statistics	
	Downloads	*Hits*
Engagement of Policy Makers in Agricultural Innovation Processes in Ghana: Cases of Fisheries and Livestock Commodities	2352	6060
Research Notes on Current Issues in Cameroon Agriculture	1968	5412
A Comparative Study on the Determinants of the Level of Mechanization in Kenya: The Case of Rice and Banana Value Chains	1716	5052
Policy Makers Engagement in Agricultural Innovation Processes in Ghana: Successful and Unsuccessful Cases of Technology Dissemination	1572	5328
Understanding the Engagement of Policymakers in the Success or Failure of Agricultural Innovation Processes: Lessons from Africa Countries	1452	4848
Innovation Opportunities for Wheat and Faba Bean Value Chains in Ethiopia	1392	6288
Report on Rice Innovation Platform in Mali	1260	6096
Engagement of Policy Makers in Agricultural Innovation in Tunisia: Stories of Success and Failures	1236	5076
Adoption of Technologies and Crop Productivity in Ethiopia: The Role of Agricultural Information	1212	3996
Assessment of the Tunisian Olive Oil Value Chain in the International Markets: Constraints and Opportunities	1128	3924

PARI publications published through ZEF channels are also reaching a sizeable number of readers (Table 2).

Table 2: Download statistics for selected PARI publications published by ZEF

Title	Citations	Readers	Downloads
Honey Bee Network in Africa: Co-creating a Grassroots Innovation Ecosystem in Africa	14	371	198
The forgotten agriculture-nutrition link: Estimating the energy requirements of different farming technologies in rural Zambia	7	299	128
African agricultural mechanization: Myths, realities and an emerging research agenda	1	277	60
4Uber for tractors? Opportunities and challenges of digital tools for tractor hire in India and Nigeria		234	6
Foreign direct investment in the African food and agriculture sector: trends, determinants and impacts		190	180

f) Policy Briefs

Seven additional policy briefs were generated as part of PARI's work in 2019, in order to aid the on-going communications policy:

- PARI Policy Brief No. 12: Small-Scale Irrigation Potential In Sub-Saharan Africa
- PARI Policy Brief No. 13: How to Keep Tractors Running in Africa?
- PARI Policy Brief No. 14: Foreign Direct Investments In Africa's Food And Agriculture Sector
- PARI Policy Brief No. 15: Seed System Development: Fertile Grounds In Sub-Saharan Africa
- PARI Policy Brief No. 16: Improving energy access in rural areas
- PARI Policy Brief No. 17: Improving protein nutrition of dairy cattle in the tropics
- PARI Policy Brief No. 18: Mechanizing African Agriculture

g) Policy Events

During 2019, PARI hosted or participated in several policy-relevant conferences in Germany and Africa to share research insights and policy recommendations, and network with partners. In addition to the above-mentioned **ZEF-UCAD conference on climate change and food security** in November in Senegal, other highlights included:

PARI Side-event at the African Green Revolution Forum, 3-6 September, Ghana:

Under the theme "Grow Digital: Leveraging digital transformation to drive sustainable food systems in Africa", the **African Green Revolution Forum 2019** took place in Ghana in September. PARI researchers used this opportunity to present their research on digitalization to key African policy stakeholders. At a side-event organised by the Bill and Melinda Gates Foundation and CTA, PARI coordinator Dr. Heike Baumüller gave a moon-shot pitch outlining her vision for digitalization in African agriculture by 2030.

At the side-event organised by PARI on "Creating an enabling environment for digitalization to transform African Agriculture", researchers from the Kenya Agriculture and Livestock Research Organisation (KALRO), the Council for Scientific and Industrial Research of Ghana (CSIR-STEPRI) and the Agricultural Research Council of Nigeria (ARCN) presented experiences from their respective countries on the factors that have driven or hindered the application of digital solutions in agriculture (Picture 3). The presentations were followed by a high-level panel to discus show the research results could be translated into practical policy initiatives (Picture 4).

Picture 3: PARI Team at AGRF 2019

representing (from left to right) ARCN, ZEF, FARA, CSIR-STEPRI, KALRO

Picture 4: High-level panel at PARI side-event

From left to right: Sandra Abrokwa Owusu-Kyerematen, Ousmane Badiane, Yemi Akinbamijo, Hon. Gerardine Mukeshimana

PARI side-event at the AAE Conference, 23-26 September, Nigeria:

On 23 September, PARI organized a side-event alongside the African Agricultural Economists Conference on the theme "Agro-industrial transformation as a driver for employment generation, food security, and rural development in Africa". A panel consisting of PARI researchers and young agricultural economists from around Africa offered insights from their research. In order to stimulate a lively debate, the session was organized as a moderated panel discussion to give the researchers an opportunity to challenge each other and be queried by the audience.

PARI researchers and representatives from all partner organisations have also taken part in other additional events that are cross-related to PARI research. These events include scientific conferences, continental meetings and bilateral engagement.

Scientific conferences

PARI research was presented at a several international and African scientific conferences, for example:

- 73rd Annual Meeting of the German Society of Nutrition Physiology 2019, 13-15 March, Göttingen, Germany (UHO)
- World Bank conference on Future of work in Agriculture, 18-20 March, Washington D.C., USA (ZEF)
- Annual Meeting Agricultural and Applied Economists Association (AAEA), 21-23 July, Atlanta, USA (UHO)
- 32nd International Conference of the Biotechnology Society of Nigeria, 19 August, Ibadan, Nigeria (FARA)
- XIII International Symposium on Ruminant Physiology, 3-9 September, Leipzig, Germany
- Tropentag 2019, 18-20 September, Kassel, Germany (UHO)
- 6th African Conference of Agricultural Economists, 23-26 September, Abuja, Nigeria (UHO, ZEF)

Policy events and informal meetings

PARI researchers also took advantage of African, Indian and German policy events in 2019 as well as bilateral meetings with key policy stakeholders to raise issues that emerged out of PARI research, for example:

- FARA delegation to H.E. Ambassador Josefa Sacko, African Union Commissioner for Agriculture and Rural Development, 5 April (FARA)
- Meeting to launch of the new partnership with AERC, 6-12 May, Nairobi, Kenya (ZEF)
- FARA and partners support formulation and implementation of science-led policies in the context of S3A, 21 June, Rome, Italy (FARA)
- African Food and Security leadership dialogue, 6 August, Kigali, Rwanda (FARA)
- African Green Revolution Forum, 3-6 September, Accra, Ghana (ZEF, FARA)
- Courtesy call on Executive Governor of Abia State, 25 September, Nigeria (FARA)
- Hosting of Yam Improvement for Income and Food Security in West Africa, 2 October, Accra, Ghana (FARA)
- Hosting of Arewa Research and Development Platform, 3 October, Accra, Ghana (FARA)
- Meeting with African Union Development Agency (AUDA), 4 October, Addis Ababa, Ethiopia (FARA)
- Supporting agricultural Innovations and IAR4D in Jigawa State, 4-10 October (FARA)
- Advancing the Pan African Agricultural University, 27 October- 1 November, Punjab Agricultural University (PAU) in India, (FARA)
- Event at Agritechnica entitled "Acre of Knowledge" organized by DLG, 11 November, Hannover, Germany (ZEF)
- RUFORUM 15th Annual General Meeting, 2-6 December, University of Cape Coast, Ghana (FARA)

h) Social Media Outreach

PARI is using social media, notably Twitter and Facebook, to disseminate key research findings, including through dedicated social media accounts hosted by PARI as well as through accounts hosted by PARI partners.

Twitter @PARI_ZEF

In 2019, Twitter was the most used and successful social media channel for communication. The number of followers of the PARI account (@PARI_ZEF) has increased significantly. From the launch of the Twitter account in September 2015 until December 2019, the number of followers had grown to 2526. At the peak in May, PARI's tweets reached 65.7K Impressions (Figure 3), 1.884 Page Visitors and 89 new followers (

Figure 4). Examples of successful Twitter posts are provided in Figure 5.

Figure 3: Monthly impressions of PARI tweets for 2019 (in thousands)

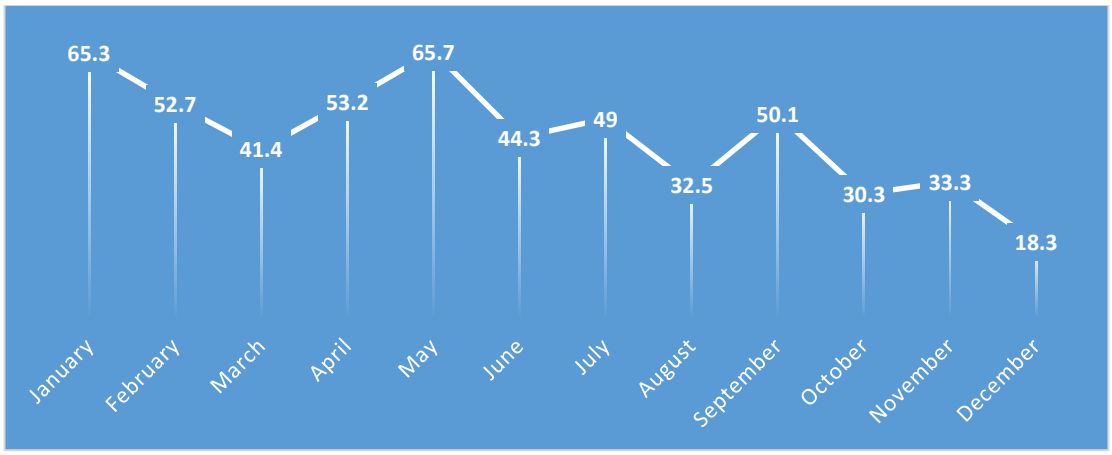


Figure 4: Number of Twitter visitors and new followers in 2019

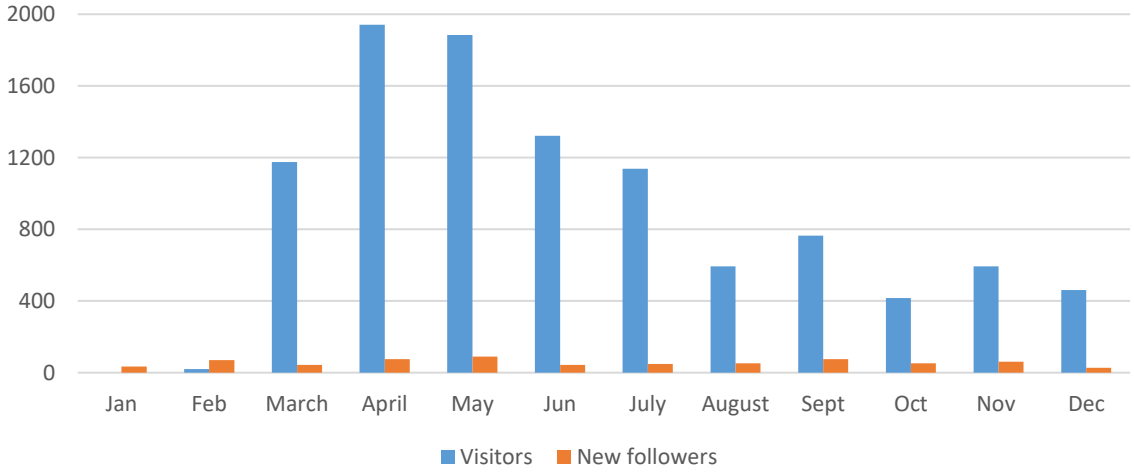


Figure 5: Examples of successful PARI tweets

PARI @PARI_ZEF
Congratulations to our Director **@joachimvonbraun** who received the "One World Medal in Gold" for his research & policy advise in support of ending hunger from Dr. Gerd Müller & Dr. Maria Flachsbarth from **@BMZ_Bund** on December 12th 2019. **#SDG2 #PARIZEF @FARAinfo @ZEFbonn @UniBonn** pic.twitter.com/jUBSpKYbrV

Reach a bigger audience
Get more engagements by promoting this Tweet!
Get started

Impressions	9,955
Total engagements	223
Profile clicks	63
Likes	59
Media engagements	40
Detail expands	26
Retweets	25
Replies	6
Link clicks	3
Hashtag clicks	1

PARI @PARI_ZEF
Can **#agriculture** technology live up to the hype in **#Africa**?

Dr. Baumuller **@PARI_ZEF** senior researcher had the chance to sit down with **@sarajerving** from **@devex** during the **#AGRF2019** conference

@ZEFbonn @FARAinfo @MamoPanel @IFPRI_WCAO #SDG2 #ICT4Ag #ICT4D

https://www.devex.com/news/how-can-agtech-live-up-to-the-hype-in-africa-95559 …

Impressions	5,029
Total engagements	70
Likes	22
Link clicks	21
Profile clicks	13
Retweets	12
Hashtag clicks	2

PARI @PARI_ZEF
Rural **#youth** need viable livelihood opportunities to escape **#poverty** and realize aspirations.

Article **@ZEFbonn** alumni Dr. Essa Chanie Mussa in Welt ohne Hunger - https://bit.ly/2IaM8Ab

@Welthungerhilfe @BMZ_Bund @giz_gmbh @GatesAfrica @ONEinAfrica @WFP_Africa @KfWpress **@WWF** pic.twitter.com/zSqRGfx0zn

Impressions	4,931
Total engagements	33
Likes	11
Link clicks	8
Retweets	5
Media engagements	3
Detail expands	3
Profile clicks	3

PARI @PARI_ZEF
Call for Papers- **#Conference** on Climate Change & **#Food** Security in West **#Africa**

Join **@ZEFbonn** & **@UCAD_Senegal** in **#Dakar #Senegal** to promote collaboration on this crucial topic http://bit.ly/2OS4v2f

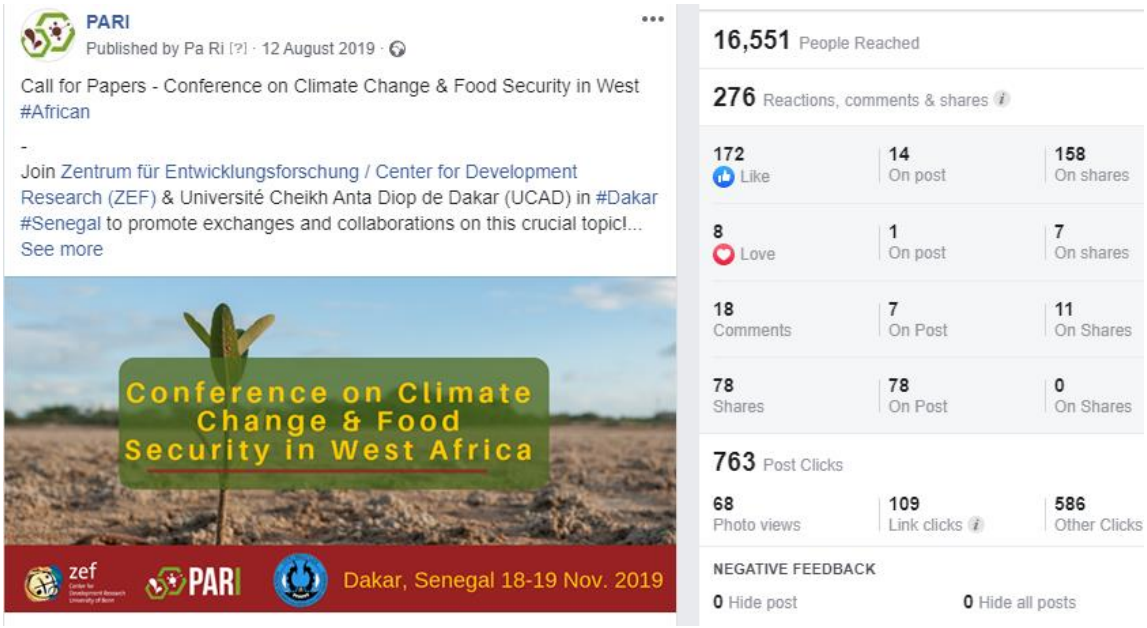
@CIAT_Africa @FAOAfrica @Agro1Media @FARAinfo @African_Farms @MamoPanel #sdg2 pic.twitter.com/izc8OLYCmI

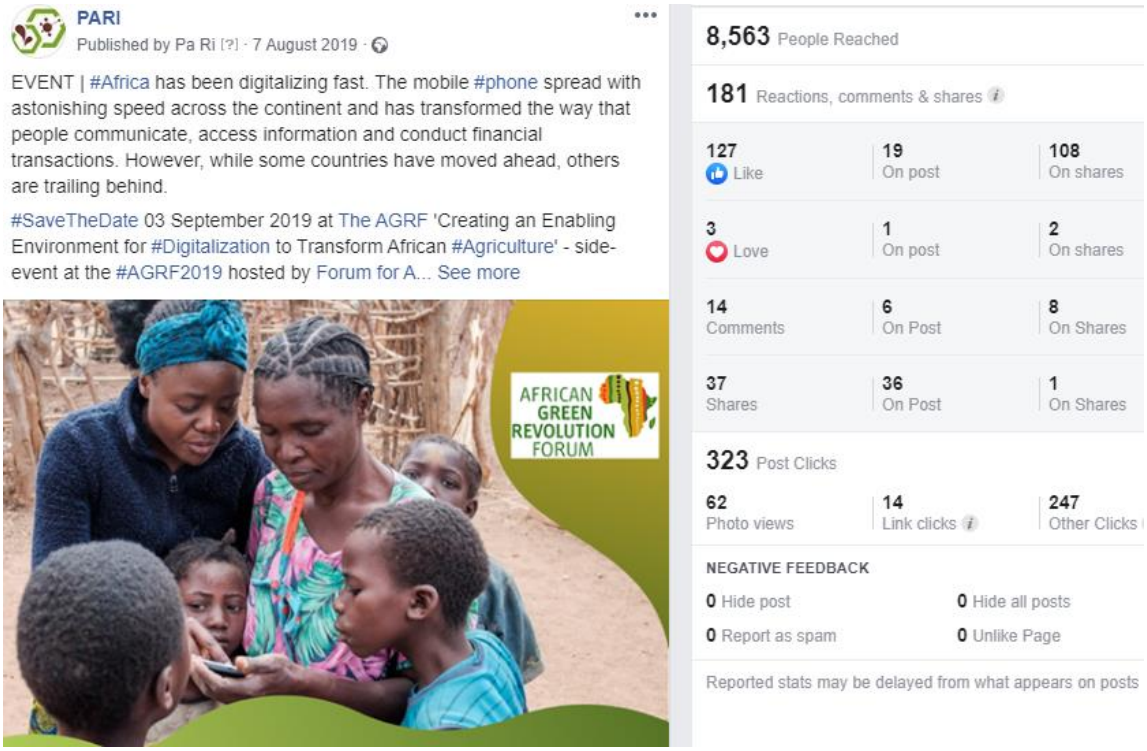
Impressions	2,731
Total engagements	80
Link clicks	24
Likes	17
Media engagements	14
Profile clicks	11
Retweets	10
Detail expands	2
Replies	1

Facebook pari.zef

The Facebook audience has been gradually increasing with approximately 495 new followers in 2019. Some of the best-performing PARI posts on Facebook are included in Figure 6.

Figure 6: PARI Facebook post on latest publications





Social media channels of PARI partners

In addition, PARI is disseminating its findings through the social media channels of the partner organizations to reach a wider audience. In particular FARA is connected to a large audience of relevant stakeholders in Africa. The FARA Twitter account currently has 23,499 followers (an increase of 1600 followers compared to 2018) who receive regular updates about PARI. FARA has also significant Facebook outreach with total reach of 77,027 followers in 2019. PARI publications are also shared through FARA's Dgroups, which had an increase of 3300 members from 2018-2019, to a total of 34,501 members in 2019. In April 2019, FARA has also activated their YouTube channel, reaching to initial 133 subscribers by the end of the year.

3. Summary of PARI activities in 2019 and outlook for 2020

Deliverable	Status by end-2019	Outlook for 2020	Lead organization(s)
Work package I: Investments in innovations to improve the productivity and resilience of agricultural and food systems			
Activity I/1: Accompanying impact analyses to identify cost-effective innovations			
Evaluation of agricultural technologies and their impact in Ethiopia	Published as FARA Research Report Volume 4 No. 3		FARA, national partners
Innovation opportunities in diary livestock in Kenia	Published as FARA Guide Book 2019		FARA, national partners
Study on the rice and banana value chains in Kenia and their level of mechanization	Published as FARA Research Report Volume 4 No. 15		FARA, national partners
Evaluation of the endogenous knowledge in the peanut production in Togo	Published as FARA Research Report Volume 4 No. 10		FARA, national partners
Assessment of the Tunisian olive oil value chain	Published as FARA Research Report Volume 4 No. 2		FARA, national partners
Study on the potential and drivers for livestock production in Africa	Research got underway	To be published	ZEF, national partners
Livestock country studies in Ethiopia, Kenya, Mali	Research got underway	Partly published	FARA, national partners
Study on digitalization in livestock	Research got underway	To be published	UHO, national partners
Country studies on sustainability & climate change adaptation in Sahel region	Research got underway	To be published	ZEF, national partners
Activity I/2: Development and testing of strategies for scaling promising innovations that strengthen rural areas			
Study of the effects of feed intake level on efficiency of microbial protein synthesis and nitrogen balance in Boran steers	Published as Taylor & Francis Archives of Animal Nutrition Vol 73, 2019 – issue 2		UHO
Study on the Agricultural Credit System in India	Published as ZEF Working Paper 184		ZEF, national partners
Study of mechanized agricultural services needs in western Burkina Faso	Published as FARA Research Report Volume 4 No. 7		FARA, national partners
Analysis of the current agricultural issues and separate study on the Irish potato in Cameroon	Published as FARA Research Report Volume 4 No. 4 and Volume 4 No.14		FARA, national partners
Innovation opportunities for wheat and faba bean value chains in Ethiopia	Published as FARA Research Report Volume 4 No. 5		FARA, national partners
Study on the role of agricultural information in the adoption of technologies in Ethiopia	Published as FARA Research Report Volume 4 No. 1		FARA, national partners

Study on the role of ICT in Mali	Published as FARA Research Report Volume 4 No. 16		FARA, national partners
Study on myths and realities in the research pf African agricultural mechanization	Published as ZEF Working Paper 189		UHO
Assessment of digital tools for tractor hire in India and Nigeria	Published as Hohenheim Working Paper 001-2020		UHO, national partners
Modeling the impact of technological innovation and agricultural mapping	*Malawi:* ZEF Discuss. Paper 285 *Burkina Faso:* ZEF Discuss. Paper 288		AGRODEP/IFPRI
Modeling of different small-scale irrigation technologies in Niger and Mali	Research continued	To be published	AGRODEP/IFPRI
Activity I/3: Development and application of indicators and methods for monitoring and evaluation of investments			
Micro-level analysis of the agricultural mechanization in Africa	Published as ZEF-Discussion Paper 272		ZEF
Study on energy requirements of different farming technologies in rural Zambia	Published as ZEF Working Paper 182		UHO, national partners
Study on the effects of mechanization on labor in farm households	Published as ZEF-Discussion Paper 278		UHO, national partners
Work package II: Employment and income opportunities in rural areas, especially for youth and women			
Study on the complementarity of education among smallholder farmers in Africa	Published as ZEF-Discussion Papers on Development Policy No. 277		ZEF
Study on skill development in Indian agriculture	Published as ZEF Working Paper 183		ZEF, national partners
Study on the benefits of the hitched culture in northern Togo	Published as FARA Research Report Volume 4 No. 9		FARA, national partners
Analysis of the agroprocessing sector in Ethiopia, Ghana and Tunisia	Research got underway	To be published	ZEF, national partners
Country studies on the value chains with highest jobs potential within local food systems	Research got underway	To be published	FARA, national partners
Country studies on youth employment initiatives	Research got underway	To be published	ZEF, FARA, national partners
Work package III: Policy Consultation and Policy Reform Theme			
Activity III/1: Ex ante and accompanying impact analyses to assess conducive political and institutional framework conditions for the development, adaptation and scaling of innovations			
Studies on engagement of policymakers in the agricultural innovation processes	Published as FARA Research Report Volume 4 No. 6, 11, 12 and 13		FARA, national partners

Activity III/2: Support multi-actor partnerships for the accompanying research and implementation of investment projects by strengthening pan-African networks			
Study on foreign direct investments in the African food and agricultural sector	Published as ZEF Discussion Paper 274		ZEF
Study on empowering smallholder farmers through farmer organizations in Kenya and Burkina Faso	Published as ZEF Working Paper No. 190		ZEF, national partners
Study on the honey bee network and grassroots innovation ecosystem in Africa	Published as ZEF Working Paper: 178		ZEF, national partners
Study on Socio-Economic Impact of the Milk Innovation Platform in Banfora, Burkina Faso	Published as FARA Research Report Volume 4 No. 8		FARA, national partners
Study on Rice Innovation Platform in Mali	Published as FARA Research Report Vol. 4 No. 17		FARA, national partners
Activity III/3: Evidence-based input into high-level policy fora in Africa			
Formal and informal input into policy debates	engagement in African, German and international fora	continued	All partners
PARI policy briefs	7 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 2019, PARI has seen a significant growth in research outputs, including journal articles, studies and policy briefs. Below contains an exhaustive list of the published outputs, for which most of the work was undertaken in 2019:

Publication Title	Partner	Geography	Year
Cross-country studies in Africa			
Foreign direct investment in the African food and agriculture sector: trends, determinants and impacts	ZEF	Africa	2019
The Agricultural Mechanization in Africa: Micro-level Analysis of State Drivers and Effects	ZEF	Africa	2019
African agricultural mechanization: Myths, realities and an emerging research agenda	UHOH	Africa	2019
Effects of feed intake level on efficiency of microbial protein synthesis and nitrogen balance in Boran steers consuming tropical poor-quality forage (journal publication)	UHOH	Africa	2019
Predicting dry matter intake using conceptual models for cattle kept under tropical and subtropical conditions (journal publication)	UHOH	Africa	2019
The complementarity of education and use of productive inputs among smallholder farmers in Africa	ZEF	Ethiopia, Malawi, Nigeria, Tanzania	2019
Understanding the Engagement of Policymakers in the Success or Failure of Agricultural Innovation Processes: Lessons from Africa Countries	FARA	Benin, Ghana, Mali, Togo, Tunisia	2019
Modelling the Economy-Wide Impact of Technological Innovation and Mapping Agricultural Potential: The cases of Malawi and Burkina Faso	AGRODEP / IFPRI	Burkina Faso, Malawi	2019
Empowering Smallholder Farmers through Farmer Organizations: Insights from Kenya and Burkina Faso	ZEF	Burkina Faso, Kenya	2019
Country studies			
Socio-Economic Impact of the Multi-Stakeholder Milk Innovation Platform on Actors in Banfora: Status and Prospects	FARA, INERA	Burkina Faso	2019
Study of Mechanized Agricultural Services Needs in the Rural Communities of Béréba and Koumbia in the Cotton-Growing Region of Western Burkina Faso	FARA, INERA	Burkina Faso	2019
Research Notes on Current Issues in Cameroon Agriculture	FARA, IRAD	Cameroon	2019
Suitability of Different Processing Techniques and Sales Options for Irish Potato (Solanum Tuberusum) Cultivarsin Cameroon	FARA, IRAD	Cameroon	2019
Evaluation of Modern Agricultural Technologies Adoption and Impact of Adoption on Productivity	FARA, PSI	Ethiopia	2019
Innovation Opportunities for Wheat and Faba Bean Value Chains in Ethiopia	FARA, PSI	Ethiopia	2019
Adoption of Technologies and Crop Productivity in Ethiopia: The Role of Agricultural Information	FARA, PSI	Ethiopia	2019
Engagement of Policy Makers in Agricultural Innovation Processes in Ghana: Cases of Fisheries and Livestock Commodities	FARA, CSIR	Ghana	2019
Policy Makers Engagement in Agricultural Innovation Processes in Ghana: Successful and Unsuccessful Cases of Technology Dissemination	FARA, CSIR	Ghana	2019

Publication Title	Partner	Geography	Year
Agricultural Credit System in India: Evolution, Effectiveness and Innovations	ICRIER	India	2019
Skill Development in Indian Agriculture and Food Processing Sectors: A Scoping Exercise	ICRIER	India	2019
Honey Bee Network in Africa: Co-creating a Grassroots Innovation Ecosystem in Africa	SRISTI	India	2019
Innovation Opportunities in Dairy Livestock in Kenya	FARA, KALRO	Kenya	2019
A Comparative Study on the Determinants of the Level of Mechanization in Kenya: The Case of Rice and Banana Value Chains	FARA, KALRO	Kenya	2019
Report on Rice Innovation Platform in Mali	FARA	Mali	2019
ICT in Agriculture: The Case of Senekela in Mali	FARA, IER	Mali	2019
Evaluation of the Inventory of Endogenous Knowledge on the Production and Conservation of Peanut in Togo	FARA, ITRA	Togo	2019
Evaluation of the Benefits of the Hitched Culture on Farms: Case of Kara and Savannah in the Northern Region of Togo	FARA, ITRA	Togo	2019
Engagement of Policy Makers in Agricultural Innovation in Tunisia: Stories of Success and Failures	FARA, INRAT	Tunisia	2019
Assessment of the Tunisian Olive Oil Value Chain in the International Markets: Constraints and Opportunities	FARA, INRAT	Tunisia	2019
Of bulls and bulbs: Aspirations, opinions and perceptions of rural adolescents and youth in Zambia (journal publication)	UHOH	Zambia	2019
Can small farms benefit from big companies' initiatives to promote mechanization in Africa? A case study from Zambia (journal publication)	UHOH	Zambia	2019
The forgotten agriculture-nutrition link: Estimating the energy requirements of different farming technologies in rural Zambia	UHOH	Zambia	2019
Of Trackers and Tractors: Using a smartphone app and compositional data analysis to explore the link between mechanization and intra-household allocation of time in Zambia	UHOH	Zambia	2019