

Cluster Development in Low Resource Settings: the Case of Bioethanol and Fruit Processing Clusters in Uganda

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Abstract

In this paper, bioethanol and fruit processing clusters in Uganda were taken as sectoral innovation systems, and enabling conditions and barriers to their growth analysed from a technoscientific and innovation systems perspective. Active participation of entrepreneurial university scientists in the clustering process appears to be an enabling factor. Absence of goals and incentives for investing in the cluster areas and for driving formation of markets for cluster products is a major barrier. Adopting more inclusive innovation policies, and having in place good community engagement strategies, could help overcome the barriers and expand opportunities for clusters in low resource settings to grow and become competitive.

Key words: bioethanol, cluster, fruit processing, innovation system, Uganda.

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INTRODUCTION

Cluster development is widely regarded as one of the ways of ensuring competitiveness of firms and accelerating industrial and economic growth (Brakman & Van Marrewijk, 2013; Mwamila & Diyamett, 2011). A cluster is a concentration of firms in a geographic region that are interconnected by the market they serve and the products they produce, as well as by the suppliers, trade associations, and educational institutions with which they interact (Colgan & Baker, 2003). According to Porter (2000), clusters 'represent a new way of thinking' about economic growth at all levels, but which requires new roles for companies, government agencies, universities and other organizations in enhancing competitiveness.

The cluster concept is relatively new in Uganda. Typical cluster initiatives started to be promoted in Uganda and in most of eastern Africa around 2004, mainly by proactive university scientists, who view it as a collaborative platform between universities, industry and government (Mwamila et al., 2004b). This effort led to the creation of the Makerere University-led Innovation Systems and Clusters Programme (ISCP-Uganda), which is also affiliated with the Pan African Competitiveness Forum (PACF).

Clusters are recognized in Uganda's industrial policy of 2008. The policy encourages formation of innovative clusters as a mechanism to enhance sharing of knowledge, coopetition¹, learning, value chain coordination and increased access to markets (Ministry of Tourism Trade and Industry, 2008). By their nature, clusters should thrive on their innovative potential and the value they create in their goods and services.

The aim of this paper is to highlight challenges of developing clusters and mechanisms to foster cluster growth and competitiveness in low resource settings. Specifically, the paper identifies and discusses some of the key enabling conditions and barriers to growth of clusters in Uganda. This is done using case studies of two clusters viz: the Bioethanol and Fruit Processing clusters. The case studies are approached from a technoscientific²

¹ "Coopetition" is a term that refers to firms competing and cooperating at the same time (Walley, 2007)

² This approach is based on the understanding and experiences of triple helix, mode 2 (Nowotny et al., 2001) as well as of Donna Haraway and her situated knowledges (Haraway, 1991)

and innovation systems perspective, but with a specific technological innovation system (TIS) scheme of analysis. The TIS has been highlighted, for example, by Bergek et al. (2008) as an analytic framework for understanding the strength and weakness of an innovation system. It is a variant of the concept of innovation systems framed around a technology, product or service (Lundvall et al., 2002; Bergek, Hekkert, & Jacobsson, 2008; Edquist, 2005). Thus the bioethanol and fruit processing clusters were taken as sectoral innovation systems, focusing on the product(s) or service (s) around which the clusters were formed (Niosi, 2010). An innovation system is an open and evolving relationship among a diverse group of actors involved in the production, diffusion and use of knowledge (Lundvall, 2010). A technoscientific perspective is emphasized here in recognition of the way knowledge production is distributed and often situated (Haraway, 2007; Nowotny et al., 2001). The triple helix as university-industry-government relationship (Etzkowit, 2003) is also considered, as it is the main concept driving the clustering process in Uganda. In this paper, therefore, TIS is seen as creating conditions for bioethanol production and fruit processing clusters and fostering their innovation processes. Table 1 summarizes the TIS scheme of analysis as proposed by Bergek, Jacobsson, et al., 2008.

**Table 1: Functions of technological innovation systems
(bioethanol and fruit processing)**

Function	Description
1.Knowledge development and diffusion	The breath of scientific, indigenous and local knowledge with respect to fruit processing or bioethanol production;
2.Influence on the direction of search	Factors which make investment in fruit processing and bioethanol production attractive, including incentives, policy preferences, new markets, etc.
3.Entrepreneurial experimentation	Emerging entrepreneurial activities, for example, new firms venturing into fruit processing and bioethanol production;
4.Market formation	Trends in the development of the market for processed juice or bioethanol, type of the market, potential size of the market, and what is generally driving the formation of this market;
5.Legitimation	General perception about processed juice and bioethanol or production and acceptability of these products by the community and other actors.
6.Resource mobilization	Resources that are available, e.g. financial, human, and other complimentary services to support fruit processing and bioethanol production;
7.Development of positive externalities	External economies brought about by the performance in the above functions-political support, advocacy coalitions, etc.

Methods used in the study are described in the following section. Results are presented and discussed in two parts: Part I discusses the Bioethanol cluster, and Part II the Fruit processing cluster. Conclusions and recommendations are presented in the last section.

METHODS

Twelve out of about 35 members of the Bioethanol cluster (in Jinja, eastern Uganda) were purposively selected and invited to a focus group discussion. Similarly, 10 out of about 30 firms of the Fruit processing cluster (in

Luwero, central Uganda), were purposively selected and invited to a focus group discussion. Invitations were written and addressed to the identified cluster members/firms. Furthermore, three members purposively selected from each cluster were interviewed separately. Academia representatives in the cluster and local government officials in the respective districts were also interviewed. Fruit juice processing was observed in two fruit juice processing firms in Luwero district, and ethanol brewing was observed in five ethanol brewing stations in Jinja district. Each stage of the juice production or ethanol brewing process was explained by production managers, who also addressed all questions and issues put to them. Data from the group discussions and interviews as well as relevant observation notes and pictures were transcribed and analysed in accordance with the technological innovation systems scheme of analysis presented above.

RESULTS AND DISCUSSIONS

Part 1: The Bioethanol Cluster in Jinja

1.1 Historical Context

The Bioethanol Cluster is located in Kakira near Jinja, about 80 km east of Uganda's capital city, Kampala. The cluster was formed in 2005 with the aim of producing ethanol from molasses for automobile and other industrial uses. The motivation for the cluster is to transform the historical brewing of crude ethanol, locally known as '*Waragi*', in and around Kakira Sugar Works (KSW), into a modern bioethanol industry, subsequently improving the standard of life of the local community. *Waragi* production around KSW started in the 1970s after economic collapse under the dictatorial regime of President Idi Amin. When the sugar factory closed, there were no salaries paid to workers. The workers resorted to brewing alcohol as a source of income. This brewing business continued as a fall-back position for people, who retire from or get retrenched from the sugar factory. An estimated 500 people of mixed ethnic backgrounds are directly engaged in *Waragi* production in and around KSWs. Both women and men are involved in producing and selling ethanol, although women appear to be the majority (about 70%) compared to men.

1.2 Key Actors

Figure 1 shows key actors in the Bioethanol cluster. Ethanol production progresses when there is financing and human capital available, and enabling governance regimes exist, e.g. policies, laws and regulations. Actors in the Bioethanol cluster can, therefore, be grouped appropriately as those directly supporting or engaged in ethanol production, those financing it, or those supplying the necessary human capital (knowledge and skills). Some of the actors may play single roles (sr), some dual roles (dr), while others may have multiple roles (mr). Local brewers, for example, make alcohol, but also use their locally generated funds and savings to finance their operations. KSW, on the other hand, plays one important single role, that is as a source of molasses. On the other hand, Makerere University plays multiple roles of financing, providing human resource and value addition to the ethanol production process.

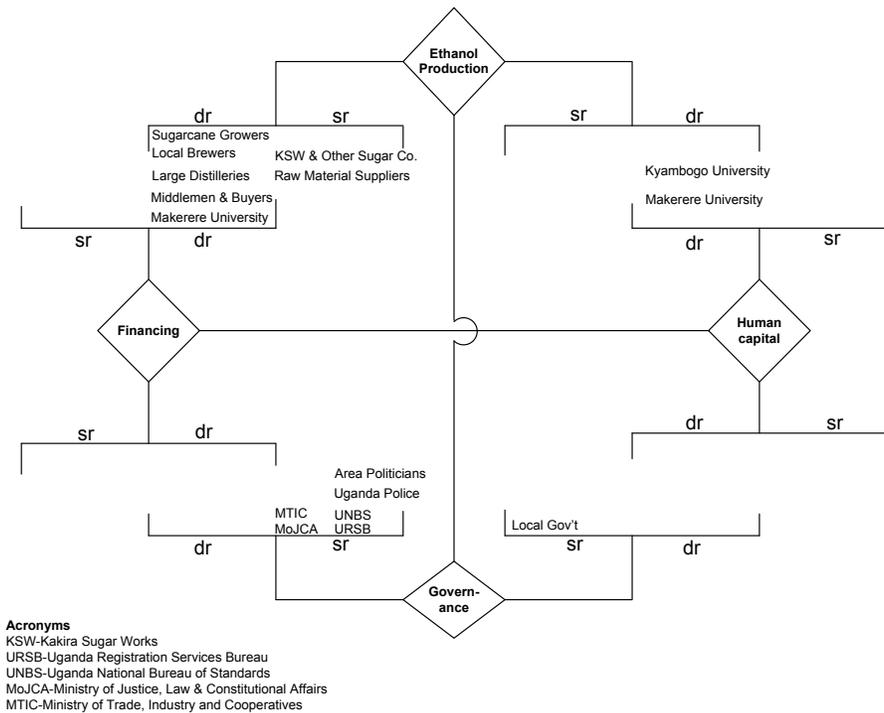


Figure 1: Key actors in the bioethanol cluster

Source: Structure adapted from Ecuru, et al., 2012.

1.3 Bioethanol Production in the Cluster

Around 1985, before the sugar factory became operational again, jaggery (crude sugar cane juice) was used as feedstock for making ethanol. Molasses started to be used again, when the factory resumed sugar production in the 1990s. Middlemen buy molasses from the sugar factory and sell some of it to local breweries. Supplies of molasses are brought also from other sugar companies in the region as far as western Kenya and western Uganda.

Brewing is done locally using metallic drums of 100 litres each arranged in series of three to five, placed over traditional earthen stoves. Firewood is the fuel used for boiling during the distillation process. In order to get 20 litres of ethanol, local brewers mix about 40 litres of molasses with 80 litres of water and 40 litres of vinase, i.e. distillery waste water known by the local brewers as '*Salala*'. Vinase is used as a fermentation medium. Ethanol produced by the local brewers is about 40% v/v, much of which is sold for human consumption.

Disposal of leftover vinase or '*Salala*' is a problem for both local brewers and local government. Vinase has high chemical oxygen demand and biological oxygen demand, which destroy plant life if indiscriminately disposed of in open fields (Chandraj, et al. 2013). In dry season, local brewers spread the vinase along the road to cover dust, but they also believe it could make a good binder in brick making and house construction.

1.4. Functioning of the Cluster

1.4.1 Knowledge Development and Diffusion

The Bioethanol cluster wants more efficient ways of using molasses, water and firewood to get more and higher quality ethanol for possible industrial use. In early 2000, the area Politician learnt about this need and introduced the group to an industrial development not-for-profit organization, which was supporting small scale industries in Uganda. The latter organization through a local scientist (chemical/mechanical engineer) at Kyambogo University trained the local brewers and connected them to ISCP-Uganda. With support from ISCP-Uganda, the scientist and local brewers organized themselves and established a cluster to produce high quality bioethanol.

This collaboration involved design and testing of a distillation column. The experiment yielded ethanol of between 80-90% v/v, which successfully powered an automobile and a generator. Unfortunately, the success was short-lived (less than a year) as one of the columns reportedly stained (with rust) and the other broke down.

1.4.2 Entrepreneurial Experimentation

There are nearly 70 brewing stations, each with approximately five to 10 people. Brewing drums per station vary from one to 10. Each station brews at least once or twice daily. Together, the local brewers produce about 500 litres of ethanol per day. New entrants in brewing alcohol come and go as they get into other businesses. Although the production of bioethanol did not progress, local brewers still believe that with a properly functioning distillation column, they can organize themselves as a cottage industry to produce and sell bioethanol for industrial uses. One of the local brewers said optimistically, “...if we could get support and come up with a cottage industry, we would be in a position to buy this Waragi from our distillers and centralise it in one place and purify it, and do packaging, bottling and market it worldwide”. Jaffe and Azumi (1960) used the term ‘cottage industry’ referring to economic activities, e.g. a small scale retail business or processing unit, which is carried out on, at, or near the home of the worker or proprietor, and usually run by the proprietor’s family members (Jaffe & Azumi, 1960).

1.4.3 Influence on the Direction of Search

The Bioethanol cluster aspires to produce bio-ethanol for industrial uses partly because of the increasing global pressure to reduce greenhouse gas emissions by developing alternative environmentally friendly renewable fuels. The Organization for Economic Cooperation and Development (OECD) projects global ethanol production will rise from 100 billion litres in 2011 to nearly 160 billion litres by 2019; and predict that whereas the feedstock for ethanol production will be coarse grains in developed countries, for developing countries it will be root and tubers and molasses (OECD/FAO, 2012). As countries explore green growth strategies, bioethanol production is expected to become more and more important in Uganda and the region. The challenge, however, is though the national energy policy and national sugar poli-

cy both recognise biofuels as a potentially renewable energy resource, there is no strategy, incentives and programs yet to translate this into action especially for bioethanol production (Ministry of Trade Industry and Cooperatives (MTIC), 2010). No national standards exist so far for bioethanol. Bioethanol does not feature prominently as one of the energy priorities for Uganda.

1.4.4 Market Formation

Most of the ethanol produced by the cluster is consumed as beverage. But with the distillation column functioning well, the cluster has potential to produce ethanol of over 80% v/v for industrial uses. One cluster member said, *“If we could come up with ethanol, pure ethanol, ours would be marketable. We did it to the range of 90% v/v. These people (i.e. the potential buyers) would come and buy—the hospitals would buy, it would be used by big hotels, the universities, laboratories and so many others because whatever (i.e. ethanol) is used in Uganda right now comes from outside Uganda.”* However, if a market for bioethanol is to be created, government regulation requiring, for example, blending with fossil fuels, would be necessary like it is elsewhere, in USA, Brazil, Europe, China, and was also tried in Zimbabwe, Kenya, and Malawi (Shiyan, 2012; Amigun et al., 2011). The challenge would be to mobilise capacity to produce sufficient amounts of bioethanol, and to address dual concerns of food and fuel competition. Also, the cluster could link with bigger distilleries to buy the ethanol, provided local brewers get fair returns for their efforts. Additionally, the ethanol could replace kerosene in local stoves and lamps.

1.4.5 Legitimation

Ethanol for industrial purposes is generally acceptable. However, local authorities are concerned about potential for its abuse if not controlled. Some members of the community have negative perception about production of ethanol by this cluster. The cluster members are aware of this but they try to cope with it. One of the cluster members said, *“People enjoy it (the alcohol) but they do not want to be associated with its production”*. Another member said, *“...there is a tendency of citing these Waragi brewers saying they make the environment dirty, and yet it is a business sustaining so many households”*. Some people also view it as an illegal trade. The *Enguli* (Manu-

facturing and Licensing) Act of 1966 prohibits the manufacture and sale of alcohol without a license. *Enguli* is an indigenous word for locally brewed alcohol. In their 2004 report the Justice Law and Order Sector observed that production and consumption of *Enguli* is widespread in the country. The report recognized that the 'selling of *Enguli* is a source of revenue especially to the rural poor and some local administrations and as a result the Act has outlived its usefulness and recommended decriminalization of the Act, given also that other big companies are by law authorised to produce a similar product (Ministry of Justice and Constitutional Affairs, 2004). However, in 2010, Uganda Youth Development Link (UYDL), a local Non-Governmental Organization published a report calling for strict implementation of the *Enguli* Act to prevent alcohol abuse and its associated dangers (UYDL, 2010). The local brewers, however, seem to find solace in the national sugar policy which they believe gives them more leverage to produce ethanol from molasses coming from sugar works. The sugar policy specifically recognises the potential of diversification in use of molasses to make portable alcohol, industrial alcohol and gasohol (MTIC, 2010).

1.4.6 Resource Mobilization

Most of the local brewers are former sugar factory workers. The skill of brewing ethanol is learned through apprenticeship within this community. Some members gained additional skills through training in, for example, entrepreneurship. The local competence base for producing more purified and standardized ethanol can be acquired from local universities and associated beer industries in the country. With respect to financing, local brewers use their own savings. The local brewers are reluctant to acquire bank loans for their businesses. Red tape, high interest rates and lack of collateral seemed to be their main concerns/barriers to accessing credit.

1.4.7 Development of Positive Externalities

The Jinja district local government is interested in this community of local brewers. The local brewers pay taxes to the local council. To improve their living conditions and waste management, the district plans to acquire land, to which the local brewers would be relocated, hopefully with better amenities. Other than forming themselves into a Bioethanol cluster, there is

no presence of advocacy groups or associations that are specifically promoting bioethanol as an alternative form of fuel. Support from civil society and the political elites will be essential for the bioethanol enterprise to grow.

1.5 Summary Conclusions

The Bioethanol cluster in Jinja is isolated with a number of policy, social, and technical challenges. The cluster could benefit from a specific policy effort, strategy and incentives aimed at promoting bioethanol for industrial uses. In the absence of such strategy and incentives, ethanol production in the cluster may remain for human consumption only, but with social and health ramifications when it is abused, including for example, domestic violence, destruction of family structures, severe and dangerous situations for the children. Therefore, the bioethanol cluster initiative, in trying to transform local ethanol brewing into a modern industrial bioethanol production, should also try to secure practices that minimize risk of alcohol dependency associated with unregulated brewing of ethanol.

Part II The Fruit Processing Cluster in Luwero

2.1 Historical Context

The Luwero Fruit Processing Cluster (LFPC) is located in Luwero district, 65 km north of Kampala City. It was established in 2005. Fruit processing in Luwero started around 1999. The main fruits are pineapple, mangos, passion fruits, papaya, avocado, jackfruit, and tomatoes. Uganda has a sizeable share of these fruits in east and central Africa (Agona, et al. 2002). The motivation for fruit processing in Luwero is value addition to create jobs for the youth and to diversify household incomes. With this goal, individual local entrepreneurs began their own small fruit processing units in their homes (cottages). Nearly 30 micro and small scale fruit processors exist in the district and approximately 70 exist country-wide.

2.2 Key actors

Figure 2 shows key actors in the Fruit processing cluster. A good number of processors supported by organized farmer groups and farmer-centred

associations are present. Private sector, government and development partners appear to have provided the necessary financial resources. The supply of skilled personnel in fruit processing seems adequate, and there is also emphasis on entrepreneurial skills, notably by Enterprise Uganda. In terms of governance, the agencies exist such as ministry responsible for agriculture, trade and investments and bureau of standards.

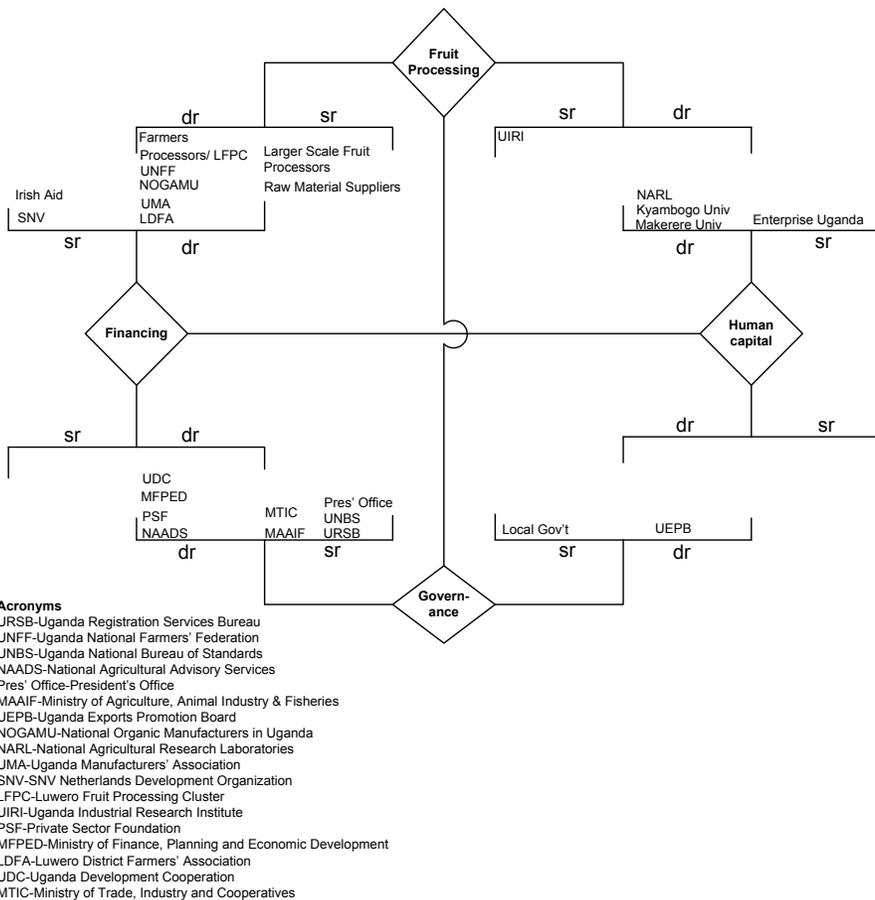


Figure 2: Key actors in the fruit processing cluster

Source: Structure adapted from Ecuru, et al., 2012

2.3 Fruit processing by the Cluster

The Cluster produces mainly mixed fruit juices comprised of pineapple, papaya, passion, and oranges. They also produce jam and tomato souce. The fruits are screened, cleaned with water, crushed and manually squeezed to extract crude juice. The crude juice is then filtered using special nets bought from supermarkets in Kampala. The filtrate (juice) is mixed in certain ratios, and preservatives (sodium benzoate, potassium sorbate, citric acid or sulphur dioxide) and additives (food colour and sugar) added. The juice (mixed) is then pasteurized at 70 – 75 degrees Celsius (for fruits) and 80-87 degrees Celsius (for jam), cooled to about 60 degrees Celsius and packed in glass bottles ready for sale.

The cluster developed plant based preservatives for their juices, which they claim works very well with a reported shelf life of two years. The idea was conceived by one of the cluster members after attending a training workshop organized by a network of indigenous people and researchers in east and central Africa. The cluster then developed the idea further, perfecting it through trial and error until they obtained a formula that seems to work well for them. The ISCP-Uganda is assisting to protect their intellectual asset.

2.4. Functioning of the cluster

2.4.1 Knowledge Development and Diffusion

The main interest for the cluster is to develop different formulations and to try out juices from a variety of fruits (blends). Some of the cluster members have started using plant based preservatives. However, the efficacy of these particular plant based preservatives is yet to be ascertained with modern scientific tools. A challenge is high cost of packaging materials, which accounts for more than half of the production cost. One processor lamented: *“Packaging is a problem. It limits our production, because at the end of the day, the production cost goes high”*. A 500ml bottle costs about one US dollar. Being small processors, the cluster does not enjoy the economies of scale to make large orders, and orders made take too long to be delivered.

2.4.2 Entrepreneurial Experimentation

The number of fruit processors in Luwero district has increased slightly since 1999. In 2008, the President of Uganda at the Luwero farmers' request promised to support building of a fruit processing factory in the region. Land for the factory was acquired, but the plan stalled when a prospective investor pulled out of the deal (Kiwanuka, 2010). For the cluster members, it seems that the factory would be of value, if it helped them grow as a cottage industry. One member said emphatically, "...our strategy is to fight poverty through cottage industry so that people can be productive right from their homes". Any future investment strategy in fruit processing in this community should weigh opportunity cost of investing in a large scale juice processing factory verses developing a fruit processing cottage industry. There are experimental fruit processing projects at the Uganda Industrial Research Institute, which is processing juice from mango and passion fruits and at the School of Bio-engineering, Food and Nutrition at Makerere University, which also houses an incubator for fruit and vegetable products. These developments within the fruit processing sub-sector in the country could enhance profitability of the LFPC through building stronger synergy among the actors.

2.4.3 Influence on the Direction of Search

Value addition and agro-processing is one of Uganda government's priorities for economic growth and development. Local processors also boast of an organic market for their juices. Although, there is no specific strategy so far for fruit processing at district and national level, it is promoted as one of agro-processing and value addition opportunities. Fruits and horticultural crops are ranked in the Agriculture Sector Development and Investment Plan (DSIP) 2010/11 – 2014/15 as a commodity generally small in size without a significant contribution to the export market, but having a high return on investment and a high potential future impact (Ministry of Agriculture Animal Industry and Fisheries, 2010).

2.4.4 Market Formation

The market for fruits is believed to be growing as people change their dietary habits in preference to fruits and vegetables. The regional market (Kenya and South Sudan) as well as the local market is also believed to be

expanding. Luwero's central location makes it a potential fruit hub, serving both local and regional markets. The fruit processors believe that they can have an edge in the organic market. One of them confidently stated, "*for us we use purely fruit juice; that makes us different from the others*". However, to sustain this unique attribute of the 'Luwero fruits', the processors would have to formally certify their 'organic' fruit claims. They would also have to label their products as organic and possibly register trademarks for the products. But most processors are not aware of trademarks, and how it is acquired or registered. Furthermore, to sustain the fruit market, the production side of it must be supported by breeding systems and good agronomic practices to ensure a steady supply of fruits, and to help maintain a distinction between organic and non-organically produced fruits. This support can come from agricultural extension agents and university partners in the cluster.

2.4.5 Legitimation

Generally, people like fruits, both fresh and processed for different consumption preferences. Parents normally buy processed juice concentrates for their children returning to boarding school. Locally processed fruits juices are also acceptable in hotels and restaurants. Local processors believe their products are well received: "*It depends*", said one processor. "*Some individuals prefer this (processed juice) others prefer fresh; whereas other families pack it (processed juice) for their children when they are going back to school*". Another describing the eating habits of customers, said, "*The pineapples you chew live; now you will not be surprised after eating this one, the pineapple, then he asks for his juice: 'Ndetera ku juice wange (translated, "please, bring me my juice")'*". The challenge with locally produced juice is that consumers do not distinguish its price from the one conventionally produced. One processor was disappointed, and said, "*people believe that all these (conventional and organic) juices are the same; so they expect you to sell it at say Uganda Shillings 500, when your bottle alone is Uganda Shillings 2,300...*". Customers tend to tag the same price on all juices in the market. They do not differentiate price and quality. Cluster firms should also bear the cost of securing quality marks for their products.

2.4.6 Resource Mobilization

The necessary human resources can be available from the local universities. In addition, the Uganda Industrial Research Institute, Uganda National Bureau of Standards and the National Agricultural Research Laboratories have specialist capacities to support the fruit processing sub-sector generally and the Luwero Cluster in particular. Other capacities exist in larger more established formal fruit processing industries within the country. With respect to financing, there are some challenges with access to credit. There have been initiatives such as the youth entrepreneurship scheme, bank loans and micro credits, but red tape and high interest rates (not less than 10% per annum) appear to discourage cluster firms from getting credit.

2.4.7 Development of positive externalities

The juice processing industry in Uganda is both non formal and formal. But there are no organized associations or advocacy groups for locally processed juices. However, the Farmer's Federation appears to be quite strong, although their focus is on productivity and welfare of the farmers.

2.5 Summary Conclusions

The LFPC has the potential to grow into a regional fruit hub. However, for this to happen, the Cluster needs to broaden its membership to encompass the multiplicity of actors in the fruit processing subsector and interactions promoted among actors.

CONCLUSION AND RECOMMENDATIONS

The active involvement of academia is paramount in any innovative cluster development effort. The university can fill a knowledge gap and catalyse innovative activity of cluster firms. However, this requires the university to maintain a significant presence in the cluster community. Establishing a field cohort for joint projects, including offering incubation support, could be part of the university's long term engagement strategy with clusters.

If the two clusters are to evolve and grow, deliberate policy measures will be necessary to guide and drive innovation and create market opportu-

nities for the bioethanol and fruit processing sub-sectors. There is need for specific targets and incentives to drive ambitions and lines of inquiry into product development and innovations within these clusters both at national and local levels.

Both the bioethanol and fruit processing cluster members seem to prefer a cottage type of industrial growth. A cluster development strategy should therefore strike a balance between investing in larger more industrial processing plants and supporting community centred cottages. This notwithstanding, the clusters must be inclusive of other actors in fruit processing and bioethanol production. More emphasis should be made on delivering products and covering the geographical spread and concentration of the actors involved; and in identifying cluster facilitators with more convening power and ability to build trust among cluster firms.

For both the bio-ethanol and fruit processing clusters, the role of the community is important in determining the direction and growth of the cluster since both clusters are community based. An active community engagement strategy is essential for clusters in these types of settings.

In conclusion, a technoscientific and innovation systems perspective can be used to identify enabling conditions and barriers to cluster development in low resource settings.

References

- Agona, J. A., Nabawanuka, J., & Kalunda, P. (2002). *A market overview of the dried fruit sector in Uganda*. Kampala.
- Amigun, B., Musango, J. K., & Stafford, W. (2011). Biofuels and sustainability in Africa. *Renewable and Sustainable Energy Reviews*, 15(2), 1360–1372. doi:10.1016/j.rser.2010.10.015
- Bergek, A., Hekkert, M., & Jacobsson, S. (2008). Functions in innovation systems : A framework for analysing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers. *Policy*. Chalmers.
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, 37, 407–429. doi:10.1016/j.respol.2007.12.003
- Brakman, S., & Van Marrewijk, C. (2013). Reflections on cluster policies. *Cambridge Journal of Regions, Economy and Society*, 1–15. doi:10.1093/cjres/rst001
- Chandraju, S., Thejovathi, C., & Kumar, C. S. C. (2013). Impact of distillery spent wash irrigation on sprouting, growth and yield of Dahlia (Asteraceae) flowering plant. *Chemical Science Transactions*, 2(2), 635–641. doi:10.7598/cst2013.364
- Colgan, C. S., & Baker, C. (2003). A framework for assessing cluster development. *Economic Development Quarterly*, 17(4), 352–366. doi:10.1177/0891242403256667
- Ecuru, J., Trojer, L., Ziraba, Y. N., & Lating, P. O. (2012). Structure and dynamics of Uganda's technological innovation system. *African Journal of Science, Technology, Innovation and Development*, 4(4).
- Edquist, C. (2005). Systems of innovation: perspectives and challenges. In J. Fagerberg, D. C. Mowery, & R. R. Nelson (Eds.), *The Oxford Handbook of Innovation* (pp. 181–208). New York: Oxford University Press.
- Etzkowitz, H. (2003). Innovation in innovation: the Triple Helix of university-industry-government relations. *Social Science Information*, 42(3), 293–337. doi:10.1177/05390184030423002
- Haraway, J. D. (1991). *Simians, cyborgs, and women: The reinvention of nature* (pp. 183–201). Free Association Books, London.
- Haraway, J. D. (2007). Situated knowledges : The science question in feminism and the privilege of partial perspective. *Feminist Studies*, 14(3), 575–599.

Jaffe, A. J., & Azumi, K. (1960). The birth rate and cottage industries in underdeveloped countries. *Economic Development and Cultural Change*, 9(1), 52–63. Retrieved from <http://www.jstor.org/discover/10.2307/1151922>

Kiwanuka, F. (2010, September 19). Construction of Luwero fruit plan stalls. *The New Vision*. Kampala. Retrieved from <http://allafrica.com/stories/201009200176.html>

Lundvall, B.-Å. (2010). *National innovation systems: toward a theory of innovation and interactive learning*. (B.-Å. Lundvall, Ed.). London: ANTHEM Press.

Lundvall, B.-Å., Johnson, B., Andersen, E. S., & Dalum, B. (2002). National systems of production, innovation and competence building. *Research Policy*, 31, 213–231.

Ministry of Agriculture Animal Industry and Fisheries. (2010). *Agriculture sector development strategy and investment plan: 2010/11-2014/15*. Development. Kampala.

Ministry of Justice and Constitutional Affairs. (2004). A study on sentencing and offences legislation in Uganda (pp. 1–46).

Ministry of Tourism Trade and Industry. (2008). *National Industrial Policy*. Kampala.

Ministry of Trade Industry and Cooperatives (MTIC). (2010). *National Sugar Policy*. Kampala.

Mwamila, B. L., & Diyamett, B. (2011). Tanzania: The evolving role of universities in economic development. In B. Goransson & C. Brundenius (Eds.), *Universities in Transition: The Changing Role and Challenges for Academic Institutions* (pp. 171–179). Ottawa, Canada: Springer. doi:10.1007/978-1-4419-7509-6

Mwamila, B. L., Trojer, L., Diyamett, B., & Temu, K. A. (2004). Innovation systems and innovative clusters in Africa. In B. L. Mwamila, L. Trojer, B. Diyamett, & K. A. Temu (Eds.), *Innovation Systems and Innovative Clusters in Africa* (pp. 3–111). Bagamoyo, Tanzania.

Niosi, J. (2010). *Building national and regional innovation systems: institutions for economic development*. Cheltenham: Edward Edgar Publishing Limited.

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-thinking science: Knowledge and the public in the age of uncertainty*. Cambridge: Piloty Press, UK.

OECD/FAO. (2012). *OECD-FAO Agricultural Outlook 2012 - 2021* (pp. 87–95). OECD Publishing and FAO. Retrieved from http://dx.doi.org/10.1787/agr_outlook-2012-en

Porter, M. E. (2000). Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly*, 14(1), 15–34. doi:10.1177/089124240001400105

Shiyan, C. (2012). Development of Biofuels in China Technologies , Economics and Policies.

Uganda Youth Development Link. (2010). *The road map to alcohol: policy and regulation in Uganda*.

Walley, K. (2007). Coopetition: An introduction to the subject and an agenda for research. *International Studies on Management and Organization*, 37(2), 11–31. doi:10.2753/IMO0020-8825370201