

The Public–Private Partnership: A Case of Agricultural Innovation in Uganda?

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Abstract

This paper reflects on the concept of innovation and its value as a framework for studying science and technology in a development context. We propose a model in which innovation is the outcome of an encounter between different technological cultures. We examine the case of a public private partnership (PPP) in Uganda involving various actors in the sorghum value chain. The PPP was intended to stimulate the design and implementation of pro-poor innovations. However, what happened in fact was merely the inclusion of a particular group of farmers into an exclusive value chain. This outcome raises questions about the role of science in general and that of public agricultural research institutions within innovation systems that involve private sector companies. The paper focuses on what was considered the central innovation, an improved sorghum variety called Epuripur. In a program to support smallholder farming, Epuripur was multiplied by small scale farmers and then purchased and processed by the private sector in the industrial production of a new lager beer. The PPP structure was assumed to offer public organizations access to private-sector resources, including cutting-edge scientific expertise and technologies. However, the bulk of the so-called research activities undertaken during the program involved routine selection and field testing of sorghum varieties in order to meet quality standards required by the brewery. The paper is based on original empirical research carried out by the first author, including interviews with researchers, corporate employees, farmers and extension workers.

Introduction

Reforms of agricultural research organisations in Africa around the turn of the millennium shared a perception of an overall failure of the public-sector in delivering the knowledge and innovations that were needed to put agriculture on the right track towards poverty reduction, increased production and efficiency. In line with the structural adjustment programmes of the 1990s, donors and international development agencies were convinced that research potential and technological progress had been choked by the inert bureaucracies of the public sector, and should be reinvigorated and made effective with help from the private sector. Public–private partnerships (PPPs) in agricultural research in developing countries fit within the broader agenda of innovation for development.

We argue that the concept of PPPs resonates well with the idea of innovation systems for agricultural development. In both concepts, public- and private-sector organisations are considered key actors. A key assumption behind the idea of mobilising PPPs for technological innovation is that they will increase the effectiveness of research and development for the benefit of end-users. In the case of agricultural research for rural development, this implies creating opportunities for smallholder farmers to improve their situation, leading to an overall reduction of rural poverty. However, we argue that research and technological change as developed by formal-sector actors is different from technological change in farmers' practice. Rather than considering research organisations, private companies, farmers and other actors as part of a single system, we argue that innovation models for agricultural improvement are an encounter between different technological cultures. In such a model farmers and farming comprise a specific technological culture, characterized by experimentation and adaptive change.

We illustrate our argument with the case of a PPP that was established in eastern Uganda, which was intended to stimulate smallholder sorghum production for use as the primary raw material for industrial beer brewing. We introduce this PPP in the section after next. Before that, we discuss the concepts of the PPP and the innovation system, demonstrating their close conceptual association. After describing the arrangement of the sorghum PPP, we then move to a detailed description of the

history and outcomes of the sorghum PPP, focusing on different aspects of the case. The final section draws conclusions and makes recommendations.

This paper is based on field research carried out by the first author in 2007. Interviews were held with individuals involved in the PPP including two researchers, a plant breeder and a socio-economist who were members of the program team, which was based within the National Semi Arid Resources Research Institute (NaSARRI), an institute of the Uganda National Agricultural Research Organisation (NARO) located in Soroti, eastern Uganda. Individual interviews were also conducted in Soroti District with 40 randomly selected sorghum farmers. Focus group discussions were held with eleven key informants, two from the National Agricultural Advisory Services (NAADS), one from the private seed company AfroKai Ltd., four from Soroti District Farmers' Association (SODIFA) and four local councillors from the communities to which the interviewed farmers belonged. Research reports, news articles and bulletins complemented responses obtained from the different categories of respondents.

Innovation systems and public–private partnerships

The concept of the PPP can be traced to the emergence of recent developments in the analysis of technological change, which conceptualised innovation as the outcome of a systemic process in which many actors are involved: the innovation system. This concept has its academic roots in institutional economics, although Godin (2009) shows a parallel emergence in the policy environment of the Organisation for Economic Co-operation and Development (OECD). As an economic argument, technological change as a factor for economic growth is considered to emerge from institutional collaboration between public research institutes and industrial R&D, supported by professional and academic education. In recent decades the innovation system concept has been taken up in studies applied to technological change in developing countries (Hall et.al., 2001; Lundval et.al., 2009). Agriculture, a key sector in developing economies, is widely perceived to benefit from a reorganization of research and technological development based on the innovation systems concept (World Bank 2006). Although the list of actors considered to play a role in an

innovation system is long and inclusive, public research institutes and private-sector R&D have a prominent role.

A second trend in the transformation of agricultural research organisations in developing countries is an emphasis on organisational efficiency. Based on neo-liberal reform principles, public sector services like agricultural research were reduced in size under the assumption that the private sector could take up certain tasks equally well or better (Chang, 2009). Within this framework, developing new technologies for agriculture was seen as a process in which cooperation between public and private sector was not only desirable but unavoidable, especially when costly research procedures are involved, as in the case of agricultural biotechnology (Byerlee and Fischer, 2002).

The position and role of Uganda's public agricultural services have changed over the past decades as a result of the country's national development agenda, which closely followed the structural adjustment policies of the World Bank and the International Monetary Fund. In 1998, Uganda developed the Poverty Eradication Action Plan (PEAP), which was reframed in 2002 and later subsumed within the 5-year National Development Plan (NDP), which was launched in 2010. A key goal of these plans is to raise the income levels of smallholder farmers, in particular through better linkages to national and international markets. The Ugandan agricultural policies since the early 2000s have stimulated the involvement of private-sector companies in the development of agricultural technologies. There has been a notable rise in the number private seed companies and agro-processing industries (Mubangizi et al., 2012; Kabeere and Wulff, 2008; Nangoti, Kayobyoyo and Rees, 2004).

Private-sector companies are considered to play an important role in poverty eradication by providing inputs, advice or credit to increase production, as well as by buying up agricultural produce. However, inputs sold by commercial companies do not necessarily fit the farming systems of smallholders, while not all of the products emerging from smallholder farms are ready-made commodities. Where technological changes in crop varieties, production methods or processing are needed, public-sector research institutes are supposed to play a role in partnership with the private sector. PPPs are designed to enable this.

Processes of technological change that transcend the boundaries of a single organisation are likely to evoke controversy and friction, because technical procedures are intrinsically related to institutional characteristics (Bijker and Law, 1992). Moreover, established institutions and long-term interactions between certain organizations may lead to a phenomenon known as technological trajectory or technological paradigm, referring to a preferred technical model or method that excludes alternative pathways (Dosi, 1982; Vanloqueren and Baret, 2009). An alternative view sees innovation as encountering technological cultures (Richards, 2004; Smits, 2002). This perspective takes the close interaction between technical procedures and institutional characteristics as a starting point. In fact, institutions emerge out of a technical procedure or, more generally, the performance of a commonly defined task. Because tasks are different, institutional features differ too. In the case presented here, NARO's production of science-based techniques and inputs for the agricultural sector, NBL's brewing of quality beer and farmers' production of a sustainable output from crops and livestock all make different institutions. Routines for problem-solving do not follow pre-set logics and collaboration is not based on a universal language. For each task-performing social unit, the available resources, knowledge and skills that are employed through social exchange result in tried and true repertoires of action, shared meaning and forms of solidarity that together form the technological culture. Consequently the introduction of new techniques, methods or forms of organization is enacted differently within each specific setting, creating effects and consequences beyond planning or prediction. Thinking about the innovation process as an encounter between technological cultures helps to explain the case presented in the following sections. In the conclusion we will come back to the lessons for our case and the wider implication for models of innovation.

The case study: Epuripur sorghum for Eagle Lager

From the early 2000s a reform process was set in motion to open up the NARO and make the organisation operate more in research partnerships with various stakeholders, including the private sector. A particular policy instrument used by the government of Uganda was to offer a tax rebate of 10–15% to industries using local

products as opposed to imported products. Attracted by this incentive, Nile Breweries Limited (NBL, a subsidiary of the multinational brewing company SABMiller) approached the NARO in 2000 to explore ways of producing sorghum for brewing clear beer.

On average sorghum occupies 265,000 ha of arable land in Uganda, a production area slightly smaller than those for maize and millet (FAO, 1995; NARO, 2003). It is an important food crop in the country, grown mainly as a subsistence crop by resource-poor farmers. The cropping area stretches out over the semi-arid regions of the country and cultivation typically involves low use of external inputs. In these conditions, sorghum yields are not very high and over the years government services have tried to improve the productivity through development of new varieties, recommendations on cultivation practices, crop protection, post-harvest handling and marketing.

In 2001 a PPP was established between the NARO and NBL to procure sorghum from smallholder farmers in Eastern Uganda. The NARO entered the partnership through the involvement of NaSARRI, which is responsible for research on semi-arid cereal crops in Uganda, including sorghum. Other parties involved were AfroKai and the NAADS. The partnership program envisaged the distribution of seed of an improved sorghum variety called *Epuripur*. *Epuripur* was developed by NaSARRI researchers and released in 1995 by the National Variety Release Committee. It was selected for the PPP project in 2001 following a series of trials and technical tests with different sorghum varieties.

For a first cropping season in 2002, NBL contracted NaSARRI to start multiplying seed of *Epuripur* on 27.5 acres. The contract farming scheme was launched in Soroti District, which has remained the stronghold for the programme up to the present. Farmers were offered a contract which committed them to produce *Epuripur* sorghum. Provided certain quality standards were met, the contract guaranteed that NBL would buy the harvest. Sorghum production was arranged through contracts between individual farmers and AfroKai. In the initial years contracts could be terminated at thirty days' notice. After 2004 this was extended to sixty days. NBL processed the sorghum and launched a new alcoholic beverage, Eagle Lager, which

was launched on the Ugandan market in December 2001. Eagle Lager was marketed as a cheap beer made from locally produced sorghum.

The roles and responsibilities of the actors involved in the PPP were determined in stakeholder meetings and workshops. Various memoranda of understanding and contracts were drawn up to bind the actors to their specific roles. The activities of the various actors included mobilizing farmers, arranging contracts with farmers, seed supply, monitoring of farming operations, price setting, quality control and delivery of the harvest. Although the NARO and NBL were the main partners, most of the contracting arrangements and sorghum cultivation activities were designated to specific departments or other organisations. For the public sector these were NaSARRI and the NAADS. NaSARRI was involved in on-farm demonstrations, made agronomic and quality guidelines and organised trainings for trial management. Much of the direct interaction with farmers was done by district and field officers of the NAADS, who were responsible for selecting farmers and supporting them to meet quality standards. Locally active NGOs (CARITAS-Uganda, SELFHELP International and ADRA Kotido) were involved in similar activities. The commercial-sector organisation most active at farm level is the seed company AfroKai, which arranged the multiplication and distribution of Epuripur seed and purchased the sorghum harvest from contract farmers for delivery at the brewery.

Production and income effects

Production figures collected by the NARO and NBL show a clear rise in the total production of sorghum on the various districts, resulting in clear and increasing income effects (Table 1). Provided quality conditions were met, farmers received a premium price for their sorghum, about 50–100 Ugandan shillings above market prices. Farmers reported improved household incomes from Epuripur sales as the most important factor in their experience of the program. One farmer stated: “I never imagined that I could pocket 300,000 shillings from one sale as a farmer, moreover from sorghum, never”. This income boom from Epuripur was echoed by almost all the farmers interviewed. However, farmers assumed a risk: their harvest could be rejected if its quality was considered inadequate. Farmers then had to sell their harvest on the open market or store it for consumption.

Table 1: Epuripur Production and income earned by farmers (Metric tonnes), 2001–2006 (Source: NaSARRI)

Year	Epuripur Production (tonnes)	Uganda Shillings earned
2001	12 tonnes of foundation seed at SAARI	
2002	600 tonnes	180 million
2003	1,462 tonnes	438.5 million
2004	1,677 tonnes	503 million
2005	2,371 tonnes	711 million
2006	4,000 tonnes	1.2 billion

Sorghum production also expanded in other districts (Table 2).

Obviously, the farmers profiting most were the ones with the better fields and access to inputs, enabling stable quality production and sale of their sorghum to NBL year after year. As the General Manager of AfroKai explained:

“Several farmers receive reasonable and stable income from Epuripur (...) and because of Epuripur, we have taken farmers to a level where banks and micro-finance companies can now give them loans when we recommend them. This means they can access loans for other business ventures once a relationship is built with the bank”.

Table 2: Trend of Epuripur sorghum production (kg) (2003–2007) by district and season (Source: NaSARRI)

District	2003A	2003B	2004A	2004B	2005A	2005B	2006A	2006B	2007
Apac	-	27,379	-	98,406	-	473,917	22,206	1,247,099	-
Hoima			11,570	15,254	93,709	69,925	335,199	46,234	-
Kumi	112,205	77,274	156,250	81,317	96,700	16,630	775,936	-	-
Lira	-	14,972	-	46,247	33,300	382,975	158,300	1,766,133	-
Masindi	19,401	126,741	72,668	73,070	27,937	75,405	338,280	145,297	-
Palisa	43,212	208	96,962	-	419,570	-	3,569,563	-	-
Soroti	282,512	294,549	328,209	585,819	110,143	422,554	599,924	2,220,659	-
Others	107,231	220,991	87,921	40,620	62,456	86,161	235,561	366,330	-
Total	599,702	862,114	753,580	940,733	843,815	1,527,567	6,033,969	5,791,752	-

The successes of the sorghum program were widely exposed in the media (The New Vision, Wednesday, January 15, 2003, The East African, Friday, March 13 2009, The Eagle Bulletin, June 2003, MATF Newsletter, December, 2006, Issue 5). But behind the impressive production figures there was a complicated reality, in which the partners involved faced several challenges. Moreover, not all those who were considered to benefit actually did profit. We first look at some of the challenges in the

agriculture production process and then focus on the involvement of the agricultural research institutes and the role of science in the process.

Paper contracts and farming realities

The main issues arranged by the farming contracts were the inputs and support farmers would receive and the conditions for delivery of quality sorghum to the company. However, contract farming creates an operational space for farmers, technicians and advisors to negotiate over the technicalities of the production process and quality assessment of the products (Vellema 2002). This operational space is created not only through different interpretations by the contracting parties but also because there is considerable fluidity and instability in cultivation conditions and material items. The most prominent example is the core item governed by the contracts, Epuripur seed.

Nearly all the interviewed farmers complained about seed distribution and quality. Complaints included late delivery of seed, contamination of seed with seeds from other varieties or weeds, and low germination rates. Farmers also grumbled that AfroKai restricted the supply of seeds to farmers in order to regulate the volumes of grain produced for NBL. Farmers also said they did not understand why there was a price difference between seeds and harvested grain from their fields. These last two points of dissatisfaction are interesting because they indicate that farmers are accustomed to an open market for sorghum and unregulated seed exchange. The dominance of an informal seed market for sorghum also created a challenge for the organisations that supplied the seeds. Interviewed researchers from NaSARRI said they did not have enough funding to produce basic seed. The release of funds from the central NARO office was erratic, which negatively affected the implementation of planned activities. Researchers also mentioned that control over seed multiplication and trade was weak, resulting in frequent adulteration of Epuripur seeds.

Breeders, seed producers and farmers equally suffered from pests, in particular the sorghum midge, stem borers, birds and the parasitic weed *Striga*. Also, few farmers have adequate irrigation facilities, so erratic rainfall patterns had an immediate impact on the quality of the crop. In order to meet the agreed quantity and quality

standards, farmers had to increase the labour input into the crop. More than half of the interviewed farmers considered labour supply and the lack of mechanization as major bottlenecks.

Environmental factors are non-negotiable and staff of the NAADS and AfroKai had few means to support farmers to overcome them. Overall, there was much more to control than these officers could handle. Their main activities involved selecting farmers and farmer groups to match with expected acreage, distributing seeds, regular inspections and record keeping for all the farms involved, and providing advice on cultivation methods, harvesting, and handling the harvested grain. The interviewed NAADS officers said they had insufficient resources to monitor all these field activities.

These difficulties help to explain why, in spite of the rapid increase in local sorghum production, staff from Afrokai and SODIFA reported that it was hard to mobilize farmers for contract farming. The farmers appeared to be sceptical about the benefits of contract farming and the importance of adhering to the contract details. Since AfroKai was obliged to supply the tonnage agreed with NBL, a situation emerged in which AfroKai had no reason to be very strict on compliance issues, which in turn allowed farmers to ignore contract details as long as their harvest, or even only part of it, was accepted and purchased for the premium price. Although we lack direct confirmation from farmers or Afrokai, it is equally likely that AfroKai purchased some grain of suboptimal quality, or procured the harvest of farmers who met the criteria but did not have a grower's contract. This created a situation in which farmers who were already able to produce quality sorghum without further support were placed at an advantage.

Public extension, private collection

The PPP entailed a division of tasks, in which research was undertaken by the public sector partners. Basic research was carried out by the NARO (in the guise of NaSARRI), with subsidiary research and extension activities carried out by the NAADS. The post-harvest processing into beer was taken up by NBL, the main private sector partner. Thus, the real public-private partnership was limited to the

stage between research and brewing: the production process from seeds to harvest was overseen by the NARO, NAADS and AfroKai.

The main research organisation involved in the selection of Epuripur is NaSARRI, the NARO research station located in Soroti. NaSARRI carried out the initial research leading under the program, in a project entitled Participatory Evaluation of Sorghum Varieties for Yield, Grain Quality and Malting Potential in Low and High Land Areas to meet Market Demands. The project entailed studies on the entire production process, including crop management technologies to improve yields, post-harvest handling and storage technologies for sorghum. Farmers were involved in the selection of varieties, which implied that the field experiments served a dual purpose, for scientific data collection and demonstration to the farmers (Maat and Glover, 2011). Research activities focused on the documentation of existing knowledge on sorghum varieties, among farmers as well as within the food industry. About three hundred sorghum accessions were characterized on morphology and evaluated for grain quality, malting potential and yield. Desired traits such as fast maturing, drought tolerance, *Striga* tolerance, and pest and disease tolerance were identified. A breeding programme was set up to further improve these qualities.

Besides producing Epuripur foundation seed, the other immediate responsibility of NaSARRI researchers was to establish demonstration gardens on station to train selected contract farmers on commercial production of the crop. Initially, researchers alone supervised sorghum cultivation on farms. Later, researchers trained NAADS district coordinators from eleven districts to support this activity, alongside staff from AfroKai.

Researchers from NaSARRI worked with farmers in order to find out the optimal conditions for Epuripur production. These 'research-contact farmers' are farmers with whom the research institute maintains a long-term

Box 1: Recommended agronomic practice (Source: NaSARRI)

- Land for planting sorghum needs to be prepared three months before planting time to enable rotting of ploughed plants and ensure timely planting
- Sorghum posts a seed rate of 4 kg per acre or 10 kg per hectare
- Row cropping (60 cm from row to row, 165 cm from plant to plant and 111,000 plant population per hectare), enabling thinning, weeding, spraying and harvesting
- Weeding 2 to 3 weeks after germination
- Seed dressing to avoid diseases and insect pests
- Crop rotation, rogueing and use of resistant varieties
- Harvested when dry to a moisture content of 11–13% to avoid insect infestation and damage
- Nitrogenous fertilizers are not recommended for very dry conditions
- Plastered drying floors for grain processing

relationship. Farmers' contributions during training for Epuripur seed multiplication were recorded by researchers. Researchers reported that farmers suggested indigenous sorghum management technologies. Selected farmers were trained to use the integrated crop management packages and this was followed by distributing seeds to farmers initially in 4 districts and later in 26 districts. A list of recommended agronomic practices (see Box 1) was appended to the growers' contracts.

The private-sector partners were involved in several of the extension activities but hardly in research. Although NBL staff were involved in determining brewing quality standards for sorghum, most of the actual research was performed by the NARO. AfroKai, the company interacting most directly with the farmers, was mainly responsible for logistics. AfroKai was not contracted by NBL until 2003, a year after NBL has begun using Epuripur for Eagle Lager. AfroKai typically used people from the NAADS or SODIFA to mobilize farmers from the various sub-counties. Although AfroKai staff visited farmers frequently, they communicated the status and progress on the crop (or lack thereof) to the other partners. Whenever additional support or other interventions were required, this was usually supplied by one of the NARO stations or the NAADS.

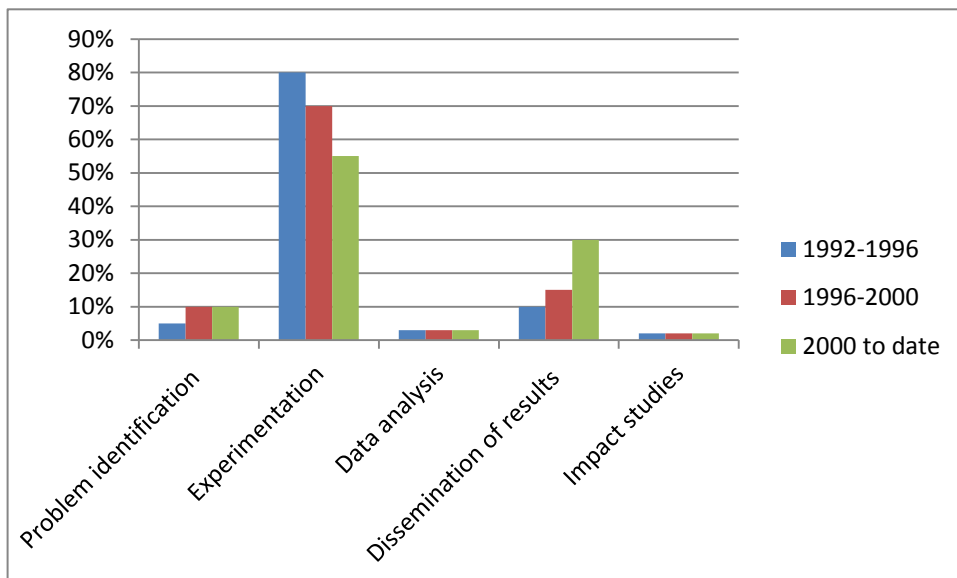
Most of the interviewed farmers said they had first heard about Epuripur from other farmers, indicating that Epuripur was a subject of conversation and that the message entered the farming community through various channels. The government and NBL funded several radio programmes that discussed Epuripur growing. They also organised meetings, trade fairs and field days, and facilitated interactions between farmers. Farmers and other stakeholders were given posters and brochures to share with people who could not participate in the field days. NBL became a frequent visitor of national agricultural events, where it exhibited Eagle Lager.

The project also benefited from the long-term research and breeding programmes that produced Epuripur. Epuripur was one of three new varieties introduced by the NARO in Uganda from the late 1990s (NARO 2000). Research on sorghum began in 1956 and was given a more central place on the research agenda in the 1960s. An observed decline in soil fertility and droughts were two major incentives for breeders to look for better varieties. An interesting finding from the analysis of the documents

and interviews with researchers was that Epuripur emerged out of a breeding programme aimed at quality improvement for food production. The criteria breeders looked at had to do with use of the grain in bread or other food items, as well as drought tolerance to allow cultivation in semi-arid areas and hardiness to obtain a good yield in poor soil and climatic conditions.

Discussions with SODIFA members revealed that, before 2000, several farmers had worked closely with NARO researchers to help evaluate different varieties of sorghum, other crops and livestock. The collaboration had commenced way back in 1993. When the programme on sorghum production for beer brewing was launched in 2000, much of the selection and testing of the Epuripur variety had already taken place. Additional tests were required mainly for malting, an investigation that required a laboratory rather than farmers' fields. Only a few of the interviewed farmers indicated that they had been involved in participatory evaluation of Epuripur after 2000. This suggests that much of the research on sorghum and the development of new varieties had taken place before the creation of the PPP. This is confirmed when looking at the research budgets (Fig. 1).

Figure 1: Budgetary allocation for sorghum research (mean amounts derived from official work plans, budgets and estimations from researchers)



Furthermore, little of the funding for research came from the private sector. The research funds that were set aside for Epuripur after 2000 were allocated to problem

identification, technology development and information exchange. According to researchers coordinating the PPP programme and NARO reports, the Ugandan government provided 90% of these funds from the national budget. These funds were supplemented with donor funding for specific research activities, such as establishing stakeholders' priorities through needs assessment, setting research priorities, setting up experiments (on farm and on station) and participatory technology evaluation. The trend in funding for sorghum interventions from different sources showed that 8% of research resources came from bilateral funding from Uganda's development partners, notably the NARO/DFID project between 2001 and 2002. In the same period, the private sector contributed just 2% of funding to research.

As Figure 1 showed, budgets for experimentation diminished after 2000, whereas funds for dissemination increased. The increase in funding for dissemination activities is not attributable entirely to Epuripur promotion. The establishment of the NAADS in 2002, with funding from the World Bank and other donors, entailed a reallocation of public funds for extension (Bukenya, 2010). Respondents interviewed for this research treated the creation of the NAADS as indirectly supporting the work on Epuripur, since the NAADS was a key player in disseminating the seed to the sub-counties in the districts where it is grown. Aside from supporting the NAADS, donors including the European Union and World Food Programme financed the purchase and distribution of Epuripur seeds for the Internally Displaced Persons (IDPs) in Teso and other affected areas from 2003, 2004 and beyond. The seed packs were part of resettlement package provided to IDPs when they returned to their homes after the civil war.

The analysis of the budgets indicates that research activities on Epuripur after 2000 were most likely part of the overall research budgets of NaSARRI. The central office of the NARO provided annual budget allocations to its stations, which had a certain freedom to divide the resources. The general trend shown in Figure 1, of diminishing research expenditure on sorghum, seems a good indicator that Epuripur sorghum for beer production emerged from on-the-shelf technology, which could be easily transformed from a variety aimed at increased food production into a variety for beer brewing.

Indirect impacts of the Epuripur sorghum–Eagle Beer program

No doubt the largest effect of the NARO–NBL partnership was a substantial transformation of the Ugandan beer market. Besides Eagle Lager, NBL introduced another sorghum beer brand, Eagle Extra. In 2009 the magazine *The East African* announced that NBL had invested US\$ 28 million in new production equipment and planned to double its production. The company currently produces 935,000 hectolitres of beer per annum, an increase from 750,000 hectolitres a few years ago (*The East African*, Friday, March 13 2009). The latter figure represents about 500,000 crates of beer a month. Eagle Lager and Eagle Extra are among the cheapest lager beers available on the Ugandan market. This has contributed to rising sales, partly by widening the consumer markets and partly by taking market share from more expensive beers. The knock-on effects on farmers are substantial, since NBL now buys at least 300,000 tonnes of Epuripur sorghum per season. Since NBL offers farmers a better farm-gate price, this has increased the overall income of farmers.

Increased sorghum production in Uganda and rising sales of Eagle Lager attracted the attention of international agencies. For example, the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), an organisation coordinating pan-African, international and national agricultural research in the region, runs a programme to encourage marketing opportunities of sorghum and other grains. The successful uptake of Epuripur for beer brewing was considered a positive example. This supported the position of the NARO within ASARECA, leading to further collaboration with neighbouring countries.

The Epuripur sorghum PPP also demonstrated the potential to take on-the-shelf technologies or semi-finished research products and incorporate them in a commercial value chain. An example similar to the introduction of Epuripur, though on a smaller scale, was NARO's support for smallholder production of potatoes that were purchased by the Ugandan fast-food chain Nando's (Kaaria et al, 2006). The success of these commercial ventures may act as a stimulus for other companies to engage in similar PPP agreements.

At another level the NARO–NBL PPP exemplified a wider rearrangement of the role of public and private parties in the production and distribution of seeds. Private

firms are now able to negotiate with the NARO to secure exclusive or partial rights to seed varieties produced by the public-sector institutes (NARO, 2004).

Conclusion: research and the innovation process

Creating a linkage between public sector research and industrial production requires an area of shared interests and activities. The general picture emerging from the literature is that there is considerable variation in what these shared interests and activities can be (cf. Grandin et al, 2004). In the case of the NARO–NBL PPP, the endeavour can best be described as the creation of a regional or national value chain connected to an agricultural innovation system (Pietrobelli and Rabelotti, 2011).

What NBL needed from its public-sector partners in order to produce sorghum beer was first and foremost the organisational capacity of NaSARRI and the NAADS to mobilize farmers and intervene in the agricultural production process. The research capacity of the NARO was required to a limited extent and its input was based largely on studies and experiments carried out before the establishment of the partnership.

Two major questions emerge from the case presented: how does the PPP as a vehicle relate to the wider reforms of the NARO? And what lessons can be drawn for the role of agricultural research in the innovation process?

The answer to the first question can be found in the change process undergone by NARO in the early 2000s (Akullo, forthcoming). A Plan for the Modernization of Agriculture, part of the wider PEAP, included reform of the agricultural research system to increase its contribution to the improvement of agriculture. After a review process of the entire organisation, a Core Implementation Team (CIT), a group of national and international experts, was created to change the NARO. Although the name suggests a leading role, the CIT's main task was to facilitate the process of change and provide guidelines and proposals to be taken up by the NARS staff members.

A key principle in the reform process was to increase interaction between research institutes and the farming community, putting farmers at “the centre of decision

making at all levels” (NARS review Task Force, 2002: 40). Collaboration with other institutes and parties, including commercial companies, was considered important in this regard. However, although partnerships in general were mentioned, PPPs in particular were not highlighted. In all the documents and reports of the reform process, reference to PPPs was made only in very general terms. Moreover, the aim of the reforms to increase the interaction with the farmers was considered by many scientists as restating an obvious point. They considered that efforts to include farmers in research activities had already been taken up. They doubted whether collaboration with new partners would result in better ways to reach farmers.

With regard to the second question, the case presented shows that new partnerships for agricultural innovation can be effective in creating new market opportunities for farmers. The NARO’s contribution in this process may be limited in terms of actual new research, but even the wide uptake of an on-the-shelf technology is an achievement in itself. At the same time, the inclusion of Epuripur sorghum in a value chain for the production of lager beer raises questions about the stability of the chain and farmers’ ability to weather shocks. Smallholder farmers may put a lot of effort into Epuripur production, taking the risk of their produce being rejected. However, smallholder farmers are known to be good at spreading risk and it is likely that farmers whose harvest was rejected by AfroKai found other channels to sell their sorghum, used it for home consumption, or relied on other income sources to compensate for the loss.

The operational space marked out by the contracts between farmers and AfroKai also demarcated the area where the different technological cultures encountered. Rather than closely cooperating along shared principles and common procedures, each of the parties involved seemed to work along the routines they are used to, despite a commitment to make the partnership work. NaSARRI had the research capacity to do quality control of seed but not on a scale that was required for the quantities produced. AfroKai was able to make a business deal with farmers but relied on the NAADs for engaging farmers in such a deal and provide follow-up support. Again, the capacity of these organisation did not match the scale of the area and number of farmers growing Epuripur sorghum. Farmers thus were largely dependent on their own capacity to produce Epuripur, making them reluctant to sign a contract. In sum,

contract farming of Epuripur sorghum brought the parties together on an overall goals of sorghum production for the brewing company while at the same time leaving much space for each of the partners to continue their activities in ways they are used to. Epuripur thus acted as a boundary object between these various practices (Star, 2010). For a research organisations like NARO this implies that the macro-level economic effects of the PPP do not necessarily imply an effective change in the practices of smallholders farmers.

How exactly innovation interacts with the development of national or global value and what its effects are on poverty eradication depends on many factors (Cozzens and Kaplinsky 2011). A research organisation like NARO, perhaps in partnership with academic research, may have a special role to play in investigating those interactions and how they work out in farmers' practice.

The proposed model of innovation as the outcome of an encounter of technological cultures sheds a new light on the current focus of agricultural research organisations concentrating on partnerships within an innovation system. When partnerships are the norm, shortcomings of PPP or other forms of interaction are signs to further invest in partnerships, therewith "strengthening the social capital of the system as a whole" (Hall, 2004: 16). An emphasis on partnerships tends to overlook the technological question. Understanding the technological culture in which proposed changes or new technologies have to function helps to steer the innovation process in the right direction. Agricultural research organisations with a mandate to support smallholder farmers should develop a research agenda that includes the question what works for smallholder farmers and what not, within or next to partnership programmes with other organisations.

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