Institution: University of Greenwich

Unit of Assessment: 6 - Agriculture, Veterinary and Food Science

Title of case study: Transforming cassava to improve livelihoods in sub-Saharan Africa

Period when the underpinning research was undertaken: January 2000 - July 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Andrew Westby	Professor of Food Technology	01/05/1996 – present
Keith Tomlins	Professor of Food Science	01/05/1996 – 31/08/2020
Andrew Graffham	Principal Scientist	01/05/1996 – 31/10/2016
Richard Lamboll	Principal Scientist Socio-Economist	01/05/1996 – present
Adrienne Martin	Professor of Development Studies	01/05/1996 – present

Period when the claimed impact occurred: January 2014 - July 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

Cassava is critical to the livelihoods of 450 million poor people in Africa, but it is limited by many factors including toxicity, low productivity and lack of market opportunities. This case study builds on one submitted to REF2014 and describes the impact pathway and scale up from strategic research on cassava fresh root transformation to make safe, cheap and valued products for food and industrial use. Adaptive interdisciplinary research by the University of Greenwich on value chain scaling led to market-based solutions for cassava to be used as a diverse commercial/industrial commodity. More than 2,370,000 tonnes of cassava roots were mobilised in this impact period compared to 170,000 tonnes in the previous one, with gross income to smallholder farmers and processors of USD369,100,000 compared to an estimated USD30,000,000 in REF2014. Increased incomes were reflected in livelihood improvements, for example, in Nigeria wealth assets (items like radio, fan, generator and sewing machine) showed a significant increase in the beneficiary group in comparison with the control group. Women's asset status improved more than men's in some dimensions, narrowing the gap to men's asset status.

2. Underpinning research

Cassava is a staple food crop for 450 million people in Africa. Its contribution to improving the livelihoods of poor people is limited by its perishability (typically 48hrs), toxicity associated with its cyanogen context, inadequate processing and lack of market opportunities. Farmers have low yields, which could be improved by adoption of higher yielding varieties and improved agronomic practices. There is a lack of knowledge regarding best practice in scaling value chain development for the cassava sector. A value chain in this context identifies the set of factors and activities that bring a basic agricultural product in the field (fresh cassava in this case study) to final consumption, where at each stage value is added.

Professor Andrew Westby and colleagues at the Natural Resources Institute (NRI) of the University of Greenwich have developed a world leading portfolio of strategic and adaptative interdisciplinary research supported by the Department for International Development and the European Union to support cassava value chain development in Africa.

Research prior to 2000 focussed on understanding mechanisms of cyanogen reduction during cassava processing. In the period since 2000, the NRI team have produced more than 50 scientific publications investigating issues supporting cassava value chain development.

Research focussed on the efficient and safe transformation of the perishable roots into shelf-stable products, such as high-quality cassava flour (HQCF) and improved forms of traditional processed products **[3.2**, **3.3**, **3.4, 3a, 3b, 3c]**. This included overcoming problems associated with mould growth and mycotoxin contamination of traditional products **[3.1]** with improved sun or artificial drying. Mycotoxins are produced by fungi and can negatively affect human health. Artificial drying needs to be fuel efficient and produce high quality products.

Appropriate quality management protocols were developed to support the production of high-quality and food safe products to meet market demands **[3.3]**. Complementary work was undertaken to support understanding of desirable consumer attributes through sensory evaluation studies **[3.3]**. DFID **[3c]** and EC **[3d, 3e, 3f]** funded further projects that provided the basis for value chain development.

Implementation of the first phase of the Cassava Adding Value for Africa (CAVA) project (the basis for the REF2014 case study) between 2008 and 2013 supported by the Bill and Melinda Gates Foundation (BMGF), provided the basis for interdisciplinary research to understand the processes of scaling up and scaling out smallholder inclusive and sustainable cassava value chains **[3.5**, **3.7]**. This facilitated the impact of the second phase of the project (CAVA2; February 2014 to March 2019).

With over GBP4,000,000 in funding from the European Union in 2012 **[3e, 3f]**, technologies and systems were developed to support cassava value chain development including new market opportunities to drive processed product adoption e.g. using spent cassava flour from brewing beer for snack foods **[3.6]** and utilisation of wastes from cassava processing.

3. References to the research

1. Wareing, P. W., **Westby, A.**, Gibbs, J. A., Allotey, L. T. and Halm, M. (2001). Consumer preferences and fungal and mycotoxin contamination of dried cassava products from Ghana. *International Journal of Food Science & Technology*, *36*(1), 1-10. (https://doi.org/10.1111/j.1365-2621.2001.00419.x).
2. Sanni, L.O., Adebowale, A.A., Filani, T.A., Oyewole, O.B. and **Westby, A.** (2006) Quality of flash and rotary dried fufu flour *Journal of Food, Agriculture & Environment Vol.4 (3&4): 74-78.* (https://doi.org/10.1234/4.2006.920).
3. **Tomlins, K.**, Sanni, L., Oyewole, O. B., Dipeolu, A., Ayinde, I., Adebayo, K. and **Westby, A.** (2007) Consumer acceptability and sensory evaluation of a fermented cassava product (Nigerian fufu). *Journal of the Science of Food and Agriculture, 87, 1949-1956.* (https://doi.org/10.1002/jsfa.2941).
4. Obadina, A.O., Oyewole, O.B., Sanni, L.O., **Tomlins, K.I.** and **Westby, A.** (2007) Identification of hazards and critical control points (CCP) for cassava fufu processing in South-West Nigeria. *Food Control, 19,22-26.* (doi:https://doi.org/10.1016/j.foodcont.2007.01.002).
5. **Lamboll, R.**, Nelson, V., Posthumus, H., **Martin, A.**, Adebayo, K., Alacho, F., Dziedzoave, N., Mahende, G., Sandifolo, V., Sanni, L., Abayomi, L., **Graffham, A.**, Hillocks, R. and **Westby, A.** (2015) Practical lessons on scaling up smallholder-inclusive and sustainable cassava value chains in Africa. *Food Chain, 5 (1-2). pp. 28-52*. (http://dx.doi.org/10.3362/2046-1887.2015.004).
6. Omidiran, A.T., Sobukola, O.P., Sanni, A., Adebowale, A-R. A., Obadina, O. A., Sanni, L.O., **Tomlins, K.** and Tosch, W. (2016) Optimization of some processing parameters and quality attributes of fried snacks from blends of wheat flour and brewers' spent cassava flour. *Food Science & Nutrition, 4 (1). pp. 80-88.* (https://doi.org/10.1002/fsn3.255).

7. **Lamboll, R.**, **Martin, A.**, Sanni, L., Adebayo, K., **Graffham, A.**, Kleih, U., Abayomi, L. and **Westby, A.** (2018) Shaping, adapting and reserving the right to play: Responding to uncertainty in high quality cassava flour value chains in Nigeria. *Journal of Agribusiness in Developing and Emerging Economies, 8(1), 54-76.* (https://doi.org/10.1108/JADEE-03-2017-0036).

Key Research Grants

a) Westby (PI). *Improved cassava chips processing to access urban markets.* (DFID, R7580); Feb 2000 – Mar 2003; £258,671.
b) Westby (PI). *Commercialization of cassava fufu processing in West Africa that maximises benefits to livelihoods*. (DFID, R9495), Nov 1999 - Mar 2003; £231,394.
c) J. Graffham (PI). *Cassava as an industrial commodity - Approaches for expanding markets.* (DFID, R8268; R8432): Jan 2003 – Dec 2006; £267,310.
d) Westby (PI). *Development of small/medium scale enterprise sector producing cassava based products to meet urban demand W Africa (Cassava-SMEs)*. (EC through NR International Ltd., code ZJ033): Jan 2003 – Dec 2006; £661,153.
e) K. Tomlins (PI). *Improving the livelihoods of smallholder cassava farmers through better access to growth markets* (CassavaGMarkets). (EC, DCI-FOOD-2012/290-635) May 2012 - May 2017; £ 2,334,075.
f) K. Tomlins (PI). *Gains from losses of root and tuber crops (GRATITUDE)*. (EC, FP7-KBBE-2011-5; No: 289843) Jan 2012 – Mar 2015; £2,371,510.

4. Details of the impact

The first phase of the Bill and Melinda Gates Foundation (BMGF) funded Cassava Adding Value for Africa (CAVA) project formed the basis of a REF2014 case study. Smallholder inclusive value chains were established for High Quality Cassava Flour (HQCF) based on NRI's strategic and adaptive research on cassava processing and market development. At the time of REF2014, the initiative had worked with an estimated 90,000 farmers mobilising 170,000 tonnes of cassava roots, with a gross value added to rural communities of USD33,000,000.

UoG research on value chain development significantly built on previous impact figures. In the second phase of CAVA **[5.11]**, from February 2014 to March 2019, the project team led by **Professor Westby** and Professor Adebayo from the Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria worked with partners in Nigeria (FUNAAB), Ghana (Food Research Institute), Uganda (African Innovations Institute), Tanzania (Tanzania Food and Nutrition Centre) and Malawi (University of Malawi) to scale up and scale out value chain development initiated as described in the REF2014 impact case study with additional USD18,816,547 funding from BMGF. This scaling up and scaling out built on (a) new market/scaling assessments undertaken by NRI/partner teams, (b) lessons learned from the first phase of CAVA **[3.5]** and (c) NRI underpinning research **[3.1, 3.7]**.

The amount of cassava roots mobilized and the gross income from its sale and processing was over tenfold more than in the last REF. In this period, CAVA focused on value chains for HQCF, chips, starch, ethanol, improved traditional products (*gari* and *fufu* in Nigeria, *agbelima* in Ghana, *makopa* in Tanzania) and animal feed. This enabled a wider range of NRI research to be used (e.g. on traditional products **[3.2, 3.3**, **3.4]**) and provided flexibility in implementation in complex environments **[3.7]**. In total, **2,371,865** tonnes of roots were purchased in the period April 2014 to March 2019 from farmers across all five countries (compared with 170,000 tonnes over a similar time period as for REF2014) of which more than 70% went to new value chains **[5.1, 5.2].** Between April 2014 and March 2019, across all five countries, smallholder gross income from the sale of cassava roots was USD134,600,000 and processor gross income was USD234,500,000, giving a combined total of **USD369,100,000**, a tenfold increase (compared with USD33,000,000 in the REF2014 period) **[5.1, 5.2]**.

Business models were tailored to the country, location and market context. Implementation plans were developed to enable both women and men to participate and benefit. For new

value chains, 51% of roots were supplied by men and 49% by women, whereas in traditional value chains 61% were supplied by women and 39% by men **[5.1]**. For new value chains, the ratios of men and women supplying roots were similar irrespective of which product was processed. At project end, the number of direct beneficiaries across all five countries amounted to **153,738** (from project monitoring and evaluation records, **[5.1, 5.2]**. Allowing for an average family size of 5, it is estimated that 750,000 people would have benefitted from the project.

Farmers that adopted productivity enhancing technologies and supply management practices (lessons learned from CAVA Phase I [3.5]) saw an increase in income which enhanced their quality of life as well as their households. Adoption of productivity enhancing technologies (increasing yields) in response to value chain development was an important part of the project theory of change agreed with the BMGF **[5.2].** Smallholder farmers adopted productivity-enhancing technologies that enabled them to increase their yields by 58-154% (dependent on country) in response to market demands **[5.1, 5.2]**. As a specific example, the Commissioner for Agriculture for Ogun State **[5.3]** provides a testimonial that indicates that root demand in his State has exceeded 270 tonnes/day and farmers have responded by increasing their yields by 60%. Based on project data on costs of production and yield, it was estimated a smallholder farmer in Ogun State would benefit from a 67% increase in gross income against someone using traditional practices **[5.1].**

There is evidence that beneficiaries engaged in the project increased their wealth, particularly women. For example, in Nigeria **(Ajayi, 2019 [5.4])** the mean values of wealth assets (items like radio, fan, generator and sewing machine) showed a significant increase in the beneficiary group compared with the control group. There were also significant increases in some selected asset wealth of female headed household beneficiaries compared with non-beneficiaries in Nigeria. For example, possession of radio, television sets, fans and sewing machines has increased significantly more than those in the control group of female-headed households who did not participate in the project. Comparing women with men beneficiaries, women's asset status improved more than men's in some dimensions, contributing to narrowing the gender gap in some categories **[5.1, Tables 4 and 5]**.

An independent study of >2,700 households by Boadu *et al.* (2020) **[5.5]** of CAVA's work in Ghana, concluded that "*it raised participants' annual income by an average of GHC981.71*" (£124). "*This increase represents about 50.4% of the average annual income of non-CAVA respondents*". It was found that "*CAVA project participants were 23.1% more likely to have access to markets for their produce than were non-participants*". The study concluded that "*the CAVA project empowered women by increasing their level of income and participation in household decision-making regarding use of productive resources*".

UoG research contributed to reduced fuel usage and enhanced quality assurance. Innovations and processing technology improvements were important drivers in value chain development (building on research e.g. **[3.2]**), especially where they contributed to a reduction in the use of fuel and enhanced quality assurance; for example, current Nigerian drying technologies are significantly better than those at the start of CAVA (fuel usage reduced from 374 to 65 litres/ton of dried product; throughput increased from approximately 100kg/hour to around 330kg/hour of dried product and efficiency increased from 11% to 55%) (see **[5.6]**). An important feature of CAVA implementation was building the capacity of a local equipment manufacturer, making it possible to make these improvements in collaboration with him **[5.6]**. The manufacturer reports **[5.6]** that "*flash dryers based on this improved design have been exported to eight countries in Africa, with multiple sales in Nigeria including a contract of 40 units to the Nigerian Ministry of Agriculture through the Bank of Industry for use in SMEs."* Overall, 87 flash dryers were installed **[5.1]**, with installations in Nigeria, Tanzania (e.g. Kapipa Millers Ltd, Tanzania producing 4 tonnes/day of flour **[5.8]**), Malawi, and Uganda (e.g Windwood Millers Ltd who process 10 tonnes/day of flour using roots from 1,000 farmers **[5.9]**). In Ghana, one locally-fabricated flash dryer and 21 bin dryers were installed **[5.1]**.

UoG research (for example [3.1]) contributed to understanding the risks associated with poorly dried cassava and the importance of processing it safely, for example, to avoid mycotoxin contamination. Efficient sun-drying of smallholder farmer supplied roots was an important approach for producing high quality products for diverse markets. Sun-drying involves a lower capital equipment cost investment, allowing farmers themselves to engage in processing and so benefitting themselves from value addition. Sun-drying operations were used by 1,270 community processing groups in all five countries **[5.1]**. Many of the 569 small and medium scale enterprises who engaged in the project also used sun-drying because of the lower capital investment costs. Use of sun-drying accounted for 32.5% of the cassava roots mobilised by the CAVA Phase 2 project **[5.1]**.

Supply of dried cassava chips or flour to the brewing industry in Uganda **[5.7]** was one example of how the use of sun-drying allowed resource poor farmers to benefit from access to new markets. In the 2014-2020 period, Uganda Breweries Ltd purchased 18,973 tonnes of cassava flour from 1,599 households for £5,571,098 **[5.7]**. One of the smallholder processors, Zaituna, is sure of the benefits **[5.10]**, "*My livelihood has improved. I have enough skills and knowledge in managing cassava in many areas. I have managed to construct a better house, out of the sweat of CAVA. I get good money and I could buy animals. Through CAVA also, I managed to educate my boy up to university level*."

UoG's work was recognised by a number of prestigious awards. For its contributions to the CAVA project, NRI was awarded the Times Higher Award for International Collaboration of the Year (2014), the Guardian University Award for Research Impact (2015) and the Queen's Anniversary Prize for Further and Higher Education (2015-2016). The Queen's Anniversary Prizes recognises outstanding work by UK colleges and universities that shows quality and innovation and delivers real benefit to the wider world and public through education and training. The Prizes are the highest national Honour awarded in UK further and higher education. Prizes are granted by The Queen every two years.

5. Sources to corroborate the impact

1. Cassava: Adding Value for Africa Phase II Project Completion Report (2019) (https://www.nri.org/images/documents/CAVA2/Final_Narrative_CAVA2.pdf).
2. Ms Kate Lawyer, CAVA2 Program Officer, Bill and Melinda Gates Foundation.
3. Dr Adeola Odedina, Honourable Commissioner of Agriculture, Ogun State, Nigeria.
4. Ajayi (2019) CAVA2 Nigeria. Endline Evaluation Report. (https://www.nri.org/images/documents/CAVA2/NG_CAVA2_Final_report1.pdf).
5. Boadu, P., Quaye, W., Yamoahm A-A,N., Agyeman and Akuffobea, M. (2020) CBMS-20035 Does addressing gender inequalities and empowering women improve development programme outcomes? Partnership for Economic Policy. https://portal.pep-net.org/public/project/20035
6. Mr Idowu Adeoya, Managing Director, Nobex Technologies International, Lagos, Nigeria.
7. Mr Joseph Kawuki, Agriculture Manager, Uganda Breweries Ltd, Uganda.
8. Ms Oliver Faustine Matemu, Managing Director, Kipipa Millers Ltd, Mwanza, Tanzania
9. Mr Jonathan Isaac Otim, Managing Director, Windwood Millers Ltd, Lira, Uganda.
10. Summers, G. (2019) Brewing up success: CAVA2 combines quality, training and technology for farmers and industry https://www.nri.org/latest/news/2019/brewing-up-success-cava2-combines-quality-training-and-technology-for-farmers-and-industry
11. Cassava Adding Value for Africa (Phase 2) website (www.cava2.org).