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The private sector in knowledge processes and partnerships for food and nutrition security in the Global South: a case study from the Dutch Food and Business Applied Research Fund programme

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Based on a recent outlook on the food and nutrition security, the zero-hunger goal is unlikely to be achieved by 2030. To improve the situation, there is a need for transformational changes not only by producing high-quality knowledge and innovations on food and nutrition security but also by ensuring their uptake and upscaling. On this challenge, the private sector is increasingly seen to play a critical role. However, the underlying factors and dynamics supporting such private sector mainstreaming in knowledge processes and partnerships are poorly known. This paper, therefore, contributes to the knowledge gap and learns from the Dutch Food and Business Applied Research Fund (ARF) programme to explore the role the private sector has played. We found that for-profit actors can bring value to research processes and knowledge development. However, the collaborations come with challenges related to goals and interests, implementation approach, and marketing strategies. The outcomes of such collaborations may be mixed and, in some cases, lead to results that are not inclusive for the most food insecure. Partnerships that include the private sector should be cognizant of the possible challenges and proactively define approaches that leverage the private sector to add value to food and nutrition security outcomes.

Keywords: For-profit actors; agribusiness; inclusive business; smallholders; agriculture; food systems; knowledge co-creation; knowledge management; Sustainable Development Goals

Introduction

The world is one decade to the deadline of the 2030 agenda for Sustainable Development Goals (SDGs). The SDG 2 focusing on food by seeking to 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture' is one of the most pressing goals, which unfortunately is unlikely to be achieved. The number of undernourished people

worldwide has been on the rise these last five years, with more than 820 million people having insufficient food for a healthy life (Willett et al. 2019). Underperforming in achieving the zero-hunger goal is linked to the complexity of food and nutrition security (FNS), which is intrinsically related to many other SDGs (Brooks 2016). Therefore, transformation at scale and more inclusive efforts are required from policymakers, researchers, communities, and the private sector.

Of particular interest, partnerships between publicly funded research and the private sector – defined here as for-profit agricultural companies – are increasingly promoted for several reasons. One reason is that public agricultural research, although still relevant, is shrinking with both national governments and aid agencies reducing their commitment to agricultural research and development, in both the North and the South (Jin and Huffman 2016, Adesina 2019). Consequently, the private sector is increasingly assuming a more significant role in developing improved technologies for food and agriculture, with increased private agricultural research and development spending (Fuglie 2016, Pray and Fuglie 2015, Stads and Sène 2019), although more slowly in Africa (Stads and Sène 2019). Another reason is that private enterprises have the capacities to move research outputs from labs to markets and scale up innovations, for example, through commercialization (Boehlje 2004, Gallardo et al. 2016). Therefore, the private sector mainstreaming into agricultural research and related knowledge processes has become more relevant.

Consequently, there has been a large amount of research on FNS, which generates insights, technologies, and innovative solutions that could reduce hunger (Ajayi et al. 2018, Spielman et al. 2010). Now, there is an urgency for not only high-quality knowledge on FNS but also and, more importantly, the capacity to use and value this knowledge effectively (Fanzo et al. 2018), with the private sector as a critical channel. However, the underlying factors and dynamics supporting the partnership with and the mainstreaming of the private sector in knowledge processes are under-researched (Cummings et al. 2019), although essential for increased application and scaling up of FNS research. Specifically, what functions do for-profit private agricultural companies play in knowledge processes and partnerships with researchers? What challenges do stakeholders encounter in such collaborations? How do private agricultural companies support scaling up of innovations and technologies that are created in these knowledge processes and partnerships? These are relevant questions that require in-depth exploration. Our paper, therefore, contributes to the knowledge gap and learns from the Netherlands Food & Business Applied Research Fund (ARF) programme to explore the role of the private sector in knowledge processes and partnerships. It does so by highlighting reflections of ARF researchers and from the funding body on experiences of working in the ARF programme.

Since 2014, the ARF programme has developed an innovative framework for knowledge co-creation, acquisition, and utilization among researchers, the public sector, practitioners, and

the private sector. 45 transdisciplinary research projects have been implemented and have integrated scientific and non-scientific knowledge, experiences, and practices in problem-solving. Examples of projects include, among others, the development of a hybrid solar-gas mango dryer in Ghana; fortification of cereals with milk protein in Uganda; breeding spider plant (a local vegetable) for West and East African markets, development of a smartphone app to improve irrigation in Bangladesh, and formulating a local infant food in Benin (NWO accessed, 2020). The programme, therefore, provides the research with a valuable case to improve understanding of how the private sector is involved in generating, co-constructing, and scaling knowledge to advance food and nutrition security.

The paper is structured into five sections. Section 2 presents the ARF programme, its objective, approach, and foci of interest. Section 3 presents the role of for-profit actors in knowledge partnerships and processes on three aspects: relevance of private sector involvement in food and nutrition security interventions, operational challenges of collaborating with the private sector, and role of the private sector in upscaling agricultural research and innovations. Section 4 discusses the findings and their implications. Section 5 concludes and shares perspectives.

The Applied Research Fund (ARF) programme

The Applied Research Fund (ARF) programme aimed to promote research-supported innovations that contribute to food security and related business needs. The objectives of the ARF were to contribute to development and innovation. Rooting innovation in local and regional problems, socioeconomic conditions, and capabilities, was a prerequisite for optimizing the potential for meaningful impact. ARF provided grants only for high-quality applied research projects that were practitioner-driven and evolved in a process of co-creation with different knowledge partners.

Research projects funded through ARF tackled challenges related to food and nutrition security and private sector development in the 15 partner countries of Dutch development cooperation within the Multi-Annual Strategic Plans (MASPs) of the Dutch embassies (Figure 1). The projects stemmed from the knowledge and innovation needs of farmers, practitioners, and policymakers. The research-driven innovations supported new tools and technologies for food and nutrition security that should ultimately benefit the world's most vulnerable people, especially women and children. ARF was funded by the Dutch Ministry of Foreign Affairs, managed by WOTRO Science for Global Development, which is part of the Netherlands Organisation for Scientific Research (NWO), and supported by the Food & Business Knowledge Platform.

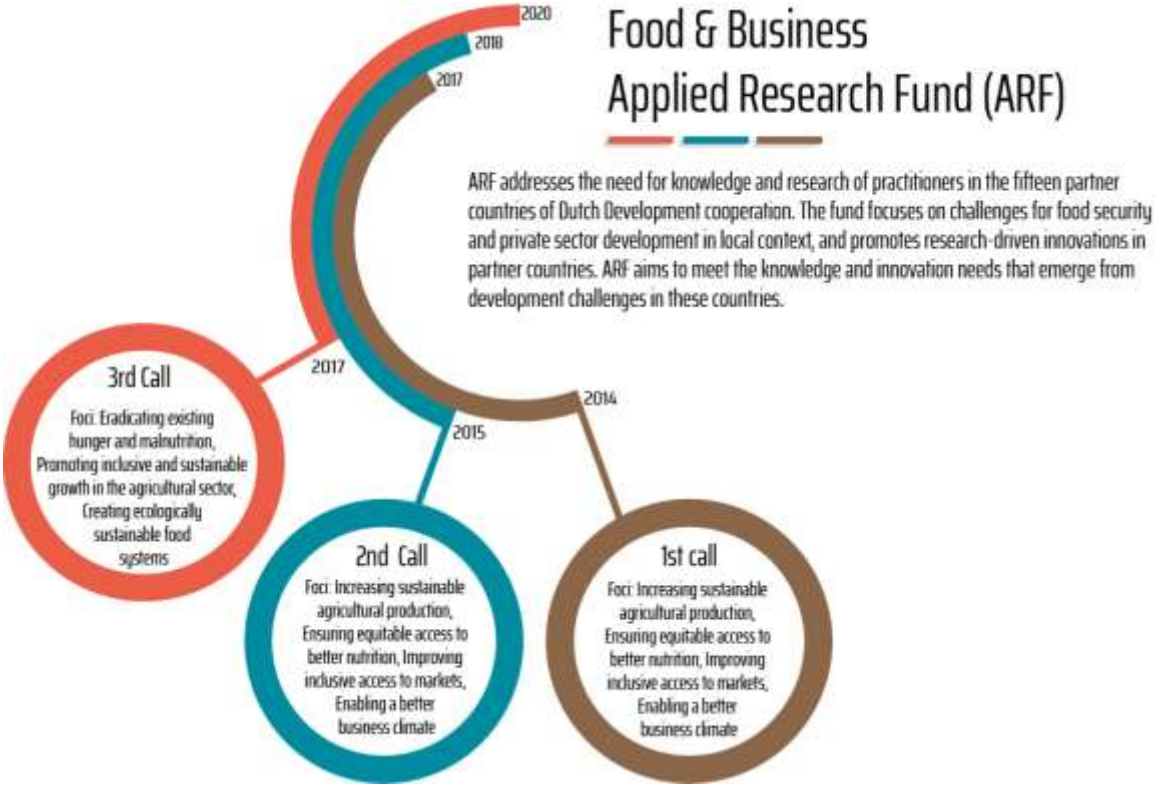

Figure 1. Description of the ARF programme, timeline and foci of calls for proposals (NWO-WOTRO 2020)

An innovation in itself

The ARF was a pioneering funding instrument because it focused on innovation through applied research, and a specific composition of multi-stakeholder consortia drove these innovations. In addition to research organisations, the consortia consisted of practitioners organisations from both the profit, not-for-profit, and public sector. In this way, different kinds of skills and knowledge – academic, practitioner, tacit, and community knowledge – were brought together to address the food security challenges (Figure 2). Notably, an innovation of the programme was that a practitioner organisation from the partner country was leading the project team to ensure local relevance and uptake. This set up of fostering a practitioner organization to lead the research process was groundbreaking compared to the common practice where research projects are led by research organizations. Corinne Lamain, coordinator of Food & Business Research at WOTRO Science for Global Development (WOTRO) underlines that ARF was the first instrument in which this set-up was applied. Placing the coordination of the research in the hands of local practitioners was based on the assumption that this would lead to demand-driven research in which the focus is on issues that were indeed encountered by local producers, consumers, and other food system actors. As such, the knowledge that was produced in the projects would be usable by those same groups.

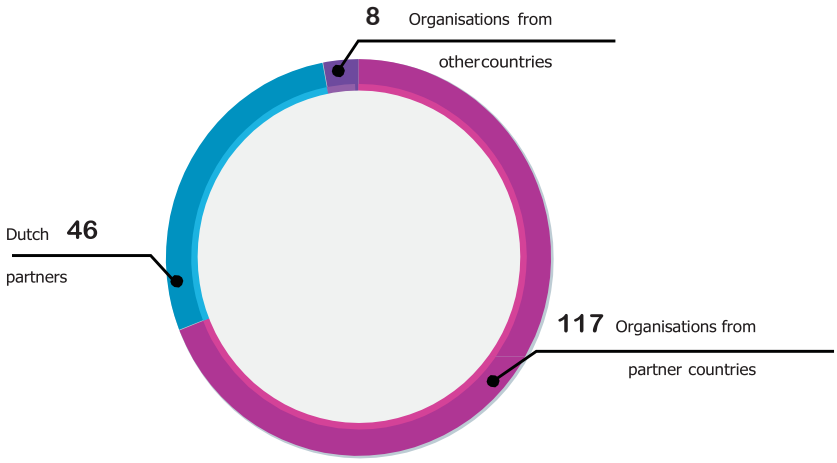

Figure 2. Diversity of partners within ARF projects consortia (NWO-WOTRO 2020)

The practitioners that were in the lead of research consortia were based in the Global South. Within ARF, practitioners organisations might include any type of organisation other than research or higher education organisations that represent a group of people actively engaged in food security, both 1) private for-profit enterprises and related support organisations, as well as 2) private non-profit organisations, such as non-governmental organisations, cooperatives, unions, civil society organisations, et cetera, and 3) public organisations such as governmental departments of line ministries or local governments, extension services (Figure 3). However, in the framework of this paper, the private sector is understood as private for-profit enterprises. The paper focuses on the collaboration within the research projects between researchers and private sector representatives.

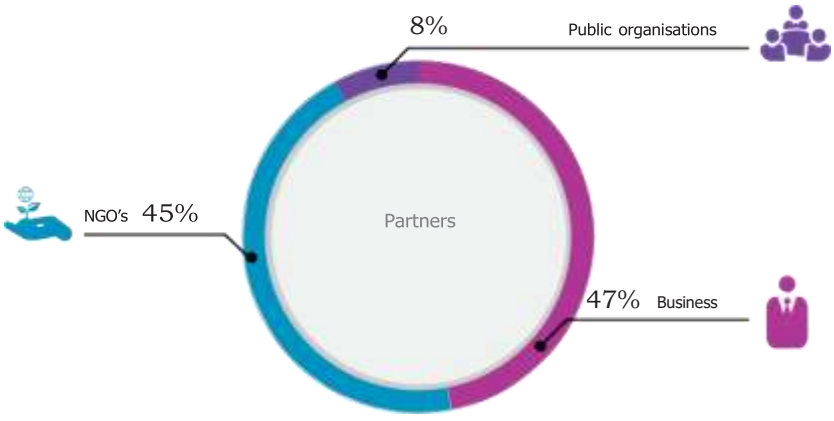

Figure 3. Practitioners organisations within ARF programme (NWO-WOTRO 2020)

Co-creation by transdisciplinary consortia was the driving force behind the ARF approach. Co-creation within ARF was understood as 'a form of cooperation in research where different parties (researchers and stakeholders) in the knowledge process (demand and supply) interact and engage in joint learning to define problems, formulate possible solutions, design the research, conduct the research, assess the results and to translate these into new practices and products' (NWO-WOTRO, 2017). Integrating practitioners' and scientific knowledge in joint research was also an innovation of the programme that helped enhance the potential for the research contributing to impact. Notably, the engagement of stakeholders was initiated during research proposal development (co-design) and continued through research execution (co-creation). This is facilitated by the joint formulation of a Theory of Change, in which the problem statement and desired impact are presented, as well as the expected Pathways to Impact that specifies how actors need to be engaged in the research project. This exercise places the project within its wider system and gives insights into complex change processes. The Theory of Change and Impact Pathways are continuously revisited during research execution in order to test assumptions underlying the expected change processes (Mayne, 2015). This approach was paired with a strong focus on research uptake, which referred to all activities that contributed to the use of research results. The use of results was vital, as the ARF's objective was to fund innovations that have a tangible and positive impact on people's food and nutrition security. Simultaneously, research uptake also aimed to improve the policy and business environment (system change). Corinne Lamain recalls how, for many of the research consortia, assigning a budget to activities for stakeholder engagement, communication, capacity strengthening, and monitoring and evaluation was fairly new. At the onset of the programme, research consortia were brought together in ARF regional workshops, in which the ARF approach, including Research Uptake, was introduced. ARF researchers that attended the workshops were positive about learning and working with the approach.

Policy context

ARF was one of two funding instruments that were part of the Food & Business Research (F&BR) programme funded by the Dutch government and managed by NWO-WOTRO. While the ARF supported relatively short research for innovation in the fifteen Dutch partner countries, the Global Challenges Programme (GCP) supported more in-depth research on emerging global topics and challenges in food and nutrition security. The F&BR programme was part of the Food & Business Knowledge Agenda, through which the Dutch Ministry of Foreign Affairs supported the global quest to develop and implement effective ways of enhancing food and nutrition security in cooperation with the private sector. The Food & Business Knowledge Platform (F&BKP) was established in 2013 to support the knowledge management activities on this knowledge agenda. The F&BKP was one of five knowledge platforms focusing on priority issues for Dutch development cooperation. Information and

news on the ARF and GCP projects were kept updated at the F&BKP website, which also showcased the platform's other areas of work.

The priorities of the Dutch government's 2011 policy on global food security were the main impetus behind the first two ARF calls. In a Letter to Parliament in 2014, the government changed its focus to three priorities, which together determined the scope of the third ARF call: eradicate existing hunger and malnutrition; promote inclusive and sustainable growth in the agricultural sector and create ecologically sustainable food systems. The earlier priority of enabling a better business climate was incorporated as a cross-cutting focus. The ARF projects were also aligned with the Multi-Annual Strategic Plans of the Dutch embassies in the respective partner countries. ARF and GCP were linked to the Dutch Top Sectors Agri & Food and Horticulture & Propagation Materials.

Methodology

The study followed a three-pronged approach to achieve its objective. First, we performed a desk-review to identify, collect, and include relevant studies. The desk-review surveyed the literature to learn from previous research on the role of the private sector in knowledge partnerships. Next, we made a screening of the consortia[i] of the ARF-funded research projects to select those that included *for-profit* actors. The selection allowed documents gathering. The gathering collected all knowledge products (findings factsheets, scientific publications, policy brief) that were released on each project's website[ii]. Then, we read their content and looked at whether gathered documents, in any extent, described or analyzed collaborations or outcomes related to the involvement of their for-profit partners. Out of 58, only 04 documents provided relevant information regarding the topic of our study, and were, thereby, included for data extraction. Besides, three key documents related to the ARF programme and relevant for our topic were added: a brochure published at the midterm of the ARF programme that highlighted partners perspectives on knowledge co-creation by multi-stakeholder consortia, the ARF final evaluation report, and an outcome synthesis study on the private sector perspective on how research can enhance business opportunities that serve marginalized farmers and consumers.

Second, an interview was conducted with the authors of the outcome synthesis study on the private sector perspective. As they recently conducted nine informative semi-structured interviews with ARF projects, we decided to discuss with them and learn from their exchanges with field partners. The purpose of the interview was to understand better our reading of documents gathered and to augment our analysis in this paper. Our interview focused on the contributions of private sector actors in the knowledge processes. The following questions guided the interview: Why such actors were involved in the research projects? How did they contribute in practice to the research? How did they benefit from the

research? What operational challenges partners were encountered during collaborations, and how they dealt with that? How did private sector actors contribute to upscaling? How knowledge partnerships could better involve private sector actors in knowledge processes. Besides, we collected the perspectives of the authors about their involvement in research projects or the funding body.

Last, we read each document and extracted data and information related to our focus questions on the role of private sector actors in knowledge processes and partnerships: successes of ARF projects in mobilizing and innovating with the private sector, operational challenges, and lessons learned on mainstreaming the private sector in knowledge processes, and role of the private sector in upscaling agricultural research and innovations. Next, we processed and summarized the information and data collected through document analysis. Afterwards, we discussed the results and compared them with academic knowledge that dealt with the role of for-profit actors in knowledge generation and research uptake.

Results

Private sector in the knowledge process of the ARF programme

The creation of transdisciplinary research consortia in which actors from the private sector collaborate with researchers, non-governmental organisations (NGOs) and/or government agencies aims to support the co-creation of knowledge. This process entails defining the problems, formulating possible solutions, designing the research, conducting the research and assessing the results, as well as translating these into new practices and products. As Frejus Thoto, from ACED, a practitioner organization involved in the ARF research programme has indicated, transdisciplinary research championed by practitioners and private sector (not researchers) is a game-changer in how action research is conducted in the food and nutrition security sector. In the experience of ACED, this innovative research design has ensured that the consortium is focused on needs that are effectively expressed by those who are supposed to 'consume' the research products and innovations.

Of the 45 ARF-funded research projects, about 15 mobilized actors from private sector defined here as for-profit agricultural enterprises. These actors were specialized in various types of businesses. Their activities encompassed food consumption/fortification products, seeds production, pest management products, weather and ICT-based extension products, crops/fruits/vegetables/fish production, and solar drying technology. They were in Africa (Kenya, Ghana, Benin, Uganda) and Asia (Indonesia, Bangladesh). The research projects they partnered with were working on the development of a specific innovation or technology including, for example, the development of a rodenticide for rice post-harvest losses, the development of sesame and plantain seeds, and the design of a weather censoring station.

Some actors reported that the development of these innovations and technologies could not have been possible without funding a research phase (Rajapandian N.R. et al. 2015, Alacho F.O. et al. 2015, Komen 2019, Etu-Bonde 2019, NWO-WOTRO 2017). Learning from the midterm ARF booklet, a private company in Bangladesh affirmed:

> *[…] we would never be able to invest in this level of resources for a technical innovation. We recognize that there are great social needs in the agricultural sector, but from a purely commercial perspective it would not have been feasible for us to hire the expertise to develop an IT solution like this from scratch.*

The contribution of for-profit actors in the research process was substantial to make sure they master the innovation processes. They actively contributed skills to the design and test of the efficiency of the products or participated in field experiments that developed new varieties, a new solar drying machine, or tailored weather forecast, among others. Private companies also played the role of brokers between researchers and end-users. This brokering role has improved connections of research with users to fine-tune the research process and outputs to the demands of the market. A related testimony was made by a Ghanaian company below (NWO-WOTRO 2017):

> *During the development phase of the weather stations, it was our role as an enterprise to ask the farmers for their feedback on how the technology could be improved. If they said: 'the daily weather forecast is useful, but what we really want is a monthly forecast', we would tell the researchers, 'this is what the customer wants, how soon can we have it?'*

Private sector actors were also more active in research uptake such as training of farmers and entrepreneurs, experience sharing, demonstrations, and extension meetings to build first contacts with farmers, entrepreneurs, and consumers that form a market of early adopters. Their benefit was, then, clear: packaging a ready market-driven innovation for commercialization. For instance, in Uganda, the affordable food cereals project showed that waterproof packaging of the newly developed infant food formula contributed to its longer shelf-life but making the product available to customers took a while because of delays in the certification process. However, thanks to the private partner's persistence and cooperation, the new infant food was officially certified (de Winter and Lammers 2020), thereby ready for the market.

Operational benefits and challenges and lessons learned on mainstreaming the private sector in knowledge processes

The collaboration of different types of knowledge in the research consortia came with benefits and challenges. The synthesis study paper presents, for example, how the collaboration with the private sector helped identify new use functions for acacia trees that were introduced in

Northern Ethiopia as part of an ARF project. When the consortium realized they needed fresh views on the project objectives, a representative of a particle board factory was included in the advisory board. They saw an opportunity for the functioning of the tree beyond land restoration, the purpose for which the research consortium had introduced the trees in the region. Through this engagement, farmers were introduced to new value chains, offering them an opportunity to increase their income. It was by the involvement of different types of knowledge and interests that the benefits of the project were enhanced.

Although the co-creation approach indeed generated new knowledge and innovations in some instances, the collaboration process within consortia with private sector actors was not always easy. Some operational challenges were faced. First, there were challenges concerning goals and interests (Etu-Bonde 2019, NWO-WOTRO 2017, Syspons 2019). As the ARF evaluation pointed out:

> *[…] it can be challenging to bridge the interests of consortium members for whom research is more important, and those for whom action and application is more relevant. Thus, even though the collaboration between various partners can lead to synergies, the assumption that the interests and world views of partners will align through collaboration cannot always be confirmed.* (Syspons 2019).

Indeed, although the project's goals of societal and policy relevance were shared, partners had different expectations about the actual results of the research (e.g. short-term success versus long-term benefits and impact) as well as different interests. From the perspectives of business actors involved in research projects, entrepreneurs are driven by commercial motives constantly protecting property rights or patenting innovations, while the researchers' primary incentive is to enhance understanding and accordingly publish about research findings and innovation in peer-reviewed journals (NWO-WOTRO 2017).

Furthermore, researchers sometimes are confined in theories, while business actors are looking for practical outputs for businesses. To overcome this challenge, a research consortium in Ghana convened to an agreement to allocate commercial shares during the commercialization phase to all partners. Also, there were cultural, professional, and institutional differences that influenced the priorities of partners and made difficult the collaborations. In some settings, close prior personal relationships between the partners helped to facilitate communication, reduce tensions, and bridge the gap between differences in perceptions and interests (Etu-Bonde 2019).

There were also challenges related to the approaches used to market the research outputs of projects. These challenges arise from the need to reconcile the business perspective of the private enterprises that seek commercial viability and researchers and development partners who are more sensitive to the affordability of research outputs and innovations to poor actors.

For instance, the fact that cashew seedlings were given away for free to farmers in Uganda was identified by the business partner of the project as one of the reasons for the shallow survival rate of these seedlings. From their perspective, the success of it taking off at the farm level could not rely on the good-will of farmers. Hence, collaboration was challenged when for-profit actors opposed marketing perspectives from researchers and suggested that there could be increased ownership if the farmers had paid even a small amount for the seedlings.

Experience in ARF underlines, as Corinne Lamain explains, that research innovations are often directed to consumers that are in the middle and higher classes while the ultimate target groups of ARF are the world's most vulnerable people, especially low-income women and children. Those groups cannot afford producing, or consuming, the products that are directed at formalised (inter)national markets. Related to this, a key conclusion from the external evaluation of ARF was that:

> [..] *a "trade-off" exists between the two ARF programme objectives of fostering private sector development and supporting food insecure target groups. ARF projects that aim to establish a business model do not consistently focus their efforts on vulnerable target groups that suffer under food insecurity in the partner countries, but on those who can contribute to the business effort (which mostly are farmers with sufficient income and education).* (Syspons 2019).

A specific example of a project that addressed this challenge was a project in Benin led by a private enterprise in partnership with the University of Abomey-Calavi. The project aimed to produce and commercialize local infant foods. It successfully brought to market the first certified infant flour that is made of locally available animal and plant resources. To increase the affordability of the product for poor households, the project adopted a two-pronged marketing approach. First, it released the product in ready-made format targeting consumers in the formal, mostly urban markets in Benin. Also, it made publicly available the formulas so that poor households can make the infant flour themselves (Rampa et al. 2020). The development of such inclusive marketing approaches was not straightforward. It resulted from intense discussions within the research consortium as the private enterprise did not see it as a sustainable approach, from a business point of view.

Although collaboration can lead to challenges, it was nevertheless vital to maintaining an open dialogue on how to proceed, while never losing sight of the initial goals. An example from the statement of a Ghanaian company was shown below (NWO-WOTRO 2017).

> *The last two years have been a crash course in working in partnerships. Despite all the hiccups and differences, I strongly believe that multi-stakeholder partnerships are the way to go. The collaboration has made our innovation much more solid. Our company has learned a lot: a team from Delft University in the Netherlands and*

> *scientists from Kwame Nkrumah University of Science and Technology in Ghana joined us for a 3-day brainstorming workshop in Accra. We worked together on creating one-page business models that define our value propositions and activities for opportunities we identified for the weather station project. We have learned about exploring new opportunities and thinking big. The whole experience has put us in a different space.*

Role of the private sector in upscaling agricultural research and innovations

The ARF experience is quite recent and still ongoing; the last projects will complete in 2020. Thus, it may be too early to discuss the experience of upscaling its outcomes, extensively. However, the programme has undertaken multi-stakeholder consultations to discuss scaling up opportunities. In this section, we discuss some of the outcomes of these consultations but also present some early scaling up experiences by showcasing the role played by the private sector. Participants to the ARF consortia acknowledged that successful upscaling of innovations generated by the project is contingent upon a strong collaboration among stakeholders, including the researchers, the public sector, practitioners, and the private sector. For example, participants at the scaling up workshop organized for ARF consortia in November 2019 in Benin, highlighted that scaling up agricultural innovations does not just happen; it needs to be planned and managed by all stakeholders right from the start of the project. Researchers should collaborate with the private sector to understand market needs, and the government and legislative should ensure there is an enabling business environment that facilitates (e.g. subsidies, infrastructure, tax reduction). If these requirements are already observed in the design stage of the project, the private sector can effectively support upscaling of innovations. Corinne Lamain considers this a vital lesson for funding schemes as well: an exit strategy that is defined with the consortium partners should already be part of the research proposal.

In some cases, the private sector has played a crucial role in upscaling by ensuring the sustainability of innovations through the development of new or adjusted business models and capacity building. To do that, the ARF projects integrated their research into existing value chains, and private sector actors turned innovations into business cases. They ensured, first, that capacitated human resources and processes were incorporated in their activities to further support target groups, their customers. Next, they ensured that innovations were accessible and could be used by the target groups and thereby integrated the developed innovations into the local supply chains. For example, the solar drying project in Ghana developed a dryer produced and maintained with local materials at the design stage. In this way, the project could ensure that the dryer could be maintained and potentially rebuilt using local materials (F&BKP 2019).

Similarly, the private company involved in the weather monitoring project in Ghana integrated the innovation into their business value proposition to continue offering them to

farmers at scale. Donald Houessou, from ACED, who was a member of a consortium that aimed to improve income, food, and nutrition security in urban areas through allotment gardens in Benin, shared a similar experience. The consortium mainstreamed an upscaling strategy from the start of the project that supports capacity building of allotment gardens participants who could transform their activity into a commercial venture. Before the end of the project, the allotment gardens had secured farming contracts and were able to cover their operating costs without any further support from the project. The success story of these pilot gardens paved the way for scaling the project results, and a decision-making tool was developed to ease the scaling process for local governments.

Furthermore, the ARF projects found potential avenues for securing investment from private actors to scale up innovations. Projects that developed technologies that could be turned into business ideas were particularly prone to secure the continued investment of the private partner for upscaling. Thus, including a requirement for private sector involvement was a successful strategy for upscaling research innovations. For example, in the mango drying project in Ghana, one of the project goals was to develop a financially viable method of drying mangoes. When the financial profitability was shown in the project, the consortium partners decided to form a joint business around their solar dryer that could sustain the financing of the innovation and its upscaling at the end of the project funding (Syspons 2019). The private company is expected to lead the business.

Discussion

The ARF programme offers interesting case studies that enabled us to learn from the contributions of for-profit actors in knowledge processes and partnerships that aim to improve food and nutrition security. Indeed, by using a document analysis methodology, our study reported the experience of the ARF programme on how the private sector is involved in generating, co-constructing, and scaling knowledge to advance food and nutrition security. First, we found that in the ARF consortia, business partners worked closely together with universities and other research organisations. Most of them were involved in research projects that aimed to develop a specific innovation or technology. Although it is a new terrain, they got involved in the research processes; two reasons may justify such interest: 1) the business cases that the innovations offer at the end of the research process, and 2) the initial investments offered by the ARF programme that extend their research and development capabilities. Collaboration with private companies is also beneficial to researchers as it brings to research teams the business mindset that can be useful to the co-creation process.

Next, although co-creation was vital in driving innovation, there were however, some difficulties that challenged the knowledge processes and partnerships during the research. However, our study focused only on those that relate to collaborations with the for-profit

private sector. We found that three main challenges are encountered by research consortia while working with businesses. First, there are challenges concerning goals and interests that occur, usually, in the beginning and during the knowledge process and where priorities may differ, depending on the expectations of researchers or businesses. Second, there are collaboration challenges that occur during the research process and may oppose partners on approaches and ways to go. For instance, while researchers focus on the developed solution, business partners want to exploit a commercially viable innovation which, in most cases, may require additional work from researchers to fine-tune innovations to the need of the market and, hence, may cause frictions. Third, some challenges appear at the stage of marketing of the innovations. Here, collaborations are challenged when for-profit actors point out the need to use a purely commercial approach that targets consumers with sufficient resources. Simultaneously, researchers and practitioners prefer approaches more inclusive of resource-poor consumers, in line with the objectives of the research programme.

By looking at the reasons behind such challenges, we learnt that cultural, professional, and institutional differences between researchers and businesses are the main reasons that influence the priorities of partners. Cultural differences influence the mindsets of partners and the kind of knowledge that they consider useful, relevant, and valuable in the knowledge processes. However, the experience learns that dealing with such challenges is difficult but requires to maintain an open dialogue on how to proceed while never losing sight of the initial goals. In some settings, close prior personal relationships between partners may facilitate communication, reduce tensions, and bridge the gap between differences in perceptions and interests. Therefore, new knowledge partnerships must be cognizant of such challenges and invest in building up their relationships and mutual understandings.

Furthermore, the study found that, in the ARF programme, agricultural businesses can support the upscaling of research findings and innovations. They could play this role by ensuring innovations are tuned to the demands of the market and subsequently developing new business models or adjusting existing ones. Besides, for-profit partners can further invest resources to package a ready innovation for commercialization or integrate innovations into the local supply chains, thereby boosting its utilization. The previous examples show that the implication of private sector actors in knowledge processes may have a positive impact on upscaling innovations that help improve food security in the world. In their studies on the marketing of innovations, Boehlje (2004), Gallardo et al. (2016), Reardon et al. (2019) confirmed the potential role of private companies in upscaling agricultural innovations. Hence, there is a clear indication that private sector actors may bridge the limitation of the public sector to address the SDG2.

Despite the potential of the private sector, there are tensions as to whether this positively impacts the most vulnerable food insecure groups. For example, Ros-Tonen et al. (2019) argued that there are possibilities of adverse incorporation and exclusion in value chains

participation, and therefore, will never be inclusive to all. The evidence from the ARF programme, tends to show that upscaling processes driven by private companies mostly are in favour of households in the middle and higher classes. From a business angle, this satisfies the objectives of the private companies that include profit-making from customer segments who can pay for the innovations. However, from a developmental perspective, it is a problem as programmes like the ARF target the world's most vulnerable people, especially low-income women and children. The implication is that such programmes should clearly and explicitly disclose what we coined here as '*exclusiveness tolerance*'. That means the acceptable trade-offs between business growth and social costs should be known early in the knowledge process. In this way, all parties are aware of what the results will look like and how the business interests and developmental objectives should be combined, or rather addressed in separate efforts. This could lead to research programmes aiming at enhancing inclusive approaches on the one hand. On the other hand, this may lead to programmes that refrain from developing agricultural innovations to improve food and nutrition security of the poor with established agricultural companies that do not display and prove any commitment towards inclusive business models.

Moreover, by capitalizing on knowledge from the F&BR programme including ARF projects, about how research can enhance business opportunities that serve marginalized farmers and consumers, de Winter and Lammers (2020) found that, beyond businesses, research, local context, consumers, and policy environment are four main elements that can also facilitate upscaling. Although innovations can be purposely disruptive, challenging existing approaches and beliefs to improve the status quo, risk-averse groups, such as small-scale farmers, may not be easily inclined to welcome disruptions unless hard evidence and assurances were given about their feasibility or profitability. In this context, the active involvement of researchers may lend more credibility to the results. Next, local contexts and consumers are essential factors in developing innovations and determining the possibility of scaling innovations. Last, the policy environment is instrumental in upscaling innovations as supportive governments may create frameworks that foster efficient processing of certification requests and benefit smallholders' access to the market. The partnership between private partners and researchers may prove a valuable tool as partners could benefit from each other's unique qualifications and networks in the field.

Altogether, the findings suggest that the private sector is increasingly an important actor that should be involved in knowledge processes and partnerships. Their involvement may be more critical when it comes to designing and upscaling a product or technology for the market. This lesson is useful for practitioners and policymakers to design and support interventions aiming at developing solutions facing the agricultural sector. The paper may also serve scholars that need insights on how to actively involve private sector actors in the research process. For instance, indications regarding challenges that were faced by research consortia within the ARF programme provide a pathway to anticipate difficulties in future research partnerships.

Conclusions

The paper explored the role of the private sector in knowledge processes and partnerships that intend to improve food and nutrition security to help advance the achievement of the SDG 2. Findings indicated that for-profit actors could be an essential partner in generating and upscaling agricultural innovations. In the Global South, wherein public agricultural research is low, the private sector should be encouraged to participate more actively in knowledge creation processes, especially where it can critically contribute and add value to developing innovations. However, integrating the private sector in research raises three main challenges in terms of goals and interests, implementation approach, and marketing strategies. These challenges may be overcome if the roles, responsibilities, and interests of each stakeholder are well understood and translated into agreement and terms of references.

While acknowledging its relevance, the role of the private sector should not be overestimated or considered as a panacea for knowledge production that aims to benefit food and nutrition security for resource-poor groups. The performance of the private sector in knowledge processes and partnerships for food and nutrition security is contingent on the context of the collaboration and actions of other actors such as the government, researchers, and non-profit organizations. Finally, beyond knowledge generation, the process of knowledge sharing and upscaling is nonlinear and context-dependent. Hence the performance of the private sector in upscaling knowledge and technology may be challenged by some risks with unintended effects. Such risks should be known and controlled to ensure effective uptake of innovations.

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[i] All 45 ARF-funded projects and their consortia can be located on the Netherlands Organisation for Scientific Research (NWO) website https://www.nwo.nl/en/research-and-results/programmes/food+%26+business+research/ARF+research+projects

[ii] Each project was referenced on NWO website (cited above) and on the Food & Business Knowledge Platform (FBKP) website https://knowledge4food.net/research-projects/applied-research-fund/