Chapter 10

RESEARCH AND EXPERIMENTATION IN SUPPORT OF ARTISANAL PALM OIL PRODUCTION IN GHANA

Charity Osei-Amponsah
Knowledge Technology and Innovation Group, Wageningen University and Research, The Netherlands.
Email: cdosei72@gmail.com

Abstract

Artisanal palm oil production is a major source of livelihood, especially for many rural women in Ghana who face challenges in meeting the quality standard for crude palm oil. High levels of free fatty acids prevent artisanal processors from accessing remunerative markets. This chapter highlights how joint experimentation and multi-stakeholder interactions within the context of the Convergence of Science-Strengthening Innovation Systems (CoS-SIS) programme were used to bring about improvements in palm oil processing. A local stakeholders' platform facilitated access to training opportunities on processing. An innovation platform (IP) comprising members drawn from both the district and national levels dealt with higher-level institutional constraints that impacted on quality palm oil production. The multi-scale stakeholder approach used by the researchers ensured the flow of knowledge at different levels; between and among the artisanal palm oil processors, the farmers, scientists, extension service providers, buyers and policymakers. The paper concludes that a multi-scale approach is effective in creating space for multiple stakeholders to interact, co-learn and innovate to improve processing and product quality and derive socio-economic and environmental benefits from artisanal palm oil production in Ghana.

Keywords: Quality, Innovation platform, Institutional constraints, Co-learn, Socio-economic benefits

Introduction

Research and development (R&D) in artisanal oil palm processing usually is primarily technically oriented and only addresses a specific constraint (Li, 2007; Adjei-Nsiah et al., 2012). However, the constraints to rural development and enhanced livelihoods are multi-faceted and complex, as they are socio-technical as well as institutional. An approach is needed that allows the constraints to be addressed in an integrated manner.

Alternative ways are needed to agricultural research and decision-making (Hounkonnou et al., 2012). Scientific knowledge alone cannot provide effective solutions; hence the involvement of

multiple stakeholders in the research process is needed to provide suitable options and shared ownership (Leeuwis and van den Ban, 2004; Lang et al., 2012). Diop (1992) and Richards (1985) offer examples of how local people's knowledge, extension and formal science have interacted productively. According to Thompson (1991), if local knowledge and stakeholders' capabilities are blended with scientific knowledge and approaches, an effective and lasting result can be achieved. The CoS-SIS programme offered a transdisciplinary approach to agricultural R&D.

Palm oil is a key ingredient in the diet of many Ghanaians and also an important industrial raw material. Small-scale farmers produce about 87% of the fresh oil palm bunches in Ghana. These are purchased by artisanal processors, usually women organized around semi-automated '*Kramer*' mills (mostly owned by men) for the production of crude palm oil (CPO). The small-scale operations produce between 60% and 80% of Ghana's CPO (GoG, 2010), but it is of poor quality mainly due to high levels of free fatty acids (FFA) (Osei-Amponsah et al., 2012). A high level of FFA is undesirable as it leads to a rancid taste and lower prices, and increases the cost of refining (Gibon et al., 2007). It also limits access to local industrial and export markets because the oil does not meet the required standards. In addition to the limited access to remunerative markets, the artisanal enterprise also poses an environmental challenge because of the unmanaged polluting effluents and poor air quality from the use of car tyres as fuel for boiling the fruits.

Ghana is also a net importer of high quality CPO; in 2012, it imported about 160,000 t (Index Mundi, 2013) suggesting that domestic demand for high quality CPO exists (GoG, 2010). To explore and exploit this market opportunity, it is necessary for artisanal processors to improve processing practices to meet the quality standards. According to Chandra and Osario-Rodarte (2007), improvements in the oil palm enterprise can be a major force for poverty reduction and rural development in the tropics. Few technical and institutional innovations have been introduced over the last decade and the artisanal processors receive very little support. This chapter is based on Osei-Amponsah et al. (2012) and Osei-Amponsah et al. (2014), and profiles PhD research which investigated how artisanal oil palm processing can be improved to enable small-scale producers in Ghana to access remunerative markets.

Methodology

The research is situated within the CoS-SIS action research programme, which aimed to experiment with ways to create enabling institutional contexts for sustainable productivity and improved livelihoods for smallholder farmers (Hounkonnou et al., 2012; Jiggins et al., 2016). The programme roughly followed five main stages: exploratory and scoping studies; diagnostic and baseline study; participatory action research; facilitation of a Concertation and Innovation Group (CIG), also referred to as an IP by a post-doctoral research associate; and, monitoring and evaluation of the change process. Data collection and analysis are also presented.

Exploratory and Scoping Studies

The research activity started with an exploratory study of the oil palm sector by the research associate in one district from each of the Ashanti, Western and Eastern Regions of Ghana. This study identified constraints and opportunities in the oil palm industry in Ghana (Adjei-Nsiah

et al., 2012). This was followed by a scoping study in the Kwaebibirem district of the Eastern Region to validate the findings from the exploratory study (Adjei-Nsiah et al., 2013).

All the constraints identified were categorized as social, technical and institutional issues and prioritized by various stakeholders for further R&D intervention at a specially convened workshop. The major challenge identified was 'poor access to remunerative palm oil markets', linked to the poor quality of CPO. This topic was chosen as the entry point for the diagnostic and baseline study and the lead problem for the doctoral research.

Diagnostic and Baseline Study

The diagnostic study was done in six purposively selected palm oil producing towns (Asuom, Otumi, Subi, Kade, Kusi and Takrowase) in the Kwaebibirem district. It sought to understand and analyse opportunities and constraints, and to gather baseline information on the artisanal palm oil enterprise (Osei-Amponsah et al., 2012). It was found that artisanal processors store loosened fruits for periods of up to 4 weeks after harvest (medium and large-scale mills process fruits within 48 hours) and used car tyres for boiling fruits. Artisanal processors were also not linked to key stakeholders in the industry. The findings were validated at a local stakeholders' workshop, following which experimental activities were planned.

Participatory Action Research

An action research, or 'learning-by-doing', methodology was used. Action research involves collaborative research with scientists, practitioners and service users (Chambers, 2008) and creates space for bringing about change which is usually achieved through experiential learning (Kolb, 1984; Malinen, 2000). A joint experimentation group and a local stakeholders' platform were created to facilitate knowledge sharing (tacit and codified) for the purpose of experiential and peer learning.

At an artisanal mill owned by Enye Mahooden located in Takrowase (one of the study towns), a joint experiment was carried out between February and April 2011 to assess the association between the length time the fresh fruit was stored and the variation in CPO quality and yield. The mill owner was the leader of the group that also included a technician and scientist from the Oil Palm Research Institute of the Council for Scientific and Industrial Research (OPRI-CSIR), an extension agent from the town, two processors, two mill workers and the researcher. In addition, similar, but researcher-managed experiments on the variation of storage periods of fruits in relation to the quantity and the quality of palm oil, were conducted at different artisanal mills in Kusi and Kade. Three oil palm processing towns (Wenchi, Abaam and Abodom) in the district were purposively selected as control groups.

These experiments assumed that reduction in fruit storage period would lead to lower FFA level (and higher quality palm oil) and thus potentially contribute to meeting the standards required by major industries in local and export markets. The effect of four different fruit storage periods (3, 7, 14 and 21 days) on yield and FFA levels of the CPO produced, were studied. In the final phase of the experimentation process, the findings were presented to a stakeholders' platform workshop by the leader of the joint experimentation group.

Facilitation of the Two Platforms: Local Stakeholders and the CIG

A stakeholders' analysis was used to identify representatives from the various towns who were invited to the first stakeholders' workshop at which the research was introduced and the findings of the scoping study, discussed. A local stakeholders' platform was formed, based on those who expressed willingness to be part of the process. The initial participants (approximately 30) included representatives of oil palm farmers, artisanal processors, mill owners, caretakers, and mill workers (about 65% of them directly involved with processing); four research scientists (a breeder, an agronomist, a socio-economist, an entomologist) of OPRI-CSIR; an agronomist from the Forest and Horticultural Crops Research Centre of the University of Ghana, Kade; staff of the District Agriculture Development Unit of the Ministry of Food and Agriculture (DADU-MOFA) – the director, a Women In Agriculture Development (WIAD) officer, and four extension agents; a representative from the district assembly; the CoS-SIS research associate; and the researcher (the author). Later, participation grew to over 60 stakeholders when farmers, processors and mill owners, who were not initially invited, heard about the platform and decided to join. Six workshops were organized at Kade between March 2010 and November 2012.

The second stakeholders' workshop focused mainly on the validation of the findings from the diagnostic study. These included: specific activities to be carried out during the next phase of the research process which focused on the agreed priority issue; the effect of long fruit storage on palm oil yield and quality were also outlined and tasks were shared. The third, fourth and fifth workshops discussed the experimentation process and its findings. The final workshop was used as an exit strategy meeting to discuss all the outcomes of the research and what needed to be done as a follow up to the project in the district.

The CIG served as an IP. It was established to address higher level constraints facing artisanal processing that were beyond the control of the processors and to help to link them to markets. The CIG comprised representatives from both the district and national levels: oil palm farmers, processors, mill owners, Ministry of Food and Agriculture (from the district), Ghana Export Promotion Authority, Ghana Standards Authority, District Assembly, Environmental Protection Agency, and the Ghana Regional Appropriate Technology Industrial Service (at the national level), as well as the researcher, and the CoS-SIS research associate as facilitator. The CIG consisted of 10 members and the representation changed based on a person's importance in addressing a specific issue at a particular time. The CIG is different (in terms of membership and function) from the stakeholders' platform, which operated at the local level in Kwaebibirem district. In addition, the CIG organized sensitisation workshops to raise awareness on issues, and training workshops on good processing practices in the study towns.

Monitoring and Evaluating the Change Process

To understand the new roles of stakeholders, their attitudes, practices, levels of interaction and the learning that had occurred, reflective interviews were conducted with members of the experimentation groups, some platform members and officials of the governmental organizations involved in the oil palm enterprise. Reports of these interviews were analysed to track changes in the interactions among the stakeholders with reference to the baseline information. *Ex-ante*

and *ex-post* FFA levels were also done and comparisons made between experimental and control groups (see section below).

Data Collection and Analysis

Information was gathered through key informant and personal interviews, focus group discussions, and surveys using semi-structured questionnaires. The narrative information gathered was ordered by teasing out keywords, which helped to explain important issues and was also used as a means of identifying gaps for additional interviews in order to expand the details of the analysis. At the beginning and end of the study period, palm oil samples from different mills were collected from the experimental (same processors as in baseline), and control groups of processors to assess the *ex-ante* and *ex-post* FFA levels. The American Oil Chemists' Society's official method and recommended practice Ca 5a-40 (AOCS, 1990) was used to analyse FFA levels of the samples collected. The mean FFA levels and percentage palm oil yields, the comparison of the mean differences between the yields for three different extraction equipment, and different storage periods were analysed using SPSS statistics software (version 16).

Alongside the joint experimentation, a parallel researcher-managed replication experiment was carried out with three different oil extraction machines. Both experiments tested the effect of four different storage periods (3, 7, 14 and 21 days) after bunch harvest on yields and quality (FFA levels) of palm oil produced. Using the value of palm oil yields, the profitability for producing 1 t of palm oil for each of the four storage periods, at prevailing market prices was estimated, using different market prices based on the FFA levels attained for each storage period.

Results and Discussion

Learning from the Joint Experimentation

It was evident from the joint experimentation that yield increases up to a fruit storage period of 14 days, after which it decreases with longer storage. On the other hand, FFA levels increase sharply the longer the storage period is and quality decreases. Some processors tried their own experiments to find out which period gave them the highest oil yield for the same quantity of fruits normally processed. They found that the maximum palm oil yield point occurred at 10 days. At this stage in the learning process, focus shifted to how to reduce FFA levels and maximize yields of quality CPO, as the CIG facilitation on improving access to new markets had not materialized.

For all storage periods, production of CPO was found to be non-profitable for the informal Nigerian and Togolese markets that artisanal processors operated in. However, CPO production up to a 7-day storage period was the most profitable for oil sold for the local consumer market. Also, if produced at 3 days after fruits were harvested, CPO could be sold at a profit to the local industrial or export market, however production needed to be made more efficient; the current technology processors use makes loosening of the fruits difficult.

Emerging Institutional Changes

Four main institutional constraints were addressed namely: the practice of pre-processing fruit after long-term storage; limited knowledge sharing and interaction among key actors; lack of a regulatory framework and the use of tyres as a fuel source for boiling oil palm fruits; and poor access to remunerative palm oil markets.

At *ex-ante*, 91% of processors from the six study towns had never received technical training and/or attended a workshop on improving processing practices. Most processors (73%) stored fruits between 14 to 28 days at the mills. The *ex-post* survey showed that about 75% of processors in the experimental group stored fruits for shorter periods (1-2 weeks) compared to 36% of processors in the control group.

Following the stakeholder mapping exercise, it was found that the artisanal processing enterprise comprises a variety of actors at different institutional scales. At *ex-ante,* it was found that strong interactions existed among the processors and their mill workers, farmers, mill owners, local buyers, Togolese palm oil buyers and Nigerian agents. These strong interactions ensured an effective flow of information on prices of fruits, palm oil, processing practices and immaterial resources (e.g. attending and supporting activities at the funerals of bereaved families). This was the status quo in the enterprise at *ex-ante*. The DADU-MOFA, which is responsible for agricultural development in the district, and especially its WIAD officer, responsible for collaboration and dissemination of information on good processing, did not have the resources to link up with processors. OPRI-CSIR was mostly engaged in providing high yielding oil palm planting material for sale to farmers, but did not have the facilities to provide technical advice to artisanal processors for producing high quality CPO. The district assembly responsible for the enactment of by-laws on undesirable processing practices and environmental pollution had no links with the processors. Change was triggered by the options for accessing new markets, which implied the need to upgrade processing practices, use environmentally sustainable production methods, and enhance interaction among all stakeholders for knowledge sharing and uptake.

A second mapping exercise, conducted at the end of the study, revealed emerging interactions between the processors on the one hand, and the district assembly, traditional chiefs, the DADU-MOFA and OPRI-CSIR, on the other. Also, a newly created CIG linked with processors to help them access markets and stop burning tyres for fuel. The baseline showed that 86% of processors in the study towns used tyres for boiling oil palm fruits as opposed to 72% of all respondents post intervention, who use fibre cake and kernel shells as the main fuel source. Car tyres were only used by 2% of respondents in the control group.

Improved Quality of Palm Oil an Initiative to Increase Market Access

Overall, the quality of palm oil, in terms of FFA levels, from the experimental group showed much improvement; 20.4% *at ex-ante* to 11.4% (Table 1) at *ex-post*, compared to 19.6% for the control group. The FFA content was substantially reduced, although it still remained above the 5% (PORAM, 2011) desired by industries. The results suggest that further training of processors is needed for improving quality of CPO, but this is not a sufficient condition for accessing high value markets.

Table 1. Average concentrations and standard errors of free fatty acids (FFA in %) of CPO samples obtained from the overall experimental (*ex-ante* and *ex-post*) and control groups in Kwaebibirem district

Groups (n=9, for each group)	Overall mean and standard errors of FFA concentrations (%)
Experimental *ex-ante*	$20.4 \pm 1.64^{a[1]}$
Experimental *ex-post*	11.4 ± 0.85^{b}
Control	19.6 ± 1.56^{a}

[1] Means followed by different superscripts are significantly ($P<0.05$) different.

Conclusion and Recommendations

The joint experimentation created space for interaction and learning about processing practices, as well as for improving palm oil quality. The most effective learning takes place within trusted relationships (Vernooy et al., 2007). Collaboration between the local stakeholders and CIG created space for artisanal palm oil producers, governmental and research stakeholders to engage with each other and to set up a more inclusive agenda for improving the enterprise which kept the stakeholders (especially processors) active in the learning process over a 2-year period. The study concludes that it is profitable for processors to improve CPO quality by reducing fruit storage periods for accessing the national local consumer market and remunerative local and regional soap markets and eventually, the national industrial and export market.

Institutional constraints, such as lack of access to markets, may serve as a disincentive for innovation in the palm oil enterprise. Indeed, in the processors' window of opportunity (i.e. given their existing market outlets), they saw that enhancing CPO quantity, even if it was of inferior quality, was their best option at the time as there was no immediate opportunity to tap into the higher value market for quality oil. This means that key stakeholders such as the DADU-MOFA, the millers' association and the CIG should explore food consumer markets (schools, hotels, restaurants and individual consumers), and assist the interested processors to link up. In this case, there is a need to link artisanal processors to a wider market through the interconnected set of technical and institutional changes that enables them to produce high quality CPO.

Using a case study approach of the *ex-ante* and *ex-post* situation of the enterprise, the quality of CPO from a sample of processors who had been involved in the research had improved. In addition, institutional changes occurred due to the joint experimentation and the formation of a local stakeholders' platform, which enhanced interaction among the representatives of the research institute, government extension service and mill practitioners, especially processors, something which did not exist before. Also, processors at the local level, and the CIG, collaborated to stop processors from using car tyres as a fuel source for cooking oil palm fruits.

Different models of information sharing and interventions were found to be necessary and to complement each other to address varying levels of institutional constraints. The multi-scale stakeholder approach used in the research ensured the flow of knowledge, for example among mill practitioners, within the scientific or extension community, and also among practitioners, scientists and the extension service. The artisanal palm oil processing enterprise is able to innovate if relevant stakeholders (are willing to) interact, learn to overcome constraints and create opportunities, and change institutions, which negatively affect the enterprise. The processors have discovered new knowledge through participating in this research for producing quality CPO. They also know of new options for markets and possibilities for diversifying CPO production based on the quality requirements of a particular market. The artisanal processors are therefore in a position to make better-informed decisions about their production activities and own the process of improving and expanding their livelihood options.

They have not started selling to local industrial or export markets, but they have acquired the skills and capabilities to produce high quality CPO to meet these market requirements. Along with the CIG's facilitation activities to help processors link up with new buyers, some processors on their own have made contacts with CPO exporters and with individual consumers in Ghanaian cities. Others also produce relatively high quality palm oil for restaurants, schools, hotels and special customers in Nigeria at higher prices. These are signs of success in implementing change. In this case, production of quality CPO for remunerative markets also depends on the capability and willingness of processors to make use of available windows of opportunity. At the time of writing, some processors had produced samples of palm oil, which met the required standards based on quality analysis by buyers from Italy. The CIG, the processors and these buyers were negotiating the price of CPO produced according to these quality standards. However, the new market comes with new networks, bureaucracy and complexities. These are challenges the CIG must be mindful of and be ready to help processors cope, as they learn to negotiate a space in this new arena.

Trans-disciplinarity is recommended as the more appropriate approach to research aimed at agro-processing and rural development projects to create space for multi-stakeholder interaction as a co-learning hub for innovation. Scientists from the OPRI-CSIR in the Kwaebibirem district now have the opportunity to interact closely with farmers and processors and have started incorporating some aspects of the CoS-SIS methodology in their research activities. It is recommended that the scientists, who have followed this research process, should set up a small unit to train other scientists who want to do trans-disciplinary research, and to sustain their interactions with the processors, farmers and mill owners.

Acknowledgement

The study was made possible through the financial support of the Directorate-General for International Cooperation of The Netherlands' Ministry of Foreign Affairs.

References

Adjei-Nsiah, S., Adu-Acheampong, R., Debrah, K., Dembele, F., Soumano, L., Ouologuem, B., Saïdou, A., Vissoh, P. and Zannou, E. 2013. Defying the pervasive bias against the small farm sector in Sub-Saharan Africa: Identifying entry points for institutional changes. Development in Practice 23:857-871.

Adjei-Nsiah, S., Sakyi-Dawson, O. and Kuyper, T.W. 2012. Exploring opportunities for enhancing innovation in agriculture: The case of oil palm production in Ghana. Journal of Agricultural Science 4:212-233.

American Oil Chemists' Society (AOCS). 1990. Official Method and Recommended Practices of the American Oil Chemists' Society. Forth Edition. AOCS, Illinois.

Chambers, R. 2008. PRA, PLA and pluralism: Practice and theory. p.267-318. In: P. Reason and H. Bradbury (eds.), The Sage Handbook of Action Research: Participative Inquiry and Practice. Sage, London.

Chandra, V. and Osorio-Rodarte, I. 2007. Options for Export Diversification and Faster Export Growth in Ghana: Meeting the Challenge of Accelerated and Shared Growth. Country Economic Memorandum, Volume II. World Bank, Washington, D.C.

Diop, A.M. 1992. Farmer-extensionist-research partnerships: Rodale International's experience. Discussion paper presented at Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice Workshop. Institute of Development Studies, University of Sussex, London 27-29 October 1992.

Gibon, V., De Greyt, W. and Kellens, M. 2007. Palm oil refining. European Journal of Lipid Science and Technology 109:315-335.

Government of Ghana (GoG). 2010. Master Plan Study on the Oil Palm Industry in Ghana. Ministry of Food and Agriculture, Accra.

Hounkonnou, D., Kossou, D., Kuyper, T.W., Leeuwis, C., Nederlof, E.S., Röling, N., Sakyi-Dawson, O., Traoré, M. and van Huis, A. 2012. An innovation systems approach to institutional change: Smallholder development in West Africa. Agricultural Systems 108:74-83.

Index Mundi. 2013. Oil Palm Production Figures. Available at: http://www.indexmundi.com/agriculture.

Jiggins, J., Essegbey, G., Klerkx, L., van Paassen, A., Pyburn, R. and Tossou, R. 2016. The uses of research: Action researching in and across nine agro-enterprise domains. The experience of the Convergence of Sciences-Strengthening Innovation Systems programmes in Benin, Ghana and Mali. p.101-123. In: J. Francis, L. Mytelka, A. van Huis and N. Röling (eds.), Innovation Systems: Towards Effective Strategies in Support of Smallholder Farmers. Technical Centre for Agricultural and Rural Cooperation (CTA) and Wageningen University and Research (WUR) Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS) programme, Wageningen.

Kolb, D.A. 1984. Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, New Jersey.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. and Thomsa, C.J. 2012. Transdisciplinary research in sustainability science: Practice, principles and challenges. Sustainable Science 7:25-43.

Leeuwis, C. and van den Ban, A. 2004. Communication for Rural Innovation: Rethinking Agricultural Extension. Blackwell, London.

Li, T.M. 2007. The Will to Improve: Governmentality, Development and the Practice of Politics. Duke University Press, Durham.

Malinen, A. 2000. Towards the Essence of Adult Experiential Learning. SoPhi Academic Press, Jyväskylä.

Osei-Amponsah, C., Stomph, T-J., Visser, L., Sakyi-Dawson, O., Adjei-Nsiah, S. and Struik, P.C. 2014. Institutional change and the quality of palm oil: An analysis of the artisanal processing sector in Ghana. International Journal of Agricultural Sustainability 12:233-247.

Osei-Amponsah, C., Visser, L., Adjei-Nsiah, S., Struik, P.C., Sakyi-Dawson, O. and Stomph, T-J. 2012. Processing practices of small-scale palm oil producers in the Kwae-bibirem District, Ghana: A diagnostic study. Wageningen Journal of Life Sciences 60-63:49-56.

Palm Oil Refiners Association of Malaysia (PORAM). 2011. PORAM Handbook. PORAM, Selangor.

Richards, P. 1985. Indigenous Agricultural Revolution: Ecology and Food Production in West Africa. Hutchinson, London.

Thompson, J. 1991. Combining Local Knowledge and Expert Assistance in Natural Resource Management, From the Ground Up. Case Study Series, 2. World Resources Institute and the African Centre for Technology Studies, Washington, D.C. and Nairobi.

Vernooy, R., Song, Y. and Li, J. 2007. Local Agriculture Innovation in China: Ensuring a Fair Share of Rights and Benefits for Farming Communities. Asian and Pacific Centre for Transfer of Technology, New Delhi.