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Evidencing what works in developing new market opportunities for GLDC crops

Lessons from six case studies

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RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

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Front cover image: Women inspect pigeonpea at flowering time in East Africa Credit: CRP-GLDC (https://flic.kr/p/ajKZF9)

Abstract

This paper aims to cast light on the effectiveness of interventions to promote the use of Grain Legumes and Dryland Cereal (GLDC) crops by consumers and industry. Underpinning this activity is the hypothesis that interventions which promote GLDC crops (particularly in new/ non-traditional uses) will create new and or more profitable and scalable market opportunities for smallholder farmer, increasing their income and helping drive technology adoption. These hypotheses remain largely untested, with no systematic evidence base of the sort of "promotion" activities that can create enduring, inclusive market opportunities at scale for the small holder sector producing GLDC crops. Here, we examine six case studies: i) Global competition: sorghum beer in Kenya, ii) The power of incentives: sflatoxin control for groundnuts in Malawi, iii) Marketing modernity: Smart Food in India and Eastern Africa, iv) The Politics of pricing: sweet sorghum as a biofuel in India, v) Too many moving parts? precooked beans in Uganda and Kenya, and vi) Market-led plant breeding: pigeonpea in Eastern and Southern Africa. The analysis of these case studies will allow to draw five key lessons on what works and why, and what causes failure, when implementing interventions aimed at developing new market opportunities for the GLDC crops.

Contents

1 Introduction

The CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) houses a set of five R&D flagships that span the Priority Setting and Impact Acceleration, Integrated Farm and Household Management, Variety and Hybrid Development, Pre-breeding and Trait Discovery, and Common Bean for Markets and Nutrition. Straddling these is the cross-cutting theme on Markets and partnership in agri-business (MPAB). The scope of MPAB is to explore the way market opportunities for GLDC crops can, (i) be leveraged for smallholder impact and (ii) identifying demand signals for breeding and agronomy research that could help progress new market opportunities in the future.

This assignment feeds into a specific CRP-GLDC activity including understanding the effectiveness of interventions to promote the use of GLDC crops by consumers and industry. Underpinning this is the hypothesis that interventions that promote GLDC crops (particularly in new/ non-traditional uses) will create new and or more profitable and scalable market opportunities for smallholder farmer, thereby increasing their income and helping drive technology adoption. These hypotheses remain largely untested and in particular there is no systematic evidence base of the sort of "promotion" activities that can create enduring, inclusive market opportunities at scale for the small holder sector producing GLDC crops.

The purpose of this document is to collate and review evidence and analysis of what is working and why or why not. A preliminary set of case studies have been selected based on a number of key questions:

1. Description of models. What are the different "promotion" approaches / interventions that have been used? Is there a topology of different approaches for different commodities, types of market opportunity/ strategic intent (impact ambition – farm income, nutrition, urban consumer vs rural consumer).
2. Evidence of success. What does success look like (maybe different points of view)? Scale of impact? Sustainability of impact? Who benefits, distributional issues? Wider disruptive effects on the market, policy, industry, or farm practice? Notable environmental impacts?
3. What works and why? What are the key partnerships and agencies involved, and what role do different actors play? What other design or contextual factors, including policy enabled success? Key lessons that led to success.
4. What causes failure? What are the common mistakes and bottlenecks encountered? Missing resources and expertise? Why does an intervention fail to scale or progress beyond project-based pilots? Were there issues beyond the scale of initiatives that got in the way (for example, motivations of the private sector, consumers values and interests, weak entrepreneurial capabilities, ineffective financial and legal institutions). Key lessons that led to failure / unmet ambitions.
5. Legacy. Where there any unexpected or knock-on outcomes that resulted from the intervention? Crowding in or copying the approach or market opportunity? Pivots and U-turns by implementers? Longer term dynamics that might offer hope of success in the future?

From this document, five overarching lessons emerge: i) the limited knowledge on how to engage with the totality of the value chain, ii) the importance of cooperation among actors, iii) the role of power and politics, iv) issues in the framing of problems, and v) M&E narratives. These lessons will be detailed in Chapter 2.

The summary table below illustrates key features of each case study and insights on the specific lessons each one provided. An in-depth analysis of the six cases can be found from Chapter 3 onwards.

Table 1: Typology of business model drivers

	Outline	Key lessons
Case Study No. 1 (CS1) *Chasing Global Markets:*: Sorghum beer in Kenya	Experience with 'Senator keg', a sorghum beer produced and marketed in Kenya by East African Breweries Limited (EABL) The model for clear sorghum beer in Kenya is almost entirely commercial. The key variable is price.	Clear evidence of demand and the commercial incentive to exploit it. Right combination of value chain actors with the right skills. Government of Kenya played a vital role; in particular implicit subsidy which kept the price of sorghum beer affordable for low-income consumers (compared to illicit brews) BUT Sorghum beer's dependence on state subsidy made it vulnerable to changes in tax policy (in March 2013, the government suddenly imposed an excise duty of 50% on the sale of Senator keg → imposition of excise duty on sorghum beer was self-defeating. Later, however, this was reversed, which made the damage to the value chain temporary. Why did the government change the policy? → Ethnic rivalries play an important role in Kenya politics and voters who back the losing side cannot expect any favours from those in power.
Case study No. 2 (CS2) *The power of incentives*: Aflatoxin control for groundnut in Malawi	Manage aflatoxin for groundnut in Malawi→ ICRISAT's strategy Demand driven by governments rather than by consumers. Strategy focused on exports to the EU rather than on domestic or regional markets. Success has been elusive because economic incentives for control are limited.	Successful control requires an integrated approach that combines a range of management strategies. However, success has proved elusive. → while these strategies are effective in managing aflatoxin, the economic incentive to adopt them is missing that largely explains the failure to achieve impact at scale.
Case Study No. 3 (CS3) *Marketing modernity*: Smart Food in India and Eastern Africa	The Smart Food initiative frames the 'problem' as one of consumer demand. Aims to reduce malnutrition. no value chain is involved.	Some changes/awareness at the individual level of consumers. BUT limited impact at scale → behavioural change requires concerted action on several fronts – legislation, education, restrictions on advertising, a public health campaign.

	Outline	Key lessons
Case Study No. 4 (CS4) *The politics of pricing*: Sweet sorghum as a Biofuel in India	India has high potential demand for biofuels. High potential demand has prompted ICRISAT to re-set its research program for sweet sorghums. In 2007, ICRISAT launched a BioPower Initiative in partnership with NARS. The central piece of this Initiative was the design and testing of a prototype value chain.	Without the right policy, the technical superiority of a new technology is irrelevant. (if sugarcane remains the spoilt child of price policy in India, sweet sorghum as a biofuel will be uncompetitive). ICRISAT's economists correctly identified the policies that made sweet sorghum uncompetitive with sugarcane. But the forces behind these policies were not investigated. This de-politicises policy. Policies can be described as 'mistaken', implying that policies are a rational choice between alternative options, and that the 'mistake' will be corrected once policy makers have the right evidence. But if the technical evidence in favour of sweet sorghum as a biofuel is overwhelming, why is sugarcane so entrenched? Neoclassical economics cannot answer this question, which cries out for a political economy approach. More effective advocacy. With its fixation on molasses, India's National Policy on Biofuels seems blind to economic realities.
Case Study No. 5. (CS5) *Too many moving parts*? Precooked Beans in Uganda and Kenya	Precooked beans are a promising innovation. Yet, a smallholder value chain has a lot of moving parts. All these moving parts must work for the value chain to succeed. By the same token, a malfunction in just one moving part will cause the value chain to fail.	The project successfully increased the supply of high-iron bean seed and grain. 3 reasons for this: Partnership with intermediary organisations experienced in managing farmer groups and in aggregation remunerative pricing social inclusion BUT slow success → The value chain for precooked beans has simply too many moving parts for a short-term project.
Case Study No. 6. (CS6) Market-led plant breeding: Pigeonpea in Eastern and Southern Africa	Pigeonpea in Eastern and Southern Africa (ESA) was framed as developing improved varieties to: supply to export markets → research of developing improved varieties that were adapted to the agro-ecology and cropping system in ESA but also reached India when prices were high	The breeding programme was in the right place at the right time. Decentralisation and multidisciplinarity → ESA got some power to set its own research agenda and priorities + multidisciplinary team that supported the idea of market-led research, which was new and broke away from conventional thinking. Scaling-up the supply of seed took advantage of changes in policy while also benefitting from the involvement of a group of Asian entrepreneurs to give insights on consumers' preferences. BUT

	Outline	Key lessons
	and had the market traits favoured by Indian consumers. The ESA breeding programme is now 30 years old, having started in 1991	Short duration improved varieties which were successful in India that proved to be poorly adapted to ESA. ICRISAT's vision of a vertically integrated pigeonpea industry was never realised. Crop management failure. The focus of the ESA breeding programme has been to generate cash income from pigeonpea, rather than use pigeonpea to boost household food security and nutrition. Consequently, less attention was paid to domestic or regional demand. Overall, breeding programme had a lasting impact on ICRISAT. Market-led breeding was ahead of its time → Based on the experience of this and other programmes, ICRISAT later made market-led development into an orthodoxy, applying it even when it was not appropriate.

2. What lessons can we learn?

The case studies provided key insights on processes of change, illustrating that our knowledge around these is still fragmented. A major challenge was related to how to implement interventions that go beyond tackling single components of the value chain that enable transformation in agri-food systems. Five key themes emerge from our analysis: i) the limited knowledge on how to engage with the totality of the value chain, ii) the importance of cooperation among actors, iii) the role of power and politics, iv) issues in the framing of problems, and v) M&E narratives.

2.1 Limited knowledge on how to engage with the totality of the value chain

Agri-Food system interventions tend to rely on single point interventions framed by earlier development paradigms (Mausch et al., 2020). Such interventions often target specific components of the value chain. Yet, it might be the ability to engage with the value chain in totality that determines the impact of an initiative – and possibly its potential to achieve impact at scale. CS1 is a key example of the importance of building a value chain – and ensure the combination of right actors with the right skills – to unlock the initiative's success and its ability to achieve impact at scale.

On the contrary, CS2, CS3, CS5 and CS6 show how lack of correct engagement with value chain actors thwarted the initiatives' take off (and possibly their scaling). CS2 shows how successful control of aflatoxin requires an integrated approach that combines a range of management strategies. Yet, even when there are effective strategies for managing aflatoxin, the absence of the right incentives for the different value chain actors leads to failure.

CS3 (conveniently) disengages with the need to build a value chain, framing the problem as a "malnutrition" problem which can be targeted by simply increasing consumption of smart foods at the household level. However, even when changing consumption habits -in this case through publicity and workshops- impact at scale cannot be achieved through simple health/nutrition messaging. The development of a value chain would be required to fix the structural problem of higher price of millets, which itself hampers consumption among poorer households. Increasing supply would translate into lower prices. This would require fundamental changes in the value chain, which are difficult to orchestrate – and thus engage with. Targeting single components (in this case, consumers) might be simpler and the proof of success can be more easily and more quickly available. Yet, doubts around the potential of the initiative to achieve impact at scale and over the long-term may arise.

CS5 is an example of how a promising innovation still requires careful value-chain build up to achieve impact at scale. The precooked beans case shows that even when an innovation is packed with potential, the growth can be slow initially, as it requires a dedicated value chain to be put in place. CS5 recognizes that smallholder value chains have a lot of moving parts that must work simultaneously for the innovation to take off. Building the precooked beans value chain was a complex and time-consuming process, and the project was labelled as having a "slow growth". However, this is a limiting vision; building a value chain should be considered a long-term investment – not something to be achieved in a 2 ½ year project. This point will be further developed in paragraph 6.

Finally, CS6 used innovative models for vertical integration of the value chain. Yet, ICRISAT's vision of a vertically integrated pigeonpea industry was never realised. The case study highlighted that there had been a lack of understanding of the ways this could happen in ESA. The sub-sector analysis was based on models (such as the silkworm in Thailand) that were very different from the pigeonpea case.

2.2 Importance of cooperation among actors

Together with the need to develop a value chain to enable the scaling of the innovation, the case studies also illustrate how partnerships and cooperation between different actors including intermediary organizations, the private sector, research institutions and NGOs can boost the projects' success. This is one point which the case studies might have gotten right.

CS1 recognizes that Senator keg's success would not have been possible without a commercial company (EABL) operating in a highly competitive market, and with the necessary knowledge and experience to match products with the needs of consumers. However, the involvement of Smart Logistics Solutions, a private company which also acts as social enterprise, to act as intermediary was equally necessary to coordinate and engender additional benefits for smallholders (e.g., a farmgate price substantially above that offered by middlemen). Thus, CS1 is a textbook example of how an intermediary organization working with farmer groups can successfully link poorer smallholders with new markets. Similarly, one of the reasons for success of CS5 must be found in the partnership with intermediary organisations experienced in managing farmer groups and in aggregation (once again, Smart Logistics Solutions).

CS4 puts forth the potential of a business incubator and of partnership between research institutions. On the one hand, the projects would not have been possible if ICRISAT's Agri-Business Incubator (ABI) hadn't been able to attract a private investor (Rusni Distilleries Pvt Ltd) to make ethanol from sweet sorghum. The ABI was also able to attract other private companies like Tata to invest in pilot projects in other locations. On the other, the viability of the decentralised model couldn't have been demonstrated without the build-up of partnerships between ICRISAT, NARS, and a local NGO. Likewise, the Fairtrade model used in CS2 was developed through a partnership between ICRISAT and the National Farmers' Association of Malawi (NASFAM). CS6 also strongly relies on cooperation among actors. ICRISAT partnered with Technoserve Inc. to apply sub-sector analysis to the value chain for pigeonpea in Tanzania, Kenya, and Mozambique and Malawi. This partnership gave ICRISAT, both the rationale and the strategic framework for a market-led breeding programme. Technoserve's role was critical for market-led breeding because ICRISAT had no experience of working with the private sector.

Besides, a group of Asian entrepreneurs also provided their support to Eastern and Southern Africa (ESA). Their knowledge of customers provided the breeding programme information about the quality traits required for improved varieties in export markets, besides providing links to these markets in India and Europe.

2.3 Patterns of power and politics

CS1 and CS4 clearly show the lack of understanding for engaging with power and politics in the project context.

In CS1, the intervention was vital for the take-off of the initiative but hampered it at a later point. Initially, the Government of Kenya was prompted into action by the potential of the initiative to tackle both poverty and health concerns. While on one side the Ministry of Agriculture saw sorghum beer as an opportunity to raise the income of smallholders, on the other, the Ministry of Health saw it as a health intervention as deaths from illicit brews scandalized public opinion and challenged the government's legitimacy. Thus, the Government supported the sorghum beer through an implicit subsidy which kept it affordable for low-income consumers. However, later changes in tax policies saw the removal of the subsidy and the consequent damage to the value chain (which depended upon it). This can supposedly be attributed to a change in government. The existence of ethnic rivalries plays a key role in the politics of Kenya, even if these changes were later reversed (and thus the damage was only temporary). Changes in tax policies keep hanging over the sorghum beer value chain like Damocles' sword – leaving a legacy of uncertainty. CS1 highlights the critical role of not only policies but politics. Yet, how the project can interface with political actors and power games remains unclear.

A similar pattern is present in CS4 where sugarcane benefits not only from subsidies that reduce the cost of production but also from a Minimum Support Price (MSP) in India. There is also an MSP for sorghum for the grain but not for the stalk. The absence of support for sweet sorghum as biofuel can be attributed to the sugar lobby in India. Currently, supply of ethanol comes from molasses, a by-product of sugarcane. The sugar lobby – which can be compared in terms of political power to the gun lobby in the US - wants to preserve its interests and thus is hostile to sweet sorghum. Unfortunately, the states (agro-ecological zones) in which sweet sorghum can be cultivated are also the strongholds of the sugar lobby that makes the scaling of sweet sorghum as biofuel even more challenging. Even if ICRISAT's economists correctly identified the policies that made sweet sorghum uncompetitive with sugarcane, the forces behind these policies were not investigated. Considering policies as a rational choice between alternative options, and policy makers are willing to change policies once they are supplied with the "right evidence", is a simplistic approach. Even when there is overwhelming technical evidence in favour of sweet sorghum as a biofuel, sugarcane remains entrenched. A Neoclassical economics approach cannot explain the reasons behind this, thereby suggesting switch to a political economy approach. Furthermore, CS4 flags the need of "policy entrepreneurs" for sweet sorghum, and the creation of a powerful coalition of interest groups including scientists, researchers, bureaucrats, and private companies which would allow the establishment of sweet sorghum as a credible source of biofuel. Unless such a coalition is created, the sugar lobby will make sure its interests prevail. Once again, the inability to engage with politics and power games impedes the success of the initiative.

2.4 Problem framing

One of the patterns that emerged from the analysis of the case studies is a "framing" problem.

For CS1 and CS4, leaving politics "out of the picture" either created a legacy of uncertainty (making Senator Keg reliant on changing tax policies) or failed to capture the forces and power relationship that were shaping the rules of the game (i.e., the sugar lobby and the lack of a powerful coalition to support sweet sorghum). This suggests the need for a political economy approach which can capture these issues.

In CS2, the absence of economic incentives is appointed as the reason for failure to achieve impact at scale. Nonetheless, the true reason behind failure might lie elsewhere. There is a lock-in in the narrative that aims to target EU markets (rather than regional ones). The wish to target EU "locks-out" alternatives which could be better suited: "Strategic thinking about control of aflatoxin in Malawi is dominated by the trope of 'lost markets'. The Fairtrade model is targeted specifically at consumers in the EU. Aflasafe[1] shares the same thinking. However, the EU is already well-supplied with groundnuts and demand is not growing. By contrast, the strategy places less emphasis on demand from the large domestic and regional markets where quality standards are lower and can be met more easily. This export-focused strategy has had two adverse consequences. First, by framing control of aflatoxin as an 'export issue' and not a wider issue of public health, a strategy that has effectively re- directed toxins into domestic and regional markets (Smith, 2013). Since aflatoxin regulations in these markets are not enforced, there is no incentive for producers or exporters to comply with them. Second, the focus on unprocessed nuts at the expense of groundnut oil which is aflatoxin-free, since aflatoxin contamination can be easily eliminated through a simple filtration process. Thus, producing groundnut oil for the domestic or regional market would solve the problem of aflatoxin at a stroke. However, most producers of industrial edible oil in Malawi prefer using sunflower seed and soybeans because these have a much higher oil yield than groundnuts. This

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[1] https://aflasafe.com/

requires a change in priorities for plant breeding. Rather than focus on developing confectionery groundnuts, breeders in Malawi will have to develop varieties with higher oil content to match the needs of the processing industry.

In CS3, framing the problem as a consumption-related problem did not allow the "smart food"[2] intervention to engage with bigger issue such as the need to build a value chain for smart foods; "A focus on demand should not overshadow the structural factors that limit supply".

The project for precooked beans often invoked the model of the 'Bottom of the Pyramid' (BoP) (Chege et. al., 2016, 2019; NARO, 2017), or the market represented by people living on less than $2.50 per day. But because precooked beans cost more than dry beans, they will be bought primarily by urban, middle-class consumers. Precooked beans will thus improve nutrition in the middle of the pyramid, not the bottom. Growing demand for precooked beans from the middle of the pyramid will benefit the poor by increasing the income of bean growers, including women. This flags the need to re-visit the marketing model for value added products.

CS6 presents both sides of the coin. On the one side, it shows how framing the problem in a new way – in this case, market-led development – has the potential to break away from conventional thinking and open new pathways. CS6 had a lasting impact on ICRISAT: based on the experience of this and other programmes, ICRISAT later made market-led development into an orthodoxy, institutionalising it as Inclusive Market Oriented Development (IMOD). On the other side, this success had an unintended downside: market-led development started being applied indiscriminately, even in contexts in which it was not appropriate.

CS6 presents an additional insight on the "framing" problem: the focus of the ESA breeding programme was to generate cash income from pigeonpea, rather than use pigeonpea to boost household food security and nutrition. Consequently, the programme paid less attention to domestic or regional demand.

2.5 Do we have the right M&E frameworks?

The problem of framing is closely interlinked with the M&E frameworks used to evaluate the projects. Many of the current M&E frameworks promote short-cycle projects that develop incremental solutions (Conti et al., 2021; Hall and Dijkman, 2019), and thus fail to capture the success of the initiative in the long-term. CS5 is representative of this issue. The creation of a smallholder value chain is a long-term investment. Evaluating the success of the initiative based on the first 2 ½ years makes the progress look "slow" – without acknowledging its long-term potential. The pressure to show quick 'impacts' results in unrealistic targets and expectations that underestimate the complexity of developing smallholder value chains.

CS3 also raises questions about the definition and measurement of impact. Marketing has two elements: knowledge and behaviour. In terms of the AIDA (Attention Interest Desire Action) model, the evidence of 'impact' from "SmartFood" relates primarily to knowledge – creating awareness and interest (e.g., ICRISAT, 2018). The evidence on creating desire and action – changing behaviour – is more limited. This is not just because it is too soon – the problem lies deeper. Changing eating habits is notoriously difficult. Behavioural change requires concerted action on several fronts – legislation, education, restrictions on advertising, a public health campaign. Smart Food can demonstrate the potential benefits of changing consumer behaviour, but any changes at scale in behaviour and on demand for millets will be long-term and measured over generations. This once again challenges the M&E frameworks which want to bring proof of "success" in short time spans, and opens the way to

[2] https://www.smartfood.org/smart-foods/

simplistic approaches to change, considering it as something that can be quickly achieved rather than a long-term process.

Besides, CS3 highlights an additional issue of “targeting”. Millets are too costly for low-income consumers. Thus, one way to avoid the problem of high prices for millets is to target middle-class consumers. Once made aware of the health benefits they can afford to pay more. However, this has implications for funding. Aid investors are focused on the Millennium Development Goals (MDGs), concerned with reducing malnutrition not obesity. Beneficiaries are supposed to be resource-poor farmers and not white-collar diabetics. This makes marketing modernity a hard sell, that may be one reason why ICRISAT must continue to target millets at rural populations.

3. Case Study No. 1: Chasing Global Markets: : Sorghum beer in Kenya

"*The need of a constantly expanding market for its products chases the bourgeoisie over the whole surface of the globe*". Karl Marx.

3.1 Introduction

A market for clear sorghum beer has recently emerged in Africa. On the supply side, the main driver is global competition between multi-national breweries. On the demand side, the drivers include public health concerns over the consumption of harmful 'illicit brews', and demand from 'aspirational' low-income consumers for low-cost 'modern' beer. In combination, these factors have resulted in rapid growth in sales of clear sorghum beer both in West and East Africa. This case study focuses on experience with 'Senator keg', a sorghum beer produced and marketed in Kenya by East African Breweries Limited (EABL), but the same analysis is relevant for elsewhere in Africa.

A defining feature of capitalism is its constant search for new markets. The beer industry is a classic example. Globalisation began in the 1980s as demand slowed in Europe and the USA (Poelmans and Swinnen, 2011). Because beer is costly to transport, globalisation has occurred not through trade but through mergers and acquisitions for in-country production (Colen and Swinnen, 2011). In Africa, four main players control the industry, with AB InBev (which acquired SABMiller in 2016), Castel, Heineken and Diageo accounting for 90% of Africa's $13 billion market (Deutsche Bank, 2015). This market is highly competitive. However, competition is of a limited kind. Between 1998-2002 Kenya was the scene of 'Beer Wars' between rivals EABL and SABMiller. This ended when SABMiller withdrew from production Kenya and EABL withdrew from production Tanzania. Thus, although it faces competition from imports, EABL has a monopoly in the production of beer in Kenya.

Africa will account for 40% of global volume and profit growth for the beer industry in the next 10 years (Deutsche Bank, 2015). Growing demand reflects Africa's fast-growing, urbanising and young population. Because African consumers have low incomes, 80 % of their expenditure on alcohol goes on 'illicit brews'. This has spurred innovation in low-cost beers (Hesse, 2015). One such innovation is sorghum beer. Nigerian Breweries Limited, a member of the Heineken Group, introduced the first sorghum beer in 1988, followed in 2002 by SABMiller with Eagle Lager in Uganda (Mackintosh and Higgins, 2004). Thus, new markets drive innovation, and once sorghum beer had been introduced no competitor could afford to stand still. Understanding this wider context helps explain the commercial success of sorghum beer in Kenya.

3.2 Description of models

EABL is a subsidiary of Diageo, a British multinational, and is Eastern Africa's second-largest conglomerate. In turn, EABL owns East African Maltings Limited (EAML), which brews Senator keg. As a commercial company, EABL's business model is based on profitability. Social goals such as serving resource-poor farmers and low-income consumers or improving public health are subordinate to this primary commercial goal.

EABL's model for clear sorghum beer is essentially a marketing model focused on the demand side or 'the route to market' (Orr et. al., 2013). This required intensive market research which identified the precise consumer segment for clear sorghum beer and the optimal price for the product. Sorghum beer was targeted at 'aspirational' consumers wanting to trade-up from home-brews but who could not afford bottled beers made from more expensive malted barley. Original plans to sell Senator beer in bottles were abandoned in favour of selling in kegs, which kept packaging costs low and avoided competition with EABL's own bottled beers, particularly its flagship brand 'Tusker'. Retail channels were kept strictly separate, with bars selling Senator keg forbidden to sell Tusker. Sales-points involved the creation of exclusive Senator keg bars which combined the sociability of traditional drinking dens with the middle-class image of a clear, hygienic beer consumed in a modern setting. Senator keg bars, with their colourful branding, were like a sanitised shebeen. In sum, EABL's marketing strategy for Senator keg drew on its proven expertise in tailoring products for specific consumer segments while carefully differentiating new products so as not to reduce demand for existing brands.

By contrast, innovation on the supply side of the model for sorghum beer was more limited. One possible business model for EABL was contract farming, with the brewery contracting directly with smallholders to supply sorghum. EABL used this model for barley, but only with large commercial farms. Contracting with numerous scattered smallholders was considered too costly. On the other hand, innovation was necessary because clear sorghum beer required a different variety of sorghum – white, with low tannin – instead of the red, high-tannin varieties usually preferred by smallholders. This combination of EABL's need for a specific type of sorghum and its aversion to contract farming with smallholders created the space for intermediary organisations.

Into this space stepped Smart Logistics Solutions Limited (SLS). Although SLS is a privately owned Kenyan company run on commercial lines, it is also a social enterprise, with the goal of improving the livelihoods and incomes of smallholders in Eastern Kenya. SLS played several key roles. SLS organised smallholders into marketing groups, arranged for the distribution of sorghum seed, the collection of harvested sorghum in aggregation centres, which is then bulked and cleaned at a central warehouse before transport to EABL in Nairobi. Through its forward contract with EABL which guaranteed a buying price, SLS was able to offer smallholders a farmgate price substantially above that offered by middlemen. Smallholders are paid for their grain through Equity Bank either through personal bank accounts or electronic M-Pesa accounts.

The model for clear sorghum beer in Kenya is almost entirely commercial. The key variable is price. On the demand side, Senator keg must compete on price with illicit brews. This determines the price that EABL can offer suppliers, whether these are middlemen selling at the factory gate or intermediary organisations contracted to EABL. On the supply side, smallholders are relatively free agents who can choose, based on availability and market prices, whether to sell sorghum or retain it for home consumption. However, government has also played an important role, first through the Kenyan Agricultural and Livestock research Organisation (KALRO) which has developed and supplied seed of Gadam sorghum and more importantly, as we shall see, through favourable policy.

3.3 Evidence of success

Actors in the value chain for sorghum beer had different definitions of success. For EABL, success was evidenced in commercial terms by sales. No separate sales figures are available for sorghum beer. Six years after its release, however, Senator keg overtook Tusker to become EABL's best-selling beer by volume. Following the launch of Senator keg, EABL's sales revenues rose from KES 19 million in 2005 to 59 million in 2013. For the intermediary supplier Smart Logistics Solutions, success was evidenced by its ability to supply the quantity of sorghum required by its contract with EABL. For smallholders, success was evidenced by the increased profitability of growing sorghum thanks to the higher farmgate price offered by Smart Logistics.

The success of Senator keg suggests impact at scale. EABL's annual demand for sorghum in 2012 was 25,000 t, of which Kenyan growers supplied 8,000 t, with Smart Logistics Solutions supplying 3,000 t. The total number of smallholders in Kenya supplying EABL was estimated at between 20-30,000. These included poorer smallholders. Members of producer groups supplying Smart Logistics had an above-average share of households headed by women, which are poorer than those headed by men (Orr et. al., 2013). There is an important lesson here. Sorghum beer is a successful value chain, but the brewing process uses little raw material and sorghum itself is used as an adjunct, which reduces the amount required still further. Thus, commercial success does not necessarily require large volumes of sorghum or benefit vast numbers of smallholders.

3.4 What works and why?

Of the five case studies, sorghum beer is the most successful in terms of its impact on consumers. This is because the value chain is part of a competitive, dynamic industry harnessed to the power of global capital. In this market, innovation is the key to growth – and survival. In Africa, the market for beer has awesome potential (Deutsche Bank, 2015). Global competition for a share of this market ensures that the value chain for sorghum beer in Kenya has a bright future.

Sorghum beer in Kenya is a textbook example of how an intermediary organisation working with farmer groups can successfully link poorer smallholders with new markets. For this model to work, however, three things were necessary.

First, there had to be clear evidence of demand and the commercial incentive to exploit it. The business case for sorghum beer was strong. Market research by EABL suggested that illicit brews accounted for over half of alcohol consumption in Kenya. This was a large untapped market. Using sorghum adjunct as a substitute for imported barley malt offered EABL a significant (20-30%) saving in costs. With EABL's dominant market position in Kenya – 80 % of the market for beer – the profits from replacing illicit brews with sorghum beer would go to EABL rather than its competitors.

Second, there had to be the right combination of value chain actors with the right skills. EABL possessed the business and marketing skills to develop a new product and take it to market. As a commercial company operating in a highly competitive market, it had the necessary knowledge and experience to match products with the needs of consumers. Senator keg was a triumph of marketing. Smart Logistics Solutions had the entrepreneurship skills to develop a successful social enterprise. Social enterprises need charismatic leaders or champions. Rose Mutuku, the CEO, was a former marketing executive with EABL with the entrepreneurial skills to see a new business opportunity and to combine commercial and social objectives within the same organisation. Aid investors were eager to support social entrepreneurs and help the organisation succeed. USAID provided grants to Smart Logistics Solutions to build its central warehouse in Machakos.

Finally, the Government of Kenya played a vital role. The government supported sorghum beer for several reasons. Deaths from illicit brews scandalised public opinion and challenged the government's legitimacy. The Ministry of Health welcomed sorghum beer on grounds of public health. The Ministry of Agriculture saw sorghum beer as an opportunity to raise the income of smallholders. The Ministry of Finance saw sorghum beer as a source of revenue. As elsewhere in Africa, taxes on alcohol in Kenya are a major source of revenue. However, illicit brews evaded tax. By taxing EABL's profits on sorghum beer, the Treasury could recover some of the tax revenue it lost from illicit brews.

More importantly, the Ministry of Finance supported the need to make sorghum beer competitive with the price of illicit brews. This was possible only if government agreed to waive the excise duty that it normally charged on beer. Without this implicit subsidy, the price of sorghum beer could not be kept to the level at which low-income consumers would be willing to switch from illicit brews. In 2004 the government granted a remission of 30% on excise duty, increased to 100% in 2006. This allowed Senator keg to be sold at KES 20 (USD 0.26) per 300 ml glass, the same price as most illicit brews. This tax break was critical to the success of sorghum beer both in Kenya and in neighbouring Uganda.

'Raw material inputs represent only about 15% of the retail selling price of beer and thus it is clear that even a drastic reduction in the cost of raw materials will not have a significant impact on the retail selling price if margins are to be maintained. The key success factor in a project of this nature, then, is to obtain a reduction in excise duty applicable to a product made from predominantly local raw materials and which could demonstrably contribute to economic development within the country' (Mackintosh and Higgins, 2004: 238).

3.5 What causes failure?

Sorghum beer's dependence on what was effectively a state subsidy made it vulnerable to changes in tax policy (Orr, 2018). In March 2013, the government suddenly imposed an excise duty of 50% on the sale of Senator keg. EABL passed the increase in price onto consumers, which immediately raised the price of Senator keg from KES 20 to KES 45 per 300 ml glass. The effect on the value chain was catastrophic. Sales of sorghum beer fell by over 75 %. EABL cut its demand for sorghum grain by one-third. Intermediaries – Smart Logistics Solutions and the traders who supplied EABL – found that business had dried up. The cost of the damage inflicted on the industry was estimated at over KES 6.4 million, of which 65 % was incurred by EABL, 31 % by the government in lost tax revenue, 3 % by sorghum growers and 1% by intermediaries (Opiyo, 2014). The revenue generated by the excise duty did not compensate for the loss of income tax paid on EABL's revenues. Thus, the imposition of excise duty on sorghum beer was self-defeating.

The motives for the government's decision are unclear. The decision was made just four months following the general election in December 2012, won by Uhuru Kenyatta. Campaigning and election promises had increased the fiscal deficit to unsustainable levels, making it imperative to raise tax revenue. Moreover, the income tax paid by EABL had not kept pace with growing sales, which may have created a perception in government circles that EABL was profiting unduly from the sales bonanza produced by sorghum beer. However, the reason may simply have been political. Sorghum in Kenya is grown primarily in the Eastern and Western regions, home to the Akamba and Luo tribes which supported the opposition in the 2012 elections. Ethnic rivalries play an important role in Kenya politics and voters who back the losing side cannot expect any favours from those in power.

Two years later, in 2015, the decision to impose excise duty was reversed. Excise duty was reduced from 50 % to 10%. Instrumental in this reversal was the Cereal Growers Association (CGA), a farmer organisation which formed a coalition of interest groups to lobby the government. Recovery was swift. Before the imposition of excise duty in 2013, the number of farmers in Kenya supplying EABL with sorghum was 12,000. By 2018, this number had grown to 45,000 (Annual Report 2018). EABL has expanded the production of Senator keg, opening a new Senator Keg Brewery in Kisumu, which sources sorghum from Western Kenya (Annual Report 2018). Thus, the damage inflicted on the value chain has been temporary.

3.6 Legacy

This change in tax policy has left a legacy of uncertainty. After excise duty was reduced to 10% in 2015, three years later it was raised to 20%. In 2018 there were plans to raise it further to 40%. EABL protested that this would cut demand by over 80%. Changes in excise duty, therefore hang like a Damocles sword over the value chain in Kenya, creating uncertainty and reducing the potential of sorghum beer for inclusive, market-oriented development. From the government side, while a total remission of excise duty might be justified by the 'infant industry' argument while sorghum beer was still a new product, the loss of tax revenue was harder to justify once Senator keg had become EABL's best-selling beer. This contest over an acceptable rate of excise duty seems set to continue as the market for sorghum beer grows.

Sorghum beer in Kenya is a powerful example of how smallholders may benefit from global competition for new and dynamic markets. The market for beer is growing faster in Africa than anywhere else, making it a lucrative market for multinational companies. The prospects for future growth in demand are strong. Sorghum beer in Kenya shows this demand can be met using a commercial model of market development in which smallholders are organised into groups for collective marketing through an intermediary organisation.

4. Case study No. 2: The power of incentives: Aflatoxin control for groundnut in Malawi

'Most of economics can be summarized in four words: "People respond to incentives". The rest is commentary'. Landsburg (1995).

4.1 Introduction

Aflatoxins are a by-product of two strains of fungi – *Aspergillus flavus* and *Aspergillus parasiticus*. Because aflatoxin is harmful to human health, governments regulate the level of aflatoxin in food. In the European Union (EU), for example, the maximum allowable limit is set at 4 ppb (parts per billion), equivalent to 0.1 µg/kg for food safety purposes. African exporters have found it hard to meet these stringent quality standards. As a result, many African smallholders have been excluded from these markets.

Groundnut (*Arachis hypogaea* L.) was once one of Malawi's main source of foreign exchange. However, exports collapsed in the 1990s and although volumes have risen since 2007, they are nowhere near previous levels. This collapse has been blamed on the introduction of maximum allowable limits by the EU in 1982 (Nyondo et. al., 2018). However, the collapse predated these standards (Otsuki, 2001). Certainly, these regulations now make it difficult for Malawi to access these markets. Studies in Malawi have found aflatoxin levels of between 1.6 – 2.9 µg/kg in 64-75% of locally produced or imported groundnut-based therapeutic foods and 34.2-115.6 µg/kg in locally processed peanut butters and roasted groundnuts (Nyondo et. al., 2016). In consequence, the bulk of exports now goes to countries that do not enforce regulations for aflatoxin levels of groundnut imports. In the period 2010-2014 only 7% exports went to high enforcement countries, such as the EU or South Africa (Edelman and Aberman, 2013). ICRISAT's strategy for management of aflatoxin centres on the perceived need to 'recapture' these markets.

This case study reveals three main features of ICRISAT's strategy to manage aflatoxin for groundnuts in Malawi:

1. Demand is being driven by governments rather than by consumers;
2. Strategy has focused on exports to the EU rather than on domestic or regional markets; and
3. Success has been elusive because economic incentives for control of aflatoxin are limited.

4.2 Description of models

ICRISAT and its research partners have piloted two interventions for aflatoxin control in Malawi. One monitors levels of aflatoxin to meet safety standards by using cheap test kits. The second reduces levels of contamination in farmers' fields by using biocontrol measures. Obviously, these interventions are not mutually exclusive, but they require different models.

Fairtrade

Between 2002-2008 ICRISAT partnered with the National Farmers' Association of Malawi (NASFAM) to develop a quality assurance system which involved sampling and estimating levels of aflatoxin contamination in groundnuts purchased by NASFAM (Siambi et. al., 2008). Testing was made using low-cost enzyme-linked immunosorbent assay (ELISA) kits at an ICRISAT laboratory established at Chitedze Research Station, near Lilongwe. The test results allowed NASFAM to differentiate and target products for different markets based on the maximum allowable limits. By testing for quality prior to shipment, NASFAM reduced the risk of rejection at point of entry in the importing country.

NASFAM members are organised into clubs which sell their groundnuts to designated marketing centres. This allows for easy traceability because the growers are known. Clubs selling groundnut with high levels of aflatoxin can be identified and measures taken to reduce contamination. Once a system for monitoring quality is in place, farmer groups are eligible to be certified for Fair Trade, allowing them to obtain a premium price for their groundnut sales. However, these bonus payments are ploughed back into the community rather than paid to farmers. In 2003 NASFAM partnered with TWIN Trading, a London-based Fairtrade organisation, to re-establish a market for Malawian groundnuts in the UK (Smith, 2013). In 2004 they obtained Fairtrade International Certification for the Mchinji Area Smallholder Farmers Association (MASFA). TWIN states its annual groundnut requirements each March, which allows NASFAM to plan production and marketing for the coming season.

Aflasafe

Aflasafe® is the trade name for a biocontrol agent which is broadcast 2-3 weeks before floweringthat controls contamination at the growing stage. It was developed by the International Institute of Tropical Agriculture (IITA) and the United States Department of Agriculture (USDA). Aflasafe ® was approved by Malawi's Pesticides Control Board (PCB) in April 2020. The next steps are to finalize a commercialization strategy, which will involve the private sector in the production and distribution of the product. After a competitive selection process, IITA will license the products to a private sector manufacturer and distributor to make the products available for farmers' use. IITA will also provide technical assistance to aid in the start-up manufacturing process for Aflasafe ® products. The Aflatoxin Laboratory at the Chitedze Research Station will continue testing future crops to assist bringing Aflasafe to market in Malawi. This commercialisation strategy has yet to be implemented in Malawi.

4.3 Evidence of success

The Fairtrade model has been successful in breaking into the UK market. Between 2007-2011 TWIN provided a market for over 4,000 MASFA farmers and generated an income of $527,000 and Fairtrade premia to the value of $58,000 (Smith, 2013). In 2013 the Fairtrade Premium for groundnuts was US$ 110/t (NRI, 2013).

On the debit side, MASFA has not always succeeded in producing groundnut that meets the EU's quality standards. The low quality of groundnut limited the volume that is bought from MASFA by NASFAM on Fairtrade terms to 72 t per year produce (this amount can be increased once quality increases). However, since 2007, the volume of groundnut exported by NASFAM to Fairtrade markets have been steadily decreasing, despite an increase in production. This is attributed to the poor quality of the nuts that made them unfit for export to the European market. In 2011, for example, MASFA's entire shipment to Fairtrade was rejected because of aflatoxin contamination (NRI, 2013).

More importantly, NASFAM has not been able to successfully replicate this model in Malawi. To date, MASFA remains the only one of NASFAM's 42 Associations to have been certified by Fairtrade (NRI, 2013). The Fairtrade model is 'successful' in the sense that it works as a pilot, but has not yet proved that it can be replicated at scale.

Aflasafe®

There is evidence that Aflasafe ®successfully controls aflatoxins. Trials in farmers' fields in Malawi showed that Aflasafe® cuts the amount of aflatoxin in maize and groundnut by at least 90%. In nearly all cases, this brought aflatoxin levels down to under 4 ppb – the EU's safety limit[3]. However,

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[3] https://aflasafe.com/2019/05/20/malawi-aflasafe-mwmz01-mw02-aflatoxin-laboratory-food-safety-maize-groundnuts-misst/

others have argued that Aflasafe® may not reduce aflatoxin below the regulatory standard and suggested that this is one reason why growers in the USA have not adopted biocontrol (Njoroge, 2018). Since Aflasafe® has not yet been commercialised in Malawi, there is no evidence of successful adoption. Moreover, the evidence for commercial success elsewhere is not yet available. Aflasafe ®has been licensed in other countries in SSA, including Nigeria and Kenya. Scaling-up has required public investment to build the capacity to manufacture Aflasafe®. The first Aflasafe® plant in Eastern Africa is a government facility at the Kenyan Agricultural and Livestock Research Organisation (KALRO) research station in Katumani. The hope is that demand from farmers will give the private sector the incentive for commercialisation.

4.4 What works and why?

The key driver for the success of the Fairtrade model has been consumers' willingness to pay a premium for 'ethical' products. Meeting this demand has required two further actors on the supply side. One is a farmer organisation that can track the provenance of the groundnut supplied to the market. Traceability is important to ensure quality and take corrective action if standards are not met. NASFAM plays this role with MASFA. The second actor is the public sector – in this case ICRISAT – which has the scientific expertise in testing for aflatoxin. Experience shows that this model can deliver groundnut of the required quality, although not consistently. The problem lies with scaling-up. In Malawi demand for Fairtrade groundnut exceeds supply. This comes down to competition from local and regional markets. These markets offer some advantages for smallholders, which limits the supply available for Fairtrade.

Unlike the Fairtrade model where demand is market-driven by consumers willing to pay a premium, demand for Aflasafe® has been driven primarily by concern for public health by government. Aflatoxin is seen as a public good which has justified public sector investment in development, testing, and manufacture. Success in developing and registering Aflasafe® ® involved partnership with various public sector organisations (e.g., IITA) and government. Aflasafe® clearly 'works' at a technical level. However, it is not yet clear whether Aflasafe® 'works' commercially. Aflasafe® has not yet been commercialised in Malawi or indeed in Eastern Africa. Farmers' demand for Aflasafe® remains an open question. The economic incentive for farmers to adopt Aflasafe® depends on consumer demand for safe groundnuts. Currently this is not the case for consumers in Africa. Generating this demand in Africa will require raising public awareness of the health risks from aflatoxin and/or enforcing the existing regulations on safety limits. Otherwise, the incentive for adopting Aflasafe® will depend on scaling-up the Fairtrade model.

4.5 What causes failure?

Managing aflatoxin is complex because contamination can occur at all stages of the supply chain. Successful control therefore requires an integrated approach that combines a range of management strategies. However, success has proved elusive. The main reason is that while these strategies are effective in managing aflatoxin, the economic incentive to adopt them is missing. This absence of economic incentives largely explains the failure to achieve impact at scale.

Table 1 shows the factors preventing adoption of key management strategies. Host plant resistance (HPR) is the classic IPM strategy but despite intensive efforts no improved variety yet has the desired combination of good agronomic traits with stable high levels of resistance (Njoroge, 2018). Early planting reduces the risk aflatoxin caused by drought stress, but farmers prioritise the sowing of maize (a food security crop) and tobacco (a cash crop) over groundnuts (Njoroge, 2018). Good agricultural practices (GAP) (e.g., ridge spacing, plant-spacing, timely weeding) require additional labour. One evaluation found that "farmers were adhering to field management practices because they believed doing so would increase yield—not because they wanted to reduce aflatoxin" (USAID, 2015: 22). Timely harvesting can prevent contamination, but this requires diverting labour from other tasks. Using tarpaulins or Mandela cocks to dry groundnuts to 8 % moisture content before storage have not been widely adopted, for unknown reasons. Good storage practices – sacks and well-ventilated rooms - entail an additional cost. Wetting groundnuts makes them easier to shell by hand but also causes contamination. Yet mechanical hand shellers are expensive, result in high levels of loss from breakage, and require screens that can fit different sizes of groundnuts (Njoroge, 2018; NRI, 2013). Sorting grains by hand is common, but while mouldy and rotten nuts are thrown away, shrivelled nuts enter the food chain since households process them into flour (Tsusaka et. al., 2016; Nankhumwa, 2015). Finally, growers may be unwilling to sell groundnuts to NASFAM, which reduces the risk of aflatoxin by delaying purchases so that groundnuts have time to dry. Growers who need cash urgently may prefer to sell to other buyers. Although MASFA members are obliged to sell their groundnuts to NASFAM, in practice most groundnuts are sold to local buyers who sometimes offer higher prices. In 2011, only 15 % of MASFA's production was bought by NASFAM (NRI, 2013). Hence, there is no immediate price incentive for growers to adopt management strategies that reduce aflatoxin.

Table 2: Disincentives for farmers' management of Aflatoxin

Aflatoxin management strategy	Disincentive for adoption
Pre-harvest	
Resistant improved varieties	Not available
Early planting	Maize and tobacco have priority
Good agricultural practices (GAP)	Additional labour
Biocontrol with Aflasafe®	Additional cost
Post-harvest	
Timely harvesting	Additional labour
Drying nuts and haulms using Mandela cocks	Unknown
Drying unshelled groundnuts off the bare ground, on tarpaulins	Unknown
Storing unshelled groundnuts in jute sacks off the ground in well-ventilated areas.	Additional cost
Shelling by machine	Breakage losses, unsuitable machines
Sorting bad grains	No market for grade-outs
Selling to NASFAM	Buy later, lower prices

This absence of incentives extends right along the value chain. Farmers' decisions to invest in aflatoxin management strategies are all related to profitability (Nankhumwa, 2015). Traders have no incentive for traders to pay higher prices for uncontaminated groundnuts. Most sales are made in local or regional markets in Kenya, Tanzania, and Uganda where the regulations on maximum allowable limits are rarely enforced (Edelman and Aberman, 2015). As Nakhumwa (2015: 217) points out, "Unless both the domestic and regional markets are stringent on quality, it will be difficult to achieve sustained headway on quality management in Malawi". Similarly, processors do not use set grades and standards for buying groundnut, except when buying for therapeutic foods which are tested for aflatoxin (Nakhumwa, 2015). Finally, exporters have no incentive to ensure that groundnuts are safe. Currently, exporters receive a 25 % tax credit for exporting groundnuts, but this is not conditional on testing for aflatoxin (Edelman and Aberman, 2015). Moreover, prices for groundnuts inside and outside Africa are converging, giving exporters even less incentive to target European markets (Nakhumwa, 2015). In sum, high demand for untested groundnuts and a lack of enforcement explains why traders and exporters have no incentive to control aflatoxin and why ICRISAT's interventions have had such limited impact.

4.6 Legacy

One legacy of the Fairtrade model has been investment to upgrade the value chain. In 2011 NASFAM and TWIN launched Afri-Nut, a groundnut processing business with the capacity to process 4000 t of nuts per year. The factory (located in Lilongwe) adds value by blanching and roasting nuts. An on-site laboratory ensures that products meet the EU's quality standards. In its first year Afri-Nut processed 1000 t of groundnuts and employed 60 workers though did not breakeven (Smith, 2013). The expectation is for 80 employees, working in two shifts when the plant is fully operational. It is hoped to operate 11 months/year and eventually process up to 20,000 metric t/yr with a value addition of roughly 100 per cent over the raw materials (NRI, 2013). However, Afri-Nut cannot improve the quality of the nuts it receives – it can only sort the good from the bad and maintain quality. Consequently, it is up to farmers ultimately to improve their product if they are to take advantage of the processing facility and increase sales to Fairtrade (NRI, 2013). In short, the problem lies on the supply side and farmers' economic incentives for managing aflatoxin.

Strategic thinking about control of aflatoxin in Malawi is dominated by the trope of 'lost markets'. The Fairtrade model is targeted specifically at consumers in the EU. Aflasafe® shares the same thinking:

'Aflatoxin is locking Malawi out of lucrative export markets. Billions of kwacha – millions of dollars – are lost to Malawi every year. Yet with effective aflatoxin control, groundnut exports alone could grow tenfold, and account for an impressive 10% of the country's current exports'[4]

This strategy assumes that exports to the EU depend solely on successful control of aflatoxin. Yet the EU is already well-supplied with groundnuts and demand is not growing (Oosterman, 2003). To replace these suppliers, therefore, Malawi requires some other competitive advantage. The groundnut varieties traditionally grown in Malawi produce very large kernels. This gives Malawi a potential niche in the market for snack nuts (Oosterman, 2003).

By contrast, the strategy places less emphasis on demand from the large domestic and regional markets, where quality standards are lower and can be met more easily. Yet this may be a more effective strategy:

"Malawi needs to focus more on regional markets considering its current low skills base and low technology being used. Heavy investment required to manage quality demanded by EU markets may not be justified for the time being when the regional markets are offering competitive prices for low quality" (Nakumwa, 2015: 181).

This export-focused strategy has had two consequences, First, by framing control of aflatoxin as an 'export issue' and not a wider issue of public health, this strategy has effectively re-directed toxins into domestic and regional markets (Smith, 2013). Since aflatoxin regulations in these markets are not enforced there is no incentive for producers or exporters to comply with them.

Another consequence has been a focus on unprocessed nuts at the expense of groundnut oil. Groundnut oil is aflatoxin-free since aflatoxin contamination can be easily filtered out through a simple filtration process. Thus, producing groundnut oil for the domestic or regional market would solve the problem of aflatoxin at a stroke. However, most producers of industrial edible oil in Malawi prefer using sunflower seed and soybeans because these have a much higher oil yield than groundnuts. This requires a change in priorities for plant breeding. Rather than focus on developing confectionery groundnuts breeders in Malawi will have to develop varieties with higher oil content to match the needs of the processing industry (Nyondo et. al., 2016).

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[4] https://aflasafe.com/2019/05/20/malawi-aflasafe-mwmz01-mw02-aflatoxin-laboratory-food-safety-maize-groundnuts-misst/

5. Case Study No. 3: Marketing Modernity: Smart Food in India and Eastern Africa

5.1 Introduction

'Smart Food' is the 'brand name' that ICRISAT has given to consumer products made from its mandate crops. These products include processed foods as well as cooked grains. Launched in 2013, the Smart Food Initiative includes all five of ICRISAT's mandate crops, but the initial focus has been on sorghum and millets. This case study focuses on Smart Food's experience with millets in India and Eastern Africa (mainly Kenya and Tanzania). Finger millet (*Eleusine coracana*) is the most widely grown millet in Eastern Africa, while in India the most popular millets are pearl millet (*Pennisetum glaucum*), foxtail millet (*Setaria italica*) and minor millets (*Paspalum scribiculatum* and *Panicum sumatrense*).

The Smart Food initiative frames the 'problem' as one of consumer demand. "A major challenge we have with these foods is the image and lack of development of the value chain" (Kane-Potaka, 2019). Thus, the problem is defined as marketing ('image') and an under-performing value chain. It is not immediately clear why these two issues are treated separately – after all, marketing is an integral part of value chain development. However, marketing has a leading role because Smart Food seeks to transform millets from a 'poor man's food' into a 'health food'. This new image is targeted at urban, middle-class consumers at risk from lifestyle diseases such as obesity and diabetes. In the language of marketing, Smart Food re-positions millets to meet the potential demand of a consumer segment that is growing rapidly and has formidable purchasing power.

From a historical perspective, therefore, Smart Food is another manifestation of marketing 'modernity'. Asia's Green Revolution in rice ('modern varieties') saw 'the use of seeds to symbolize the arrival of modernity' (Cullather, 2004). In Africa, bottled beer was marketed as 'a badge of modernity' (Willis, 2002). The same with maize. In Southern Africa, white maize was originally viewed as a 'European food' (McCann, 2005). In Malawi, maize was identified with progress, millets with the backward past (Bezner-Kerr, 2015). Smart Food attempts to reverse this historical process that equated maize and modernity. The aim is to convert the 'Big 3' staple foods (rice, maize, and wheat) into the 'Big 5' by including millets and sorghum (Kane-Potaka, 2018). Millets are portrayed as a 'lifestyle choice'. The focus is not on tastes but on aspirations. Smart Food is also marketed to attract to middle-class consumers in other ways, by appealing to global concerns about biodiversity and sustainability ('good for the planet, 'good for the farmer'), as well as decreasing culinary diversity and the need to preserve 'heritage' threatened by 'Western' diets (Finnis, 2012). In India, the marketing of Smart Food has capitalised on the recent shift in food policy from self-sufficiency in food to a greater emphasis on nutrition (Pingali et. al., 2017).

Alongside this focus on the middle class, the Smart Food Initiative also tries to raise the consumption of millets among rural populations. Here the aim is the familiar one of reducing malnutrition. Where this involves increasing home consumption among growers, no value chain is involved. However, value chain development is required to promote millets in school feeding programs.

5.2 Description of models

The Smart Food initiative has four components: (1) scientific evidence for the concept of Smart Food, (2) driving demand from consumers, (3) ensuring that farmers benefit from Smart Food value chains, and (4) filling knowledge gaps by catalysing further R&D (Kane-Potaka, 2018). Information is available on each of these components. However, this case study concentrates on component (2) of this bigger model.

Driving demand

Demand for millets must be created, since consumption by urban, middle-class consumers has fallen over time. To create this demand, Smart Food has used the marketing model of the reality TV show. The format copied many features of popular cookery shows in developed countries (eg. Master Chef). The content combined entertainment and information. In Kenya, teams of contestants produced dishes using Smart Food ingredients. The results were judged by professional chefs. A voiceover by the presenter provided information on health benefits of specific Smart Foods (e.g., during pregnancy). The successful team won scholarships to a prestigious cookery school. In 2017, the 13-episode show was broadcast on Kenya's Television Network (KTN), which is a privately-owned, free to air network. In India, the reality show focused exclusively on millets, and involved 56 student chefs from 16 culinary institutes. The Smart Food Culinary Challenge was held at the M S Ramaiah University of Applied Sciences, Bangalore in 2018, and was part of Organics and Millet International Fair – 2019, an annual millet fair organized by the Government of Karnataka. Unlike in Kenya, the five-part series was not aired on national TV but is available on YouTube.

To popularise millets, Smart Food has also published cookery books with recipes developed by professional chefs (ICRISAT, 2016). Like the reality TV shows, these books are targeted at middle-class women, since they are written in English and the recipes are based on international models ('millet sushi', 'sorghum salad') that project a 'modern' image for millets. In Kenya, ICRISAT partnered with Makerere University to develop new millet products for both urban and rural consumers.

To target rural women the Smart Food initiative has used a standard 'home economics' model. In Kenya, ICRISAT promoted finger millet in six counties (Busia, Siaya, Elgeyo Marakwet, Kitui, Makueni and Tharaka Nithi) as part of the Accelerated Value Chain Development (AVCD) project funded by USAID under Feed the Future. This involved partnerships with local government departments of Education, Health, and Agriculture, where trainers were trained in the nutritive value of Smart Food, who in turn trained community health volunteers. Workshops in healthy eating were held for more than 10,000 women, as well as participatory cooking classes for over 12,000 women farmers. These taught women how to cook various healthy dishes with millets, sorghum, and pigeonpea. The training sessions also covered hygienic cooking practices and energy-saving cooking methods[5].

ICRISAT has generated evidence on the nutritional benefits of Smart Food on school-feeding programs (Anitha et. al., 2020; Wangari et. al., 2020). In Tanzania, action research replaced the normal school diet of maize porridge and beans with a new diet porridge made from finger millet accompanied by pigeonpea. The new menu was followed for 15 months. Results showed that children had a more positive image of both crops and wished them to continue as school meals. Most students wanted to eat finger millet porridge every day. This was not a treatment-control experiment that measured changes in nutrition. However, finger millet increased the intake of calcium while pigeonpea increased that of protein (Wangari et. al., 2020).

Developing the value chain

Both India and Eastern Africa already have established value chains for millets producing a wide range of flours. Processors have identified inconsistent supply as a major barrier to commercialization (Schipmann-Schwarze et. al., 2015). ICRISAT's direct involvement in developing the value chain for millets has therefore focused on the supply side, either on production or on commercialisation. For production, the focus has been on seed systems and the model for millets has been Small Seed Packs (SSPs) (Audi et al., 2016). For commercialisation, ICRISAT's favoured model has been Producer Marketing Groups (PMGs). There have been studies of PMG performance in Kenya (Handschuch, 2014). However, these are not discussed here because they are not linked

[5] https://foodtank.com/news/2018/06/empowering-kenyan-women-with-nutrition-education/

specifically to the Smart Food initiative. In India, Smart Food's only direct involvement in value chain development has been to list companies active in the value chain and hosting a workshop to encourage participation by social entrepreneurs.

5.3 Evidence of success

Since the core of the Smart Food initiative is marketing, its 'success' can be judged in terms of the AIDA marketing model:

Attention – The consumer becomes aware of a category, product or brand (usually through advertising);

Interest – The consumer becomes interested by learning about brand benefits & how the brand fits with lifestyle;

Desire – The consumer develops a favourable disposition towards the brand;

Action – The consumer forms a purchase intention, shops around, engages in trial or makes a purchase.

Awareness and Interest

TV reality shows reach a wide audience. In Kenya, the show was broadcast on Kenya's Television Network (KTN), a free to air network with an estimated audience share of 12 %. According to ICRISAT, over 800,000 viewers were reached every week through the show (ICRISAT, 2018). It is not clear how this number was reached – it may represent the total audience for KTN rather than for the program.

Publicity about the health benefits of millets through TV may have increased sales of millet flour. ICRISAT's previous research on the processing industry found that processing companies in Kenya reported rising demand for pre-packed millet flour and expected this demand to grow (Schipmann-Schwarze et. al., 2016). According to processors, the main constraint on this demand was the lack of consumer awareness of the nutrition and health benefits. (Schipmann-Schwarze et.al., 2015). One in three of consumers already buying sorghum or millets were unaware of these benefits; among non-consumers, the ratio was two in three (Schipmann-Schwarze et.al., 2015). By educating viewers about the health benefits of millets, the TV shows addressed an important constraint on demand.

The Smart Food initiative has also reached rural populations. In Kenya, between 2015-2018, the initiative trained over 10,000 people through 2-day nutrition workshops; trained over 8,000 women farmers through participatory cooking classes where they were introduced to new recipes and energy efficient innovations; and reached over 80,000 households with nutrition messages through a variety of behaviour-change communications activities. Through these activities, the initiative has reached over 20,000 children below 2 years with nutrition messages through their parents (ICRISAT, 2018).

Desire and Action

The ACVC project in Kenya found that, in one year, women's and children's behaviour changed significantly towards a more micronutrient diet. This is indicated by an increase by 15.4% of the dietary diversity score for women and of 79.5% of the children's dietary diversity score. No socio-economic information (e.g., income) is available for this sample (ICRISAT, 2018). Similarly, efforts to promote simple value-added products that could increase cash income generated interest among rural processors. Nine in 10 processors were willing to adopt at least one of the products in their businesses – with the most preferred being millet muffins (ICRISAT, 2018). However, action by millet producers was absent. According to ICRISAT, surveys showed "an increase in sales of grain at the farm level for all [Smart Food] crops except finger millet and groundnuts, which *typically act as a safety net during drought.*" (emphasis added).[6]

5.4 What works and why?

A TV reality show 'works' in the sense that this medium allowed Smart Food to reach a large audience. In Kenya, free-to-air set-top- boxes currently sell for an average of $ 35 and 4.3 million households own a TV set. ICRISAT's consumer survey for millets found that TV and radio were the most effective channels for information on health benefits (Schipmann-Schwarze et. al., 2012).

Targeting millets at middle class consumers makes sense commercially. Both India and Africa have a large and growing middle-class. Africa's middle-class population, based on expenditure of USD 4-20 per day, is estimated at 44 million, or 13.4 % of Africa's total population. In ESA, this translates to a middle class of 16.8 million or 8.7 % of the total population (Ncube et. al., 2011). For India, estimates for 2018 suggest 61 million upper middle-income households ($ 8.5-40,000) and 8 million high income households ($ 40,000 >) (Bain and Company, 2019).

Spending by these groups will drive consumer demand. One estimate for five countries in Eastern Africa (excluding Kenya) suggests that annual expenditure on food by middle-class households (with incomes of USD 4-20 per day) will reach USD 164 billion by 2040. Middle-class consumers spend 55-62 % of their total food expenditure on processed products. These include 'low-value' processed products like maize flour and milled rice. 'High-value' processed products include breads and bakery products, industrially – produced vegetable oils, and food eaten away from home. This suggests that middle-class consumers could spend between USD 53 – 67 billion on processed food products by 2040 (Tschirley et. al., 2015). For India, forecasts suggest that consumer spending by middle- and high-income households will rise by USD 4 trillion by 2030 (Bain and Company, 2019). Total consumer expenditure on food will rise by USD 1.3 trillion, of which 32 % will be spent on 'healthy and organic' products (Bain and Company, 2019).

Clearly, the market for processed food has huge potential for Smart Food. We do not know the size of the potential market for Smart Foods, or what specific products will generate the highest demand. However, if current trends continue, we know that: (1) ESA will see a rapid growth in the number and share of middle-class consumers (2) they will account for most of the expenditure on food and (3) a high share of their food expenditure will be on processed products, which may include Smart Food.

5.5 What causes failure?

The potential causes of failure lie not in marketing but in the structural factors determining the development of the value chain.

One is the high price of millets relative to rice in India or maize in Africa. In Kenya, millets are double the price of maize (Orr et. al., 2016). In India, millets are also more expensive than rice, which is subsidised through the Public Food Distribution Scheme (PFDS) (Adekunle et. al., 2018). High prices limit the potential for increasing demand among rural populations. Experience with school meals in rural Tanzania found that whereas replacing beans with pigeonpea reduced costs by 22 %, schools could not continue to include finger millet on the menu as it was too expensive (Wangari et. al., 2020). Thus, educating rural consumers on the health benefits of millets may not increase consumption, except among better-off households. A recent study in South India concludes that 'to achieve any meaningful penetration into the market held by these small millet alternatives, the prices of millets must be substantially reduced' (Finnis, 2012). In India, the incentive to buy millets is

[6] https://foodtank.com/news/2018/06/empowering-kenyan-women-with-nutrition-education/

further reduced by the PFDS, which gives lower-income consumers access to cheap rice (Priyam, 2017).

Against this, rural households say they are willing to pay (WTP) more for biofortified millets. In Kenya, one study reported that 60 % of consumers were willing to pay an average premium of 42 % above the prevailing market price of finger millet for new biofortified varieties of pearl millet (Ongudi 2018). However, this figure seems improbably high. In India, non-rural consumers in Kanataka were also willing to pay a price premium of 27% for fortified finger millet (Meier et. al., 2020). Banerji et al. (2016) found a premium of 29% for biofortified pearl millet among rural consumers Maharashtra. In both cases, providing information on health benefits increased consumers' WTP.

A second structural factor (which explains higher prices) is the limited supply of millets. The only way to reduce prices is by increasing supply. But average yields are lower than for rice or maize, which results in lower production. At the same time, average labour requirements are higher. In combination, this results in high unit costs of production. In South India, high labour requirements (and particularly the absence of machine milling) were a major disincentive to grow millets. Despite being aware of the health benefits from millets, women preferred to reduce their workload by growing cassava (Finnis, 2009). Another constraint on supply is that millets are grown as an insurance against drought. This makes rural households unwilling to sell in years of low rainfall. Thus, the AVCD project in Kenya successfully increased 'sales of grain for all crops except the ones that are typically bought during droughts' (FReSH, 2018).

5.6 Legacy

Although changing the image of millets as a 'poor man's crop' is necessary for driving demand, framing the problem as one of 'marketing' has several implications for R & D.

A focus on demand should not overshadow the structural factors that limit supply. High prices for millets make it difficult to generate broad-based demand from the rural population and schools. However, this does not apply to other Smart Food like pigeonpea which may be cheaper than the alternatives. This suggests the need to differentiate Smart Foods and target individual crops at different consumer segments.

One way to avoid the problem of high prices for millets is to target middle-class consumers. Once made aware of the health benefits they can afford to pay more. However, this has implications for funding. Aid investors are focused on the Millennium Development Goals, which are concerned with reducing malnutrition not obesity. Beneficiaries are supposed to be resource-poor farmers not white-collar diabetics. This makes marketing modernity a hard sell. Which may be one reason why ICRISAT must continue to target millets at rural populations.

Finally, marketing raises questions about the definition and measurement of impact. Marketing has two elements: knowledge and behaviour. In terms of the AIDA model, the evidence of 'impact' from Smart Food relates primarily to knowledge – creating awareness and interest (e.g., ICRISAT, 2018). The evidence on creating desire and action – changing behaviour – is more limited. This is not just because it is too soon to observe such changes– the problem lies deeper. Changing eating habits is notoriously difficult, as in the UK where obesity is becoming the norm. Behavioural change requires concerted action on several fronts – legislation, education, restrictions on advertising, a public health campaign. Smart Food can demonstrate the potential benefits of changing consumer behaviour, but any changes at scale in behaviour and on demand for millets will be long term and measured over generations.

5. Case Study No. 4.: The Politics of Pricing: Sweet Sorghum as a Biofuel in India

"*Policy and enabling environment support play a crucial role in promotion of ethanol production from alternate feedstocks like sweet sorghum*" (Basavaraj et. al., 2013a: 121).

5.1 Introduction

Biofuels are alternatives to fossil fuels. Bioethanol is produced by blending petrol (gasoline) with ethanol. The ethanol is mixed in a ratio that keeps the power of petrol but reduces the emission of greenhouse gases. Sources of ethanol include a range of edible crops that contain sugar, like sugarcane or sweet sorghums. Sweet sorghums [*Sorghum bicolor* (L) Moench] have higher concentrations of soluble sugars in the plant stalk sap or juice compared to grain sorghum. They have a comparative advantage over sugarcane for ethanol production because they require less water and have a higher fermentable sugar content, while ethanol from sweet sorghum is also cleaner than sugarcane ethanol, when mixed with petrol (Ortiz et. al., 2006).

India has high potential demand for biofuels because about 80 % of its crude oil is imported (Basavaraj et. al., 2012). In 2008 the Government introduced a National Policy on Biofuels, with a target of 20% blending of ethanol with petrol by 2017. Based on a ratio of 10% blending, demand for ethanol in India was projected to reach 3.46 billion litres by 2020 (Basavaraj et. al., 2012). Currently, India's entire supply of ethanol comes from molasses, a by-product of sugarcane. However, sugarcane alone cannot meet the projected increase in demand (Shinoj et. al., 2011). The result will be a projected deficit of 3.42 billion litres of ethanol by 2020 (Basavaraj et. al., 2012). This has created an opportunity for alternative of supply, one of which is sweet sorghum.

High potential demand prompted ICRISAT to re-set its research program for sweet sorghums. In 2007 ICRISAT launched a BioPower Initiative in partnership with the National Agricultural Research Systems (NARS) in India, the Philippines, and Mali, as well as private sector partners (Vinutha et. al., 2014). The centrepiece of this Initiative was the design and testing of a prototype value chain. This case study focuses on ICRISAT's experience with this value chain in India, about which there is most information. This evidence comes from scientists involved in the Biofuel Initiative – so far there has been no external evaluation.

5.2 Description of models

ICRISAT's prototype value chain for sweet sorghum as a biofuel developed two models: a centralised model where farmers supply stalks directly to a distillery that produces ethanol, and a decentralised model where village-level crushing units convert the juice into syrup. A combination of the two models is needed to ensure the distillery has a continuous supply, without which ethanol production from sweet sorghum would not be commercially viable (Ravinder Reddy et. al., 2013: 77).

Centralised model

The main pilot plant for the centralised model was Rusni Distilleries, located near Sangareddy, Medak district, Andhra Pradesh, about 25 km from ICRISAT headquarters. Commercial ethanol production started from June 2007 (Vinutha et. al., 2014). The capacity was 35-40 kilolitres of ethanol per day (KLPD). A 40 KLPD ethanol distillery requires 8,000 ha of sweet sorghum per year spread over two seasons – 3,500 ha in the rainy season (rainfed) and 4,500 ha in the postrainy season (irrigated) (Ravinder Reddy et. al., 2013). To minimise the time and cost of transportation, sweet sorghum can only be supplied by farmers in villages within a 50 km radius of the distillery (Ravinder Reddy et. al., 2013). The centralised model was promoted through the sweet Sorghum Ethanol Research Consortium (SSERC) which was joined by Tata Chemical Limited that established a pilot plant for manufacture of ethanol from sweet sorghum at Nanded, Maharashtra in 2009, which operated between 2010-11, and by CF Biotech Ltd which established a similar pilot in Gadag district, Karnataka (Vinutha et. al., 2014).

Decentralised model

The decentralised model was developed later, as a result of experience with the centralized model whose disadvantage was the short harvest window of sweet sorghum (one month per season) making it difficult to ensure a larghe enough supply. In the decentralized model, the crushing of sweet sorghum stalks is done in the village, and the juice boiled into syrup. The advantage here is that syrup can be stored for up to two years at room temperature without deterioration in the quality of the sugar (Ravinder Reddy et. al., 2012). This allows distilleries to extend the production of ethanol into the off-season. A pilot Decentralised Crushing Unit (DCU) was established in Ibrahimabad village, Medak district, Andhra Pradesh (Ravinder Reddy et al., 2012). This had the capacity to crush stalk from an area of 20 ha during the rainy season in 30 days of operation working one shift of 8 hours per day (Ravinder Reddy et. al., 2012). The DCU was operated by a farmers' group. Syrup from the DCU was supplied to Rusni Distilleries (ICRISAT, 2012). This DCU operated between 2008-2012. A second DCU was established in Parbhani in 2010 and operated between 2011–2012 (Vinutha et. al., 2014).

5.3 Evidence of success

On the positive side, the evidence showed that:

More profitable: arm surveys showed that sweet sorghum was more profitable than the competing crops of grain sorghum and of maize, whether planted in pure stand or intercropped (Parthasarthy Rao et. al., 2013a: 104, 109).

Usable cattle feed: The decentralised model generated additional income since 55 % of the crushed sweet sorghum stalks (bagasse) was not needed to make syrup and was available for sale as fodder (Basavaraj et. al., 2013a: 129).

Increased employment: The decentralised model was labour-intensive with an average labour requirement per day of operation of 54 days for 28 days per year (Basavaraj et. al., 2013a: 124).

Competitive: Ethanol production from sweet sorghum was competitive with sugarcane juice and other grains: Evidence from Rusni Distillery showed that making ethanol from sweet sorghum gave a profit of 2.91 Rs per litre. This was equally profitable as making ethanol from sugarcane juice (2.85 Rs per litre) and more profitable than making ethanol from grains like pearl millet and broken rice (0 Rs per litre) (Basavaraj et. al., 2013a: 120).

Environmental benefits: Meeting demand for ethanol in 2020 by using molasses would require doubling the area and production of sugarcane (Basavaraj et. al., 2013a: 119). The water requirement for sugarcane (12−16 month growing season and 36,000 cubic meters of water) is about four times higher than the water requirement for sweet sorghum (8,000 cubic meters over two crops) (Basavaraj et. al., 2012: 9). Replacing sugarcane with sweet sorghum would reduce pressure on India's scarce water resources.

On the debit side, however, the evidence also showed that:

The centralised model gave a low return: Normally, a new technology requires a benefit cost ratio of at least 2. Based on an average recovery rate of ethanol at 4.5% (45 litres per ton of sweet sorghum stalk), feedstock priced at 600 Rs per ton and ethanol priced at 27 Rs per litre, the benefit cost ratio of making ethanol from sweet sorghum was estimated to be 1.22 (Basavaraj et. al., 2013a: 113). Sensitivity analysis was used to determine the effect on profitability of varying the cost of sweet sorghum. Doubling the price of sweet sorghum to 1200 Rs per ton reduced the benefit cost ratio to 0.89 (Basavaraj et. al., 2013a: 116). The only way to offset the negative impact of higher input prices was to reduce unit costs by increasing the recovery rate or raise the selling price of ethanol.

The decentralised model was unprofitable: Based on a syrup yield of 48 kg per stalk and 967 kg per ha, the gross returns and total costs per hectare obtained from sweet sorghum for syrup production were negative, at -752 Rs per ton of stalk and Rs -15,113 per ha (Basavaraj et. al., 2013a: 126). Sensitivity analysis was used to determine the effect on profitability of changing the syrup yield and the price of syrup. The syrup yield per ton of stalk had to increase from 48 kg to 124 kg or the price of syrup raised from 10 Rs per kg to 26 Rs per kg to make the DCU commercially viable (Basavaraj et. al., 2013a: 126).

Ethanol from sweet sorghum was less profitable than from sugarcane: Based on evidence from the Rusni Distillery, making ethanol from sweet sorghum gave a profit of 2.91 Rs per litre. This was less profitable than making ethanol from molasses, which had a profit ranging from 8.88 to 1.48 (Basavaraj et. al., 2013a: 120). Compared to making ethanol from molasses, sweet sorghum was second-best.

Uptake was limited: the centralised model saw nearly 1,000 farmers growing 800 ha of sweet sorghum during the 2007 rainy season, entering in buy-back agreement with Rusni Distilleries (Vinutha et. al., 2014). In the case of the decentralised model, only 100 farmers were involved in supplying sweet sorghum stalks for crushing (Basavaraj et. al., 2013a: 124).

Insufficient supply from DCU: In 2009 the DCU produced 28,500 litres of syrup (Basavaraj et. al., 2013: 124). It is unclear if this was enough to meet demand from the distillery. A SWOT analysis of the DCU suggested that it was not (Basavaraj et. al., 2013b: 199).

The models were not sustainable: Rusni Distilleries pulled out of ethanol production after just one year. Efforts to find a replacement proved unsuccessful because other distilleries did not have a license to produce ethanol using sweet sorghum and did not have the required 'logistics' to crush sweet sorghum (ICRISAT, 2012: 8). This closure had a knock-on effect on the decentralised model, which supplied syrup to the distillery. Since the DCU continued making syrup until 2012, it presumably found other buyers for its syrup. However, the DCU stopped operations when the project ended and was no longer able to meet its financial losses. A recent briefing on ICRISAT's research program on sweet sorghum for biofuels makes no mention of these two models (ICRISAT, 2020).

5.4 What works and why?

ICRISAT's Agri-Business Incubator (ABI) was successful in attracting a private investor to make ethanol from sweet sorghum. The ABI supports prospective entrepreneurs seeking to commercialize agro-technology. Since the concept of producing ethanol from sweet sorghum was new, the ABI supported M/s Rusni Distilleries Pvt Ltd, a private company owned by a non-resident Indian. ABI provided a range of services, including (1) a proof of concept study, (2) supplying seeds of selected sweet sorghum cultivars, multiplied by a private seed company, (3) a package of practices for cultivation of sweet sorghum, (4) facilitating the recruitment of field workers, promoting and popularizing sweet sorghum cultivation by farmers through melas (exhibitions) and farmers' days, (4) facilitating clearance for ethanol production from the Government of Andhra Pradesh, and (5) assistance in sourcing equity investment through private partnership and a loan from Syndicate Bank, Hyderabad, India (Belum Reddy et. al., 2006). The ABI also succeeded in attracting other private companies like Tata Chemicals Limited to invest in pilot projects in other locations in India.

ICRISAT and NARS successfully demonstrated the technical viability of the decentralised model. This required partnerships between ICRISAT, NARS, and a local NGO. Sweet sorghum was not grown by the poorest farmers. The crop was grown primarily by small and medium farmers rather than by marginal or large farmers (Parthasarthy Rao et. al., 2013a: 105). The NGO was successful in mobilising farmers to supply the DCU (although farmers received only the breakeven price of Rs 600 per ton) and in training farmers how to manage the DCU (Ravinder Reddy et. al., 2012). Farmers were also successful in learning management and operational skills. Average production costs for syrup fell by 18 % between 2008 and 2009 as farmers became more experienced (Basavaraj et. al., 2013a: 124).

5.5 What causes failure?

Experience with both the centralised and decentralised models revealed numerous weaknesses.

For the centralised model, the main weaknesses were, (1) the short harvest window for sweet sorghum (two seasons and 30–45 days per season), (2) the need to crush stalks within 12 hours of harvesting to avoid reducing the recovery rate of the syrup which limits the geographical command area of sweet sorghum cultivation to within 50 km radius of the distillery, and (3) the limited days available for crushing, so that the entire crop of sweet sorghum stalks pile up at the distillery leading to wastage as the distillery cannot crush more than 900 t per day (Vinutha et. al., 2014). For the decentralised model, the main weaknesses were, (1) management by an inexperienced farmers' association limited the efficiency of operations and increased processing costs, (2) the technology initially used for crushing the stalks was not tailor-made for sweet sorghum, and (3) the distillery incurred further costs converting the syrup into ethanol, reducing the price paid for the syrup (Basavaraj et. al., 2013a: 131). However, none of these weaknesses were big enough to explain failure.

The decisive reason for failure was price. The profitability of the sweet sorghum value chain is highly sensitive to the price of ethanol. At a price of INR 27 per litre in 2012, sweet sorghum as a source of biofuel was profitable only if sweet sorghum was purchased at INR 600 per ton. However, Rusni Distilleries had a buy-back arrangement that paid farmers INR 1200-1300 per ton of stalk, since farmers had to be compensated for loss in returns for cultivation of crops like cotton and soybean. With sweet sorghum priced at INR 1200-1300 per ton of stalk and subsequent processing costs incurred by the distillery, ethanol had to be priced at Rs 36 per litre from the existing administered Rs 27 per litre to make the distillery viable (Basavaraj et. al., 2013c: 213).

The price of ethanol in India is set by the Ministry of Petroleum and Natural Gas (MoPNG) (Saravanan et. al., 2018). The Ministry fixes this price based on the cost of producing ethanol using molasses. Thus, a distillery-gate ethanol price of INR 27 per litre translates into a molasses price of 4,500 per ton (Ray et. al., 2011). Fixing the price of ethanol according to the price of molasses reflects the National Biofuels Policy of India, which views molasses as the main source of biofuels. The price of molasses is itself determined by the price of sugarcane, which benefits not only from subsidies that reduce the cost of production but also from a Minimum Support Price (MSP). There is also an MSP for sorghum – but for the grain, not for the stalk. Without similar support, sweet sorghum cannot compete with sugarcane as a source of biofuel (Basavaraj et. al., 2013c).

Why does sugarcane enjoy such special status? Sugar in India is a large and well-organised industry. It engages around 50 million farmers and two million mill workers, besides having political patronage. Three states of India including Maharashtra, Uttar Pradesh, and Karnataka that together produce about 81% of India's sugar send 156 MPs to the Lok Sabha (Lower House), where they comprise 29 % of the total. Politicians in these states are closely linked to the sugar industry. Of the 183 sugar mills for which data are available, 101 (55%) had chairpersons who competed for state or national elections between 1993 and 2005 (Down to Earth, 2019). The Indian press has compared the power of the sugar lobby in India to that of the gun lobby in the US (New Indian Express, 2019).

The government's support for the sugar industry reflects these political realities and helps explain why the National Biofuels Policy of India is "sugarcane-centric" (Basavaraj et. al., 2013c: 217).

Sweet sorghum is, therefore, a victim of the politics of pricing. Unlike sugarcane, sweet sorghum has little political clout. For sweet sorghum to meet 80 % of the deficit in demand for ethanol would require about 2.06 million ha, which is about 50% of the area currently planted to sweet sorghum in the kharif (rainy) season (Basavaraj et. al., 2013a: 122). But the agro-ecological zones most suitable for scaling-up the production of sweet sorghum are nearly all located in Karnataka and Maharashtra (Parthasarthy Rao et. al., 2013b). These very same states are the strongholds of the sugar industry. Promoting sweet sorghum for biofuel in these states would meet resistance from the sugar lobby.

To succeed in this politicised arena, sweet sorghum needs 'policy entrepreneurs', like those who championed jatropha (*Jatropha curcas*). as a source of biodiesel (not bioethanol). India quickly abandoned jatropha because it could not deliver the volume required (Saravanan et. al., 2018). Nevertheless, the story of jatropha in India shows how a powerful coalition of interest groups – including scientists, researchers, bureaucrats, and private companies – could successfully promote a virtually unknown crop as a credible source of biofuel. The key to successful advocacy was the recruitment of 'big-name' scientists who could convince politicians (Pradhan and Ruysenaar, 2014). A similar story can be told for jatropha in southern Africa (von Maltitz et. al., 2014). The evidence for sorghum as a source of biofuel is stronger than for jatropha. Yet evidence is not enough. What is missing is a similar coalition of interest groups that can make the case for sweet sorghum at the highest levels of policy.

5.6 Legacy

ICRISAT's research program for sweet sorghum vindicates the use of a value chain approach. The prototype value chain exposed a fundamental flaw in the use of sweet for sweet sorghum as a biofuel. This meant that the prototype never got beyond the pilot stage. However, important lessons were learned. Arguably, the main lesson was a painful reminder that, without the right policy, the technical superiority of a new technology is irrelevant. So long as sugarcane remains the spoilt child of price policy in India, sweet sorghum as a biofuel will be uncompetitive.

Another legacy is the limitation of 'evidence-based' policy. ICRISAT's economists correctly identified the policies that made sweet sorghum uncompetitive with sugarcane. But the forces behind these policies were not investigated. This de-politicises policy. Policies can be described as 'mistaken', implying that policies are a rational choice between alternative options, and that the 'mistake' will be corrected once policy makers have the right evidence. But if the technical evidence in favour of sweet sorghum as a biofuel is overwhelming why is sugarcane so entrenched? Neoclassical economics cannot answer this question, which cries out for a political economy approach. A more sophisticated view of policy - making is needed to understand how to advocate for policy change.

This suggests a third legacy, which is the need for more effective advocacy. With its fixation on molasses, India's National Policy on Biofuels seems blind to economic realities. This cannot last forever. But until the evidence in favour of sweet sorghum is backed by advocacy that can reach top policy – makers, ICRISAT's ambition to promote sweet sorghum as a source of biofuel will remain a hope, not a strategy.

6. Case Study No. 5.: Too Many Moving Parts? Precooked Beans in Uganda and Kenya

"*We tend to seek easy, single-factor explanations of success. For most important things, though, success actually requires avoiding many separate possible causes of failure*". (J. Diamond, Guns, Germs and Steel, 1998: 157).

6.1 Introduction

Common bean (*Phaseolus vulgaris* L.) is a staple food crop in Eastern Africa. Production is concentrated in the East African Highlands (Andriatsitohaina et. al., 2015). Within East Africa, the top bean producers are Tanzania (1,175,232 t) Uganda (1,023,758 t) and Kenya (780,045 t) (FAOSTAT, 2020: average 2016-18). Beans are also an important cash crop. About 56 % of bean production in East Africa is marketed, with 44 % sold in local and national markets (Andriatsitohaina et. al., 2015). Uganda is a net exporter of dried beans, exporting about 20% of production while Kenya is a net importer, importing about half of its bean consumption. Consumers usually buy dry, unprocessed beans, which have a cooking time of 2-3 hours. This is a significant cost in terms of fuel and women's time. For this reason, consumers prefer varieties with short cooking times. This case study focuses on "precooked beans" in which dry bean grains are processed under high temperature and pressure. The precooked beans are then packed in airtight weather-proof aluminium sachets that can preserve the product for over six months. The product can also be packed in plastic containers or bags of varying sizes and be stored for more than a year. Precooked beans only need to be boiled in water for 15 minutes, which is a reduction of nearly 90 % in cooking time, saving consumers both time and money (UFAAS, 2014).

Precooked beans are a promising innovation because:

1. Demand for beans is high and growing: Beans provide a cheap source of dietary protein for poorer households that cannot afford meat. In Uganda, 81 % of urban households consume beans, with an average consumption of 69 g/day. Demand rises with income, with households in the highest income quintile consuming an average of 75 g/day compared to 52 g/day among households in the lowest income quintile (La Rochelle et. al., 2015). Consumption is lower in Kenya than Uganda (NARO, 2017). Consumption of beans in East Africa is expected to double by 2030 (Kilimo Trust, 2012).
2. Rapid urbanization: In Kenya, 50% of the population is projected to be urbanized by 2050 (Dalberg, 2019). Urbanization is expected to fuel demand for precooked beans, since urban consumers must pay both for beans and fuelwood for cooking (Kilimo Trust, 2012).
3. Limited competition: Although canned beans are available, they are only affordable by a minority of wealthy consumers. In Uganda, canned beans are imported and cost three times as much as unprocessed dry beans (Aseete et. al., 2018).
4. Improved varieties are available: Breeding programs for beans in Uganda and Kenya have prioritised varieties with high nutrient content, of which 12 were selected as suitable for pre-cooking (NARO, 2017).

Yet, a smallholder value chain has a lot of moving parts that must work for the value chain to succeed. By the same token, a malfunction in just one of these moving parts will cause the value chain to fail. As Jared Daimond reminds us, success depends on avoiding these many separate possible causes of failure. Creating a smallholder value chain from scratch – like the value chain for precooked beans – is therefore an ambitious objective.

This case study is based on research outputs from a project led by Uganda's National Agricultural Research Organisation (NARO) and by Kenya's Kenyan Agriculture and Livestock Research Organisation (KALRO), supported by the International Centre for Tropical Agriculture (CIAT) through the Pan African Bean Research Alliance (PABRA). The project is funded by in Kenya, and in Uganda by NARO, with CIAT through PABRA. This project is funded through the Cultivate Africa's Future Fund, a joint program of Canada's International Development Research Centre (IDRC) and the Australian International Food Security Research Centre of the Australian Centre for International Agricultural Research. Phase 1 of the project (USD 2.5 M) lasted 3 years, from Oct 2014 to June 2017 (NARO, 2017). There then seems to have been a 2-year gap, followed by a second 'scaling-up' Phase of 2 years starting in January 2019 (USD 0.5 M) (PABRA, 2019). Since the project is still ongoing there is no external evaluation. This case study is based on internal project reports and publications.

6.2 Description of models

The precooked beans project involved several different models on both the supply and demand sides.

Supply

Precooked beans require a dedicated supply chain. To improve nutrition, precooked beans are made from biofortified high-iron beans (HIB). This requires the development of a seed system to supply farmers with quality HIB seed. Since beans cook at different rates, processors require consistency of variety and quality. But most beans are sold as mixtures not as segregated varieties. This means that processors of precooked beans must bypass the mainstream market for beans and deal directly with producers (Dalberg, 2019).

Two models - the Seed Credit Model (SCM) and the Formal Seed Production Model (FSM) were set up to produce seed of varieties suitable for precooking (NARO, 2017). In the SCM model, medium and large-scale farmers were provided with seed on credit and contracted to multiply seed on a written contract basis. Seed loans were repaid in cash. The FSM model involved contracting farmers who bought seed from agro-dealers linked to private seed companies. In Uganda, farmers were linked to Community Enterprise Development Organisation (CEDO), a private seed company. Both models contracted with farmers who already belonged to farmer groups.

Two models are used for grain production. In Kenya, Smart Logistics uses the Community Production and Marketing System (COPMAS) out-grower model. Farmers are contracted and organised into informal Business Units (BU). Each consists of 10 smallholder farmer groups (SHFG), each of which comprises 15-20 farmers (Sustainable Fair Trade Initiative, 2019). In Uganda, CEDO used a Collective Marketing Model (CMM) with Seed Credit. The CMM model involved support to farmers with seed credit and some advance refinancing arrangements. In the model, men and women received equitable access to bean seed on credit which was then recovered after harvest. Farmers grew beans individually but sold them collectively, which earned them higher prices.

Once harvested, beans were aggregated using two private companies – CEDO in Uganda and Smart Logistics Solutions in Kenya. These companies collected, sorted, winnowed, graded, and packaged the grain. Two production plants were established, one at Mukono, 21 km from Kampala in Uganda and another at Kisumu in northern Kenya (IDRC, nd). In Kenya, Smart Logistics also processes precooked beans (Mutuku, 2019).

Demand

Since precooked beans were a new product, the project was faced with the task of creating demand. It followed the classic marketing model, known as the STP model: **S**egmenting the market, **T**argeting the market segment most likely to buy the product, and positioning the product by highlighting the attributes of the product that would appeal to this market segment.

In Uganda, a household survey in rural, peri-urban, and urban areas of central Uganda identified three separate market segments (Aseete et. al., 2018). The market segment targeted for precooked beans ('precooked bean enthusiasts') was mostly urban, with large families, high bean consumption, the highest expense in preparing beans, and who depended on the bean market. The analysis concluded that 'The principal consumers are likely to be low-income urban households that rely on the market as a source of bean for consumption – 63% of the market' (Aseete et al., 2016). This target segment valued several attributes of precooked beans, including enhanced nutrition, water saving and reduced cooking time. Positioning precooked beans to appeal to this target segment should therefore be based on these key selling points.

Another market segmentation used the World Bank's Living Standards Measurement Surveys (LSMS) for Eastern Africa, including Uganda and Kenya. This identified three market segments (Ouma, 2016). The socio-economic profiles of these market segments suggested that they wanted different types of bean products. Group 1 (51%, poorer, mainly rural) wanted a basic bean with 120 minutes' cooking time. Group 2 (44%, middle class) wanted a bean with value added (eg. beans plus tomatoes) and a cooking time of 15 minutes. Group 3 (5%, urban, high-income) wanted a hygienic, fun product like a bean snack. Segmentation therefore suggested two different products – precooked beans and a bean snack – targeted at different consumer segments.

In Kenya, the target segment for precooked beans was identified as consumers with 'low wealth status' (Chege et. al., 2016). Long cooking time and the high cost of fuel for cooking reduced demand among these consumers, yet they also had the lowest demand for beans, and higher prices for beans reduced demand. It was therefore unclear whether this segment was a potential market for precooked beans.

Segmentation was also conducted to identify the market for biofortified bean flour in Nairobi and Kampala (Chege et. al., 2019). This identified a market segment of households with children under five that had high demand for nutritious flour. It recommended positioning the product to attract this market segment.

6.3 Evidence of success

Seed production: Phase 1 worked with 13,503 farmers (6,445 men and 7,055 women) organized into farmer groups for seed production. Farmers were supported with 79,310 Kgs of seed credit and were able to produce 982,595 kg of seed that was used for further seed and grain production (NARO, 2017).

Grain production: Phase 1 worked with a total of 8,606 farmers (5,396 women and 3,210 men) engaged in grain production and produced 923,781 Kg of beans (NARO, 2017).

Processing: In Uganda, CEDO worked with 55 aggregators, while in Kenya Smart Logistics worked with 16 aggregators at intermediate processing level of bean seed (sorting, winnowing, grading and packaging). Precooking trials were conducted on pre-screened beans to produce three precooked bean products: a ready to eat bean snack, a bean flour, and a precooked bean product. The snack does not require additional processing and can be eaten directly or with salads (NARO, 2017). No information was available on the actual volume of precooked beans produced at the two processing plants.

Marketing: In Uganda, the target segment ('precooked bean enthusiasts') was willing to pay an average increase of 31 % in price for precooked beans and the highest acceptable price was an increase of 40 % over the prevailing market price of beans (Aseete et. al., 2018). The biofortified flour included flour from beans as well as other ingredients. The results showed that 57 % of consumers in Nairobi and 65 % in Kampala were willing to pay 50 % % more for this biofortified flour (Chege et. al., 2019). In both cases, providing consumers with information about the nutrition benefits of HIB increased their willingness to pay. Information and education communication messages were developed but were not used because precooked beans were not launched on the market until June 2017, four months before the end of Phase 1 (NARO, 2017).

Consumption: Although there are pictures of packaged and branded precooked beans, no evidence was available for sales or consumption.

6.4 What works and why?

The project successfully increased the supply of high-iron bean seed and grain. There were three reasons for this success. One was partnership with intermediary organisations experienced in managing farmer groups and in aggregation. CEDO in Uganda is a cooperative with 20,000 members which has been producing biofortified bean seed since 2007 and registered as a private seed company in 2010. In Kenya, Smart Logistic Solutions Ltd started in 2009 is a social enterprise aggregating and trading sorghum to East African Breweries Ltd. When this value chain briefly collapsed in 2015, the company switched to value addition, focusing on precooked bean products. It works with 5,000 + smallholders in Eastern Kenya (Mutuku, 2019).

A second reason was remunerative pricing. In Uganda, the profit margin for producers of dry bean was UGX 348/Kg. Expressed as a percentage of the consumer price, the bulk (54%) of the gross value added went to producers, 35% to retailers, 8% to village collectors and only 4% to wholesalers (Kilimo Trust, 2012). However, although most bean producers belong to farmer groups, these are not well organised, and the share of value added going to producers could be increased by collective marketing. Processors of precooked beans were also willing to pay a price premium. In Uganda, farmers in the CMM model with seed credit had a higher gross margin (NARO, 2017). In Kenya, the average annual net income of a farmer in a Smart Logistics group selling beans and sorghum was estimated at KES 55,790 KES/year compared to 9,289 KES for a non-member. Income from beans accounted for 55% of total farmer revenues (Sustainable Fair Trade Initiative, 2019). Smart Logistics paid farmers a quality premium on top of the market price. Farmers received USD 60 for a 90 kg bag of beans compared to the market rate of USD 50 (Agrilinks, 2019). Total revenues from premiums account for 16% of total farmer revenues (Sustainable Fair Trade Initiative, 2019).

The third reason was social inclusion. Beans in Eastern Africa are usually considered 'a woman's crop'. However, research in Uganda showed that while women gave more labour to specific activities, their labour contribution overall was no higher than men's (Nakazi et. al., 2017). This study did not explore women's control over the use of income from beans. Through capacity – building and gender training the project deliberately made sure that women benefitted from commercialisation. As a result, the project saw increases in women's participation in bean marketing, women's average incomes from bean sales, and the volume of beans sold by women (Nanyonjo et. al., nd).

On the demand side, the project successfully identified 12 varieties of HIB that were suitable for pre-cooking using pressure cooking (NARO, 2017). This was possible only because biofortification had long been a priority for bean breeding programs. It takes 10 years to develop a new bean variety. High-iron beans that were suitable for precooking were a return on this long-term investment.

The project successfully identified potential markets for precooked beans and other bean products. This owed much to the use of concepts and tools from consumer marketing, which is still relatively new in a development context.

6.5 What causes failure?

According to a study of the value chain for dry beans in Uganda made in 2020, 'Processing opportunities such as precooked beans have not yet been taken up' (CASA, 2020:28). Since the project is still ongoing, it is premature to talk of failure. It would be more appropriate to talk of 'slow growth'. Why has growth been slow? Arguably, the main reason is not structure but process. The value chain for precooked beans has simply too many moving parts for a short-term project. Consider the 10 major steps involved:

1. Screening and identifying suitable varieties.
2. Multiplying seed using famer groups.
3. Producing grain through farmer groups.
4. Aggregating grain and delivering to processors.
5. Establishing processing plants.
6. Production and sale are profitable.
7. Winning product approval from the Bureau of Standards.
8. Identifying consumers willing to buy the product.
9. Raising consumer awareness of nutrition benefits.
10. Ensuring a continuous supply to meet consumer demand.

All this is not achievable within the straitjacket of a 2½ year project cycle, which leaves no margin for error. Developing a smallholder value chain is a long-term investment. If this is the case, then success may well be achievable but with a more extended (and more realistic) time frame.

Studying this list of moving parts, there seems to be no inherent reason why the value chain for precooked beans should not be successful. Three of these moving parts are analysed in more detail below.

Part No. 5: Establishing processing plants

No major bean processor was prepared to invest in precooked beans. Reluctance to invest in precooked beans is understandable. Only 1 % of dry bean production in Uganda is processed (Kilimo Trust, 2012). In Kenya, the share is 11 % (Dalberg, 2019). Processing companies are undercapitalised and do not invest in modern machinery because of the high cost of capital required to upgrade and the 'thin' market for value added bean products. Given this limited demand, precooked beans are a risky investment. Once there was evidence of growing demand, however, bigger processors would enter the market and production would take off.

Processing precooked beans had therefore to be entrusted to a small company or a start-up business. These companies often find it hard to attract investors. As a result, production is limited. One estimate says the processor in Kisumu has a capacity of 9 tons per day (IDRC, nd). Another suggests a peak production capacity of 1 ton per month, or just 12 tons per year (Kenya News, 2019). Smart Logistics' bean processing plant in eastern Kenya operates for only half the year (Mutuku, 2019).

Part No. 6. Production and sale are profitable

To be profitable, precooked beans must sell at 40% above the price of dry beans (Aseete et. al., 2018). This is close to what consumers are WTP. The profitability of precooked beans is confirmed by the evidence from Smart Logistics Solutions in Kenya (Sustainable Fair Trade Initiative, 2019). The company markets a variety of bean products. Over the next 10 years, it is projected that 90% of bean sales by volume will consist of precooked beans and that bean products will make up 56% of Smart Logistics' total revenues.

Part No. 10. Ensuring a continuous supply to meet consumer demand.

Growing the market for precooked beans requires a constant supply for consumers to buy. This may not be difficult in Uganda which has two wet seasons and beans can be grown twice a year. But it may be more of a problem in Kenya, where beans can be grown only once a year. Relying on imports to meet demand is tricky because of the need for a dedicated supply chain with uniform varieties. However, about 40 % of demand in Kenya is met from domestic production. The goal is for precooked beans to meet 20 % of total demand (Ouma, 2016). If bean growers in Kenyan specialised in the production of varieties suitable for precooking, then supply would be more than enough to meet demand.

“Slow growth” in the value chain for precooked beans becomes easier to understand when we compare it with the value chain for sorghum beer (Table 1). Senator keg became Kenya’s best-selling beer within just six years. However, sorghum beer was produced by Kenya’s biggest private processing company which had the capacity to produce at scale, to brand and market its product at dedicated retail outlets, and which (thanks to a government tax break) could match its rival product on price. The value chain for precooked beans has none of these advantages. We should therefore not expect precooked beans to replicate the rapid growth in the value chain for sorghum beer. The trajectory will be more gradual.

Table 3: Comparing value chains for precooked beans and sorghum beer

New product	Precooked beans	Sorghum beer
Differences		
Processing	Business start-up	East Africa’s second-largest company
Marketing	Branding	Branding, advertising, Senator keg bars
Retail outlets	Supermarkets, small stores	Senator Keg bars
Price difference with competitor product	40 % higher	None
Target segment	Urban middle-class	‘Aspirational’ urban low-income
Price support	None	Tax break on excise duty
Similarities		
Unique selling points	Nutrition, saving time and fuel	Hygiene, ‘modernity’
Supply chain	Farmer groups supplying uniform variety	Farmer groups supplying uniform variety, spot market

6.6 Legacy

One legacy is the need to re-visit the marketing model for value added products. The project for precooked beans often invoked the model of the ‘Bottom of the Pyramid’ (BoP) (Chege et. al., 2016, 2019; NARO, 2017), or the market represented by people living on less than USD 2.50 per day. But because precooked beans cost more than dry beans, they are more likely to be bought by urban, middle-class consumers. Precooked beans will thus improve nutrition in the middle of the pyramid, not the bottom. Although this market segment is smaller than the BoP segment, it is the main source of demand for processed food that is growing fast in Eastern Africa (Ouma, 2016). However, growing demand for precooked beans from the middle of the pyramid will benefit the poor by increasing the income of bean growers, including women.

Scaling-up processing of precooked beans was more difficult than scaling-up production. This reflected forced reliance on small companies and business start-ups with limited production capacity. This is unavoidable if bigger, established companies are unwilling to risk investment. However, the danger is that a low level of production will not generate the critical mass of demand from consumers that is needed to encourage bigger processors to enter the market and grow the value chain.

A third legacy is the problem of matching the long-term objective of value chain development with short project cycles. All smallholder value chains have a lot of moving parts. But because the value chain for precooked beans is being developed from scratch, all these parts must be assembled at the same time. This is difficult to achieve within a short period. Yet the pressure to show quick ‘impacts’ results in unrealistic targets and expectations that underestimate the complexity of developing smallholder value chains.

7. Case Study No. 6. Market-led plant breeding: Pigeonpea in Eastern and Southern Africa

"*Never underestimate the power of ideas*". Heinrich Heine, quoted Berlin (2000).

7.1 Introduction

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is a grain legume grown in both Asia and Sub-Saharan Africa (SSA). In SSA, pigeonpea is grown primarily in Eastern and Southern Africa (ESA), where the biggest producer is Malawi (371,000 t), followed by Tanzania (252,000 t), Mozambique (200,000 t), Kenya (148,000 t), and Uganda (13,000 t).

Pigeonpea is an important commercial crop, with a large export market. Exports are of two kinds. One is grain (whole dried peas) and the other is dehulled split grain, known by its Indian name of tur dahl. Whole grain is exported to India, where domestic production has been unable to meet demand. In 2016, India's imports of pigeonpea reached 450,000 t, of which 248,000 t (53 %) came from Africa (Rawal and Navarro, 2019). Tur dhal is exported to the Indian diaspora in Europe, Canada, and to the Middle East. This market is much smaller than for whole grain. In ESA, only three countries Malawi, Mozambique, and Kenya export split seeds of pigeonpea (tur dhal).

The research 'problem' for pigeonpea in ESA was framed as developing improved varieties to supply these export markets. Africa's harvest of pigeonpea is earlier than in India, allowing exports from ESA to benefit from peak prices between July – December before the Indian crop reaches the market. The research challenge was therefore to develop improved varieties that were adapted to the agro-ecology and cropping system in ESA but also reached India when prices were high and had the market traits favoured by Indian consumers. Thus, the programme is an early example of market-led breeding. The programme also illustrates the power of ideas. The inspiration for the programme was the idea of market-led development. To a large extent, the performance of the ESA breeding programme can be explained by this single idea. Its successes were due to market opportunities and its failures were market failures.

The ESA breeding programme is now 30 years old, having started in 1991 (Silim et. al., 1992). The objective of this case study is not to evaluate the programme, but to outline its main features and identify some of the key factors that explain its performance. Information was obtained from ICRISAT staff involved in the programme and from the programme's publications, supplemented by recent studies of the value chain for pigeonpea in each country. This case study focuses primarily on Malawi and Tanzania.

7.2 Description of models

ICRISAT's pigeonpea programme used innovative models for the production and delivery of certified seed, and for vertical integration of the value chain. It also used two novel diagnostic tools.

Diagnostic tools

1. The "Kenya transect"

Breeding programmes want wide adaptation – the bigger the area their products can cover, the greater the return on the research investment. The Green Revolution achieved this by developing rice varieties that were insensitive to photoperiod or changes in daylength. Varieties would always mature after a fixed number of days no matter where they were planted. But traditional varieties of pigeonpea were highly sensitive not only to daylength but also to temperature. This ruled out breeding for wide adaptation – improved varieties had to be tailored to fit a specific agro-ecology.

These varieties were developed using “the Kenya transect”, or a range of research sites on the Equator with different altitudes ranging from sea level to 2000 m asl. The transect provided a range of temperatures with constant daylength. To study the effects of temperature alone, with daylength held constant, the programme grew the same six varieties at different altitudes. The higher the altitude, the lower the temperature. To study the effect of daylength alone, with temperature held constant, the programme floodlit the research trials at night, creating a long-day environment (Silim et. al., 2006).

Figure 1 shows how the programme used “the Kenya transect” to match varieties and agro-ecology. Short-duration varieties, which were insensitive to daylength but sensitive to temperature, could be grown anywhere at low altitude. Medium-duration varieties were sensitive to daylength as well as temperature and had to be grown at low and medium altitudes near the Equator, where daylength was shorter. Long-duration varieties were extremely sensitive to both daylength and temperature, and so had to be grown near the Equator or at higher latitudes where days were short and cool during the reproductive phase of plant growth.

Temperature	**Altitude**	**Adaptation to environment, by duration of improved variety**		
Low	High	Long duration 14-18 ^{0}C 8 months		
Medium	Medium		Medium duration 21-24 ^{0}C 5-6 months	
High	Low	Short duration 23-26 ^{0}C 3 months	Short duration 23-26 ^{0}C 3 months	Short duration 23-26 ^{0}C 3 months
Daylength		Short	→	Long
Distance from Equator (Latitude)		Near	→	Far

Figure 1: Transect analysis, for adaptation by environment. Source: Silim et. al. (2006) and Silim (2017).

2. Sub-sector analysis

ICRISAT partnered with Technoserve Inc. (a US-based NGO specialising in enterprise development) to apply sub-sector analysis to the value chain for pigeonpea in Tanzania, Kenya, and Mozambique (Freeman and Jones, 2001) and Malawi (Jones et. al., 2002; Jones et. al., 2006). Technoserve was itself in the process of adopting sub-sector analysis and invited ICRISAT to a workshop for training in the new approach. Sub-sector analyses gave ICRISAT both the rationale and the strategic framework for a market-led breeding programme. Specifically, it provided ICRISAT with:

1. A vision of a vertically – integrated pigeonpea value chain.
2. The market opportunities for pigeonpea in each country.
3. The type of product required to meet this market demand.

Seed production

ICRISAT's pigeonpea programme used a model of seed supply known as Integrated Seed System and Delivery (ISSD), where improved varieties are developed by the public sector, but seed is generated, multiplied, and distributed by the private sector. ICRISAT used two variants of the ISSD model:

1. Seed Revolving Fund

In Malawi, the programme used a Seed Revolving Fund (SRF). In this model, ICRISAT and its partners produced and supplied breeder to seed to contract growers, who produce basic or foundation seed which is bought back at agreed prices using a revolving fund. ICRISAT then supplied this basic seed to seed companies who multiplied it into certified seed. Their seeds, which are certified by the Seed Services Unit, are sold under the Malawi Seed Alliance (MASA) brand, through private agro-dealers or tenders from the State Seed Agency to supply Malawi's Farm Input Subsidy Program (FISP). The FISP targeted poorer households who received a seed voucher that was redeemed through an agro-dealer. Profits from sales realized through the SRF cover the cost of warehouse, seed packaging and transport, enabling the SRF to engage more smallholder farmers every year (ICRISAT, nd).

2. Quality Declared Seed

In Tanzania, the programme used Quality Declared Seed (QDS). In this model, the public sector produced and supplied breeder seed to registered farmer organisations or individual entrepreneurs, which then produced either basic or certified seed with limited certification by government. QDS in Tanzania can only be sold within the district where it was produced. In ESA only three countries – Tanzania, Malawi, and Ethiopia – permit the production of QDS (Rubyogo et. al., 2019).

Vertical integration

1. The Dhal Millers Association

In Malawi in 1998, eight companies formed the Dhal Millers Association to address the industry's concerns about the poor milling quality of ICP 9145 and the inadequate supply of pigeonpea grain (ICRISAT, 1998). The millers agreed to a grading system that would reward farmers for producing high-quality grain. In 1999/2000, the Association (renamed the Grain and Legumes Development Association Limited or GALDAL) contracted farmer groups to produce 100 t of seed of ICEAP 00040 and distribute the seeds to other growers (Jones et. al., 2002). Until then, contact between agricultural researchers and private-sector traders and processors in Malawi had been non-existent (Jones et. al., 2006). This was the first attempt to integrate agricultural research with the pigeonpea industry.

Linking growers and exporters

In Tanzania, Technoserve linked growers in Babati district with a trading firm exporting whole pigeonpea grain to Europe (Jones et. al., 2006). Farmer groups were contracted to grow specific varieties. The trading firm cleaned and graded the grain; the breeding programme provided technical back-up; and Technoserve provided bank guarantees to finance the deal (Jones et. al., 2006).

7.3 Evidence of success

1. Improved varieties: Before the breeding programme began, there was only one improved variety in the entire region. Fifteen years after the programme began, there were 18 (Kanoeka et. al., 2016). The breeding programme successfully combined the production traits needed by growers in ESA with the traits needed by processors and consumers in the Indian market (Figure 2).

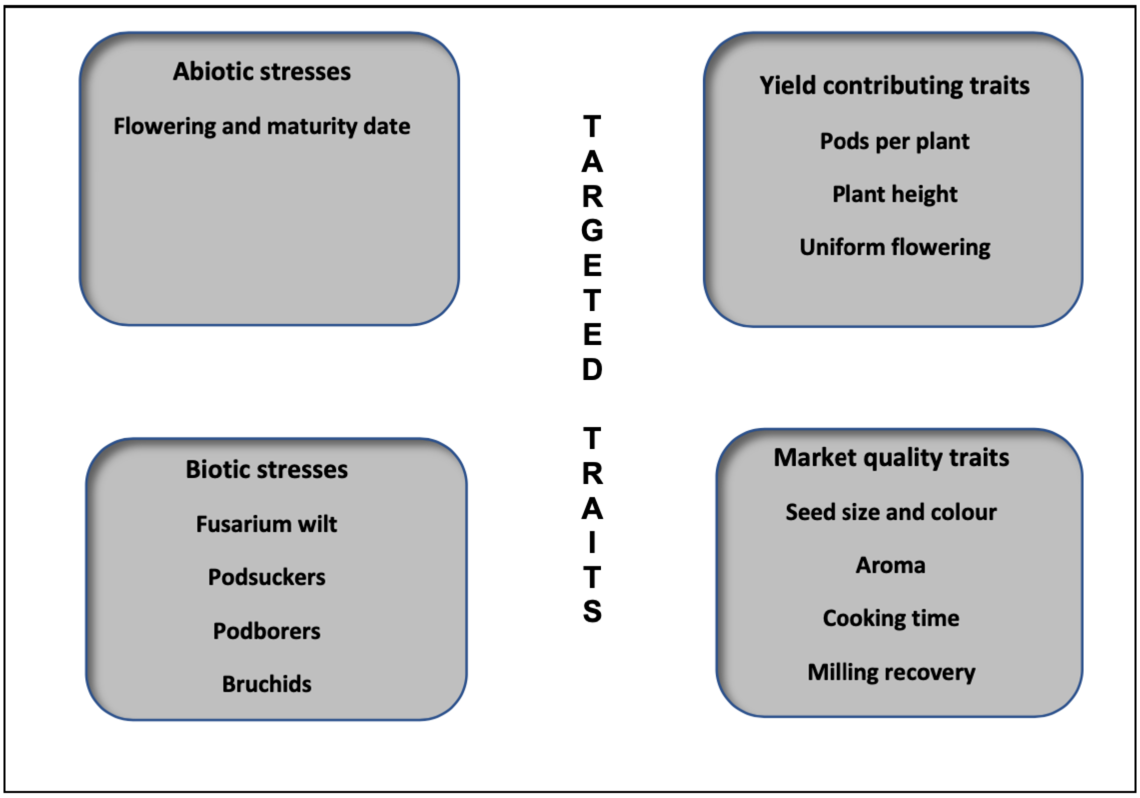

Figure 2: Priority traits in pigeonpea breeding programme, ESA. Sources: Kimani (2001).

2. Production traits included resistance to pests and diseases, including the fungal disease Fusarium wilt, which was endemic in the region. This provided the foundation for commercial success. Improved varieties had round grains, which made it easier to separate the seed coat from the cotyledons and made the grain easier to split. Rather than red or speckled grains they had white or cream grains, which produced the yellow tur dhal preferred by Indian consumers. And like local African varieties they had large or 'bold' grains, which matched consumer preferences among the Indian diaspora.

3. Seed production: An SRF for pigeonpea with a farmer cooperative in Southern Malawi shows high repayment rates (85 %) (OPM, 2019). In Malawi the production of certified pigeonpea seed grew from 83 t in 2012/13 to 672 t in 2017/18 (STAM, 2021). In Tanzania, the Tropical Legumes project (2007-2017) produced 1,448 t of certified seed, enough to plant 59,000 ha annually (Varshney, 2019).

4. Adoption: In Tanzania, by 2012 the adoption of improved varieties covered 50 % of the area planted to pigeonpea (Dalton and Regier, 2016). In Malawi, the 672 t of certified seed produced in 2017/18 would cover about 25 % of the area planted (STAM, 2021). Adoption of improved varieties in Mozambique was estimated at 10 % of the area planted (Walker et. al., 2015).

5. Social inclusion: A project to introduce an SRF to a farmer cooperative in southern Malawi found that access to certified seed was socially – inclusive. Treatment households that received certified seed and control households that did not had the same share of households living below the national poverty line (OPM, 2019).

6. Export price premium: Pigeonpea exports from ESA enjoyed a substantial price premium in the 1990s, although this later declined with increased competition from Myanmar (Jones et. al.,

2001). According to processors in Malawi, Tanzania's white grain pigeonpea earns an export price premium of 35 % over the red grain varieties exported by Malawi (Orr et. al., 2021). Technoserve reported that farmgate prices were 24 % higher for improved white varieties than traditional mixed varieties (Jones et. al., 2002).

7.4 What works and why?

The breeding programme was in the right place at the right time. Demand for imports in India surged after 2000 and ESA was well placed to meet this demand. In 2000 imports of pigeonpea to India were 44,000 t (Pathasarthy Rao et. al., 2010). By 2015, imports had rocketed to 450,000 t, with half of this coming from Africa (Rawal and Navarro, 2019). The pie was big enough for everyone: 58,000 t from Malawi, 70,000 t from Mozambique, and 80,000 t from Tanzania (Rawal and Navarro, 2019). With this export bonanza came rising producer prices. Without this expanding market, growers might have adopted improved varieties because they were resistant to Fusarium wilt, but the incentive to adopt improved varieties for sale as a cash crop would have been limited.

Within ICRISAT, two things were needed to take advantage of this market. One was a de-centralisation. In 1992 ICRISAT was restructured to give greater autonomy to the regions, with the appointment of Regional Executive Directors for East and West Africa (ICRISAT, 1994). This gave the breeding programme in ESA some power to set its own research agenda and priorities. Even so, ICRISAT HQ was sceptical about the ability of ESA to run a breeding programme and insisted that all materials were brought from India (pers. comm., Said Silim). The second was the remarkable troika of scientists involved in the ESA breeding programme. The team included an agronomist (Said Silim, ICRISAT 1991-2016), a technology exchange specialist (Richard Jones, ICRISAT 1996-2010) and an economist (H. Ade Freeman, ICRISAT 1991-2003). All three shared a common perspective on the need for research to be driven by market demand. This likeminded group also had the right mix of skills needed for a multi-disciplinary programme like market-led breeding.

Technoserve's role was critical for market-led breeding because ICRISAT had no experience of working with the private sector. At that time, ICRISAT regarded it as 'heretical' to work with any partner other than national agricultural research systems (pers. comm., Richard Jones). Technoserve had independently identified pigeonpea as a promising export crop but was not included as a partner in the original design of the programme. However, its expertise proved indispensable for (1) conducting sub-sector analyses (2) linking the programme with exporters (3) organising farmer groups and (in Tanzania) providing financial guarantees for forward contracting and (4) developing a business plan for cotton companies in Mozambique to produce pigeonpea and arranging visits by Indian buyers, and (5) setting up Mozambique's first processing plant for tur dahl (Jones et. al., 2002; Jones et. al., 2006).

Scaling-up the supply of seed took advantage of changes in policy. Two policies helped overcome the bottleneck in seed supply caused by the lack of financial incentives for private seed companies to market seed for self-pollinated legumes like pigeonpea. In Tanzania, de-regulation of the seed system resulted in the introduction of QDS, which allowed seed production and marketing at the local level. In Malawi, social protection policies that distributed small packs of seed and fertiliser allowed pigeonpea to be widely marketed in the Southern region. The Targeted Input Program (as it was then known) distributed pigeonpea seed between 2001 and 2003 (Barahona and Cromwell, 2005). After a gap, the renamed Farm Input Subsidy Program (FISP) distributed pigeonpea seed between 2009-2012 (Chirwa and Dorward, 2013). Finally, the ESA programme may have benefitted from harmonised seed policies. Allowing national Variety Release Committees to use evidence from regional yield trials reduced the time required for testing in-country and accelerated the release of improved varieties (Rohrbach et. al., 2003). However, since the breeding programme was regional in scope, with the same varieties being tested in each country, it is not clear how important this really was for the success of the programme. Without the first two policies, however, access to seed would have continued to constrain the awareness and adoption of improved varieties.

Finally, ESA had the advantage of a close-knit group of Asian entrepreneurs. Their knowledge of their customers gave the breeding programme information about the quality traits required for improved varieties in export markets, as well providing links to these markets in India and Europe. Because improved varieties offered these entrepreneurs a commercial advantage, the breeding programme was able to enlist their support in distributing improved seed and buying directly from growers.

7.5 What causes failure?

Short duration improved varieties, which were successful in India, proved to be poorly adapted to ESA. They matured when temperature was high, which was the peak period for attack by insect pests. This meant they could only be grown where farmers could afford chemical sprays. Moreover, they had to be grown as a monocrop because they were unsuited for intercropping with maize. Local varieties were long and medium duration, which meant they grew slowly and flowered only after the maize was harvested. But short duration varieties flowered earlier and so competed with maize for light, water, and nutrients. Despite this, the breeding programme saw short-duration varieties as appropriate for commercial farmers who had the cash to invest in pest control (ICRISAT, 1998). In Mozambique an ingenious attempt was made to grow short-duration varieties in rotation with cotton. Because the cotton ginneries supplied growers with seed and insecticides, farmers were able to apply cotton pest control measures to pigeonpea (Jones et. al., 2002). However, this model appears to have been unsuccessful (Walker et. al., 2015). Today in ESA, short-duration varieties are grown only after cotton in the Gezira scheme in the Sudan, where there is residual moisture from irrigation (pers. comm., Said Silim). In retrospect, they were a false start.

ICRISAT's vision of a vertically integrated pigeonpea industry was never realised. In Malawi, the Dhal Millers Association collapsed when the lead miller emigrated, and the manager embezzled the funds (pers. comm., Richard Jones). However, it may never have succeeded. Sub-sector analysis was based on commodities like silkworm in Thailand (the example used by Technoserve's training programme) that were very different from pigeonpea. Processors were wary of forward contracts because these could not be enforced, with growers selling to the highest bidder (Orr et. al., 2017). In Tanzania, side-selling has led the social enterprise Kilimo Markets Ltd. to abandon forward contracting for pigeonpea altogether (Charles, 2017). The result is that pigeonpea passes through several hands before reaching exporters, reducing the price received by growers. In Babati district, Tanzania, only 9 % of production was sold directly to exporters (Rogath, 2010). Thus, ICRISAT's vision of market-led development was killed by the nature of the market itself.

A third failure lay in crop management. Farmers' normal practice was to intercrop maize and pigeonpea in the same row, by planting two to three pigeonpea seeds between each maize planting station. However, the agronomy component of the breeding programme showed that planting two separate rows of pigeonpea between three separate rows of maize did not affect the yield of maize but increased the yield of pigeonpea by 80% (Mergeai et. al., 2001). Despite this, there is no evidence that this practice was ever adopted. One explanation may be that the practice required growers to double the plant population for pigeonpea when many already lacked access to seed. If so, then the project's failure again reflected a wider market failure, this time in seed supply.

One miss-step was the late appearance of improved varieties with a medium field duration. These were released last, after both short-duration and long-duration varieties. Short-duration varieties were released first because they were already available from ICRISAT's breeding programme in India. Long duration varieties were released next because they were better adapted to intercropping with maize, the standard practice in ESA. However, the 10 – year gap that followed the release of the long duration improved variety ICEAP 00040 in 2000 created a vacuum. In Malawi, this vacuum was filled by the unimproved variety Mthawajuni. By 2008, Mthawajuni occupied 80 % of the area planted to pigeonpea in Malawi (Simtowe et. al., 2010). The earlier harvesting of Mthawajuni avoided drought and meant higher prices for growers. However, because Mthawajuni's red grain has a lower market value, Malawi lost competitiveness in global markets (Orr et. al., 2021). The first two medium duration varieties – ICEAP 00557 and ICEAP 01514/15 – were not released in Malawi until 2010 and 2011, respectively (Kaoneka et. al., 2016). Initially, medium-duration varieties were intended for Kenya and central and northern Malawi. Yet they have proved popular in southern Malawi and in Tanzania (Charles, 2017). With hindsight, therefore, this sequencing in the release of improved varieties is puzzling.

7.6 Legacy

The ESA breeding programme for pigeonpea assumed that there was a growing export market. In 2017, however, India introduced an import quota for pulses. The pie turned out to be finite, after all. Future increases in demand in India will be met by boosting domestic production rather than by imports. The average import quota for pigeonpea remains substantial, estimated at 450,000 t per year (Subramanian, 2016). However, the export boom is over. The import quota will intensify competition between exporting countries in ESA and stimulate the search for new markets.

The focus of the ESA breeding programme has been to generate cash income from pigeonpea, rather than use pigeonpea to boost household food security and nutrition. Consequently, the programme has paid less attention to domestic or regional demand. However, efforts have been made to expand production outside the southern region in Malawi, and to increase the adoption of improved varieties to southern Tanzania (Mponda et. al., 2013). Consumers in these markets may have different preferences, which may require the development of improved varieties with other traits.

Growers like the medium-duration varieties developed by the ESA breeding programme. However, these varieties are prone to attack by insect pests and require insecticides. Many farmers cannot afford these. Pest surveys showed that, except for Kenya, growers did not use pesticides to control field pests of pigeonpea (Minja et. al., 1999). Various traits that can reduce yield losses from these pests are known to breeders (Silim, 2001), but so far there has been limited progress in developing host plant resistance (Minja et. al., 2001). Better resistance to insect pests would accelerate the adoption of medium-duration varieties.

Finally, the breeding programme had a lasting impact on ICRISAT. Market-led breeding was ahead of its time. The approach was new, liberating, and broke with conventional thinking. Based on the experience of this and other programmes, ICRISAT later made market-led development into an orthodoxy, institutionalising it as Inclusive Market Oriented Development (IMOD) (ICRISAT, 2010). IMOD generalised market-led development into a universal theory, applied indiscriminately to all five mandate crops everywhere, including where it was not appropriate. This consequence of the ESA breeding programme was unintended, but it illustrates a familiar irony in the history of ideas. All great orthodoxies begin as heresies.

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About CRP-GLDC

The CGIAR Research Program on Grain Legumes and Dryland Cereals (CRP-GLDC) brings together research on seven legumes (chickpea, cowpea, pigeonpea, groundnut, lentil, soybean and common bean) and three cereals (pearl millet, finger millet and sorghum) to deliver improved livelihoods and nutrition by prioritizing demand driven innovations to increase production and market opportunities along value chains.
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