

A Taxonomy of Failure Modes of Agricultural Technology Ventures in Developing Countries: Part 2

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ABSTRACT: *Agricultural technologies strengthen and streamline Food Value Chains (FVCs) while improving the lives and livelihoods of smallholder farmers and entrepreneurs. Technologies such as greenhouses, solar food dryers, threshers, grinders, and storage and packaging equipment can help increase the efficiency and sustainability of food value chain activities in emerging economies. However, there are a myriad of technological, infrastructural, and operational challenges that hinder the successful design and sustainable commercialisation or deployment of such products. After over a decade of research, experience, and consultation in the field, we present here an initial taxonomy of potential failure modes during the design, implementation, and maturity phases of agricultural technologies ventures. We argue that consideration of these failure modes early in the design process will assist agricultural technology designers and entrepreneurs in avoiding pitfalls later in the venture lifecycle. Part 2 (of 2) in this article series presents the implementation and maturity-phase failure modes. Together with Part 1 (taxonomy development and design phase pitfalls), this taxonomy aims to inform innovators and entrepreneurs seeking to launch successful and sustainable agricultural technology ventures in the developing world.*

KEYWORDS: agricultural technologies, failure modes, food value chains, humanitarian technologies, social ventures

1 INTRODUCTION

This two-part article series presents the rationale, initial development, and a preliminary taxonomy of failure modes of agricultural technology ventures that support and strengthen Food Value Chains (FVCs) in developing economies. The taxonomy presents failure modes across the design, implementation, and maturity phases of the venture lifecycle. While part 1 focused on failure modes in the design phase, part 2 (this article) presents common failure modes in the implementation and maturity phases.

2 FAILURE MODES DURING THE IMPLEMENTATION PHASE

Figure 1 summarises potential failure modes during the implementation phase of the venture: from product launch to establishing strong market presence. The duration of

this phase varies from a couple of years to a few decades until the product gains traction and the venture finally has reliable and sustainable revenues. Challenges during this phase can be classified as either internal or external. External issues (1 to 6) are those that deal with stakeholders and entities outside of the organisation delivering the product or service. Internal issues (1 and 7 to 12) all occur within the organisation, either with the product itself or the employees and organisation necessary to deliver the product.

2.1 Access to Capital

A designer must understand the parameters within which their product and venture will operate. Ventures need start-up capital. At the same time, their customers also need capital to purchase the products. For both entities, finding financial resources is often difficult.

- *Internal Access to Capital:* A new venture must have sufficient capital to cover the start-up and

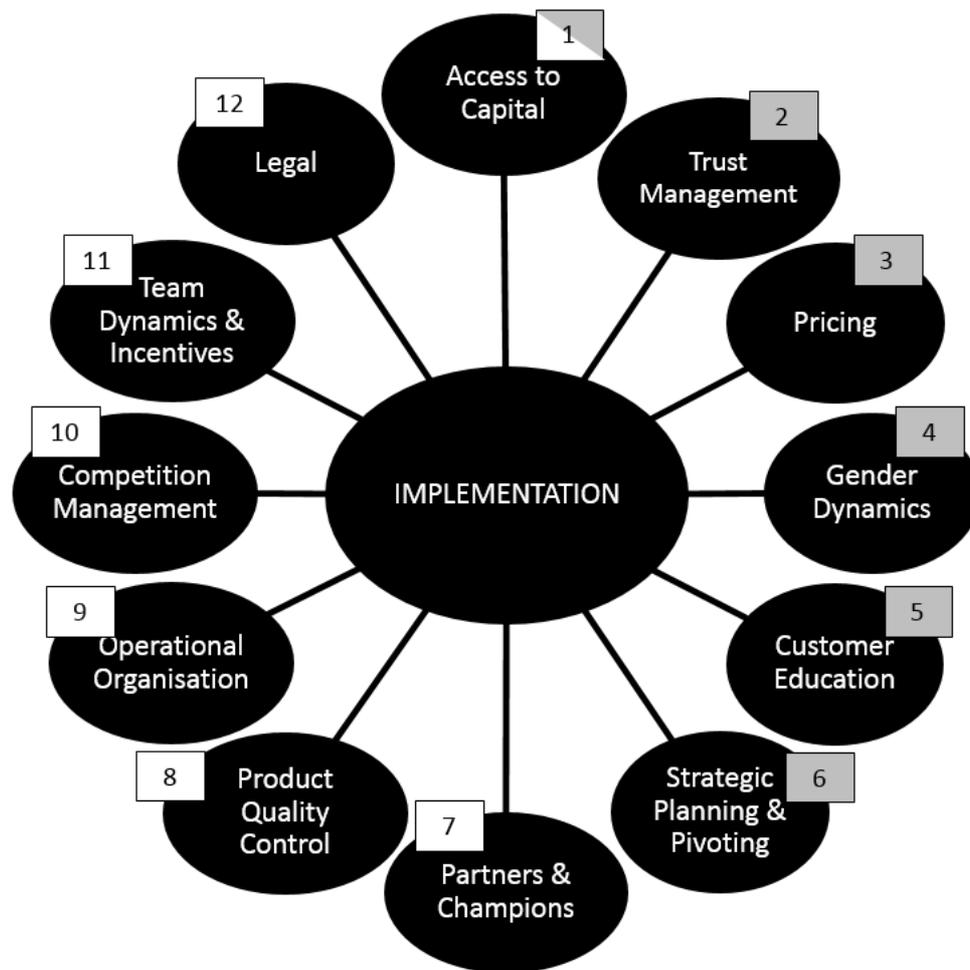


Figure 1: Challenges encountered by agricultural technology ventures during the implementation phase. Grey boxes (1 to 6) indicate external challenges whilst white boxes (1 and 7 to 12) are internal.

implementation costs. It is important to have an accurate estimation of the necessary costs to bring a venture to the launch stage of the venture lifecycle. It is common for ventures to grossly underestimate the time it would take for them to gain traction and have a cash-positive revenue model. In other words, even after product launch, ventures may need loans and equity for several years or even decades. Ventures fail when they are not able to demonstrate impact and continuously raise funds over an extended period of time and/or when they aim ‘too big’ initially instead of prioritising achievable commercial or fundraising sustainability.

- *External Access to Capital:* In the developing world, the majority of farmers are smallholders. If a farmer wants to purchase a new agricultural technology to improve their livelihood, they need seed funding. Traditional seed funding comes from a combination of personal savings and/or family, friends, and neighbours. An agricultural technology venture needs to develop avenues and channels that will allow farmers to reach their product. One option is working through

the financial sector, by building relationships with Savings and Credit Cooperative Organisations (SACCOs), Micro-finance Institutions (MFIs) and other actors in the informal lending space. Other actors such as non-government organisations (NGOs) and governments can also help, but implementation failure can also result from donating products to end-users who have no financial stake or other sense of investment. Ventures thus fail when they do not establish partnerships or other avenues for customers to access capital and invest in their products.

2.2 Legal

Ventures encounter a multiplicity of legal issues in formal legal spheres and grey areas when they function in the informal economies of developing countries.

- *Informal Legal Issues:* In most developing countries, a large portion of the economy is run informally. Many small businesses and enterprises operate successfully despite remaining officially unrecognised by the

government. Formalising a business tends to be an expensive and time-consuming process that may not be feasible or realistic during the start-up phase. However, operating in the informal sector exposes ventures to legal risks as they grow. Every venture has to decide at what point during their lifecycle they must formalise their business. Ventures that formalise their organisations too soon fail when they are unable to pay hefty taxes and bribes and meet stringent import regulations that their informal competitors do not have to. At the same time, ventures that stay informal for too long also encounter legal troubles (like tax evasion) and have the added disadvantage of not having a disciplined and structured entity to make important operational and financial decisions or access capital from the formal lending industry.

- *Formal Legal Issues:* There are specific challenges to consider once a venture is operating in the formal economy. Examples of such issues include: taxes, employment regulations, regulatory frameworks, and intellectual property laws. A thorough understanding of the relevant formal legal issues will assist ventures in avoiding costly litigation. The legal and ethical burden is often higher for ventures operated by foreigners, and this increased scrutiny necessitates clear operations from a legal perspective. Additionally, when ventures need to conform to the laws and norms of the developing country where they operate as well as of a different (often Western) country where they receive funding, the legal burden is doubled.

2.3 Pricing

Choosing and adapting optimal price points is a complex task that is influenced by the competitive landscape, local partnerships, and customer perceptions.

- *Competitive Pricing:* Agricultural technology ventures must accurately estimate the demand and value of the product in the target marketplace. Pricing the product too high makes it unaffordable to customers and is a common failure mode. At the same time, products have also failed because they were priced too low and could not sustain their costs or were perceived as inferior to other options.
- *Subsidies:* Subsidies provided by government agencies or NGOs can help ventures bridge the gap between the product costs and the price point that their customers can truly afford. The obvious problem is the development of a black market around the product with customers reselling their products to turn a quick profit. Also, subsidies are not sustainable in the long term. This study encountered several ventures that heavily subsidised products to demonstrate demand and boost sales numbers for marketing and fundraising

purposes. This created an artificial demand for the product, which was either sold for a profit in different regions or was misused, with the ultimate result being the venture’s downfall. Similar situations arose when ventures were not able to make the jump from subsidised rates to regular rates for the products because people were expecting to pay the subsidised price.

2.4 Gender Dynamics

In many non-western societies, gender roles and norms can be different and stricter and hence necessitate a greater level of attention. The roles are derived from cultural perspectives and societal norms and have direct implications on lifestyles. Ventures that do not understand these implications will struggle to develop appropriate dissemination strategies, in terms of marketing, sales, and follow-on support. Gender dynamics can also influence financing strategies for ventures. For example, women in some cultures avoid borrowing money from friends, neighbours, and relatives. At the same time, many MFIs prefer to lend to women because of higher repayment rates. Women’s cooperatives are also popular in some countries’ agricultural sectors. Ventures fail when they do not consider gender dynamics in every aspect of the venture, especially during the implementation phases. They must consider not just how men and women will access and operate their product differently but also espouse a systemic view of how that product creates perceived and real value for all users.

2.5 Customer Experience

Some agricultural technologies require a substantial amount of training or experience in order to be operated safely and effectively. Ventures attempting to implement such products must determine what level of training their customers require, and how it will be delivered. Accurate and specific market research and testing is important for making informed decisions regarding the process of customer education. The technology will not be used effectively, and thus not be successfully implemented, if ventures do not adequately educate and engage their end-users. One common sub-mode of failure in this study was that, while ventures tend to do a reasonable job educating their customers when the product is sold, mechanisms for lateral knowledge sharing between end-users that take the specific location and circumstances of the customers into account are rarely developed. This long-term lateral knowledge sharing is often more important than the brief operation and maintenance training provided early on.

2.6 Strategic Planning and Pivoting

Ventures introducing new technology products into a market must be extremely flexible. Properly timed strategic adjustments to the product, marketing strategy, customer

base, or the implementation approach can make the difference between reaching maturity and failing to get traction for a venture. Ventures fail when they do not continuously assess what is working and what is not and pivot every necessary aspect of their venture until they are successful. We observed numerous cases of ventures or projects that failed when the team refused to change course despite overwhelming evidence that they were on the wrong track. There were many reasons why teams remained steadfast – they were not responsive to customer feedback, they truly believed that they were on the right track (despite the data indicating otherwise), they were emotionally or financially invested in a certain direction and could not convince themselves to change course, they did not know what new direction to take, or they simply lacked the decision-making structure and strong leadership to change course.

2.7 Partners and Champions

Strategic partnerships and champions help ventures to gain the access, exposure, and credibility necessary to successfully implement a technology in a new region. Thorough market research helps ventures identify the initial partnerships necessary for the implementation phase.

- *Credibility*: If an agricultural technology venture is implementing a product in a new region, it will require key partnerships to initially reach the market and avoid failure. Such partnerships, particularly if the partner is well-established in the individual community, can lend crucial credibility to the new unproven technology. These partnerships can take many forms, including government support, region-specific business endorsements, support from influential local opinion leaders and celebrities, or even symbolic support from a well-known Western company.
- *Community Engagement*: Successfully interacting with the local community at a grassroots level can establish a market presence for a given product. Foreign companies especially require early community engagement to proactively define the perception of the venture. Ventures that have brick and mortar locations with approachable representatives for potential customers can talk to tend to be better received, particularly in rural areas. For low-cost (and hence, low-margin) consumer products, this grassroots engagement strategy is onerous but critical to increasing sales and getting traction.

2.8 Product Quality Control

A lack of reliable manufacturing and distribution channels are two areas that can potentially compromise quality control, particularly in areas with poor infrastructure. As mentioned in Part 1, without consistent product quality, ventures are unable to build the trust in

their brand that is important for word-of-mouth marketing and increased sales. This study identified a wide range of quality challenges: locally-assembled products that failed because of worker training and discipline issues; imported farm implements that were of excellent quality in the first shipment but poorer quality in subsequent shipments; and low quality raw materials that negated the good manufacturing practices of vendors.

2.9 Organisational Structure

Ventures that lack clear roles and responsibilities for their employees often fail to operate effectively on the ground. Ventures must identify specific needs and hire the personnel eager and capable of effectively implementing the venture’s business strategy. Poor organisation complicates the decision-making process and decreases the odds of successfully navigating the implementation phase. The study identified several instances where the senior manager who was around made decisions for the day, leading to poorly-informed as well as inconsistent decisions. Some companies, especially in Kenya, had fairly elaborate organisational structures and advisory boards with complex rules, guidelines, and procedures. On closer examination and interviews, it was apparent that few of the guidelines were actually followed by the advisory board and decisions were made by 1 to 3 executives without consultation with other senior personnel.

2.10 Competition Management

Agricultural technology ventures encounter many situations during implementation in emerging economies where intellectual property protections are not respected or enforced. In such situations, competition management often involves overcoming challenges from counterfeit designs. This study found examples of many ventures that were unable to understand the competitive landscape of their technology and were eventually completely marginalised in the marketplace by cheap imitation products. A common approach of the counterfeiting companies was to provide higher sales commissions to retailers. Several small companies and vendors recounted instances of customers coming with workmen to study and photograph the technology product and then making it themselves in carpentry or metalworking shops. For more complex products that could not be fabricated by local workers, it took just a few months for cheap knock-offs from “China” to appear. While duplicate products were not always from China, they were always attributed to China. On a different note, technology ventures were often unaware of, or downright ignored, other local firms making similar products. There were a few instances of collaborations amongst competitors but for the most part, the concept of collaborating with a competitor was frowned upon.

2.11 Team Dynamics and Incentives

Intra-team dynamics directly impact the effectiveness of every organisation. In particular, FVC ventures in emerging economies typically involve a diverse set of stakeholders with different levels of engagement and responsibility. In order to optimise team dynamics, a venture must evaluate how each employee contributes to the venture and what their incentives are for this involvement. This study identified a very large number of projects that failed because the team either had internal conflict or a key member left.

2.12 Trust Management

Managing trust between internal and external stakeholders is paramount in developing countries, particularly for ventures championed by people perceived as outsiders. Ventures fail when they do not develop strategic partnerships to build and maintain trust in their brand and technology amongst the stakeholders. Without this trust, customers will not be interested in an unfamiliar product with no local credibility, and the venture may fail during the implementation phase. Trust is paramount in all personal and professional undertakings because farmers as well as micro-entrepreneurs prefer to work with people they know and trust at the expense of reduced profits or new customers.

3 FAILURE MODES DURING THE MATURITY PHASE

Figure 2 captures the failure modes during the maturity phase. While many of the failure modes in the implementation phase are relevant in the maturity phase, seven additional failure modes emerge once the product has an established market presence and steady sales.

3.1 Stakeholder Management

Important decisions must be made regarding the engagement of various stakeholders as a venture evolves. While certain stakeholders may be required during start-up and implementation, they may be unnecessary, or even detrimental, at advanced phases of the venture. For example, while non-profits might be involved in early stages to understand customer needs, field-test new products, and find a product-market fit, manufacturers and distributors assume more importance as the venture reaches steady-state operations. Conversely, expansion of business operations may necessitate additional stakeholders with specific expertise like supplier quality control, risk management, and franchise development. Ventures fail when they don't re-evaluate their stakeholder relationships on a continual basis and take a practical and strategic approach to building and nurturing practical relationships.



Figure 2: Challenges encountered by agricultural technology ventures during the maturity phase

3.2 Marketing

Marketing can be particularly difficult when the majority of targeted end-users live in rural areas. Non-traditional platforms and channels must be leveraged to consistently reach relatively obscure customer segments. Ventures that rely on traditional Western marketing techniques (e.g. billboards on busy roads or television ads) often fail to reach their customers in rural areas. Furthermore, marketing strategies like these are costly and potentially fatal to a venture if it does not receive a significant return on the investment. This study found that, for many successful enterprises, marketing was intricately connected to developing relationships with customers and empowering them. For example, traditional credit cooperatives were much more successful than MFIs because they employed business development officers whose job was helping communities organise themselves and save money. Social media like Facebook and WhatsApp were incredibly popular and cost-effective ways to reach the urban as well rural customers. Ventures failed because they did not proactively cultivate their markets with practical, long-term, customer-centred approaches.

3.3 Management

The initial management structure used by a venture may not be ideal as the venture moves into the maturity phase. If a venture is seeking to expand to new regions or reach a different market, it should consider the constraints of its current structure and employees. Ventures failed when they did not candidly re-evaluate the goals, team strengths and dynamics, and management styles necessary to sustain and grow the organisation. This study observed numerous cases of failure when the visionary entrepreneur did not empower a management team that was familiar with working in the specific context. On the contrary, a sizeable number of the ventures we studied were started by expatriate entrepreneurs who turned over the keys to a native, and typically much more experienced, management team once the product had significant traction.

3.4 Legal Operations

In all likelihood, a venture in the maturity stage will be operating in the formal economy. This type of operation offers different set of challenges compared to legal issues during implementation. As a venture matures and becomes more profitable, regulatory scrutiny tends to increase, and ventures need to stringently follow local laws related to employment practices, product quality, etc. Emerging economies often experience various disconnects between local laws and operational norms, which presents additional legal challenges to companies. These legal challenges are compounded when ventures have legal roots in multiple countries and must abide with conflicting regulations or by stringent requirements in Western countries that reduce profits in their target market.

3.5 Standard Concept of Operations

The concept of operations (ConOps) explains exactly how a venture will create, deliver, and capture value. This concept of operations inevitably changes and fluctuates significantly during the design and implementation phase. At the point of maturity, however, a venture should have enough knowledge and information to standardise this process. Standardised operations allow for sustainable, reliable, and more efficient products and processes. This process of converting tacit knowledge on every aspect of the venture into clearly documented procedures can be instrumental as the venture evolves and experiences employee turnover. Ventures often failed because they were unable or unwilling to document and standardise this process. As ventures grew and sales increased, they needed more employees dedicated to quality control across the organization and external vendors. These increased overhead costs decreased the profit margins and led to reduced sales.

3.6 Continued Innovation

A mature venture will attract competition attempting to replicate its success. Continued innovation allows a venture to maintain and improve its market share and enhance its competitive advantage. As is the norm in the Western world, ventures failed when they did not prioritise research, development, and continual innovation.

- *Increase Venture Efficiency:* Once in the maturity phase, a venture should have enough data and experience to optimise their process of value creation and delivery. This will maximise productivity and thus profitability. This study found that several ventures failed because they were not responsive to evolving customer needs and did not strive to periodically improve their products and processes.
- *Strategies for Growth:* A venture in the maturity phase should continuously research new market opportunities for growth and revenue diversification. Such opportunities may not have been feasible earlier in the lifecycle, but a mature venture can take advantage of experience and credibility to further expand operations. In the agricultural sector, there are often additional complimentary activities that ventures could perform by expanding into adjacent FVC activities. For example, an agriculture production venture may be able to add value by expanding into processing technologies (e.g. canning or desiccation after production). Ventures that do not strategise for continued growth and innovation consistently lose market share to new competition that is willing to innovate.

3.7 Supply Chains

Agriculture technology ventures operating in the developing world inherently face unique and complicated

supply chain challenges. For example, typically the majority of the target market lives in rural areas with poor infrastructure. Such constraints affect the manufacturing, assembly, and distribution of products. These issues are important throughout the venture lifecycle, but ventures can fail during maturity if they are unable to overcome surprise supply chain disruptions, develop backup options, and sustain their operations at scale despite supplier shortcomings. Quality control, management inadequacies, and high transportation costs were cited as major contributors to supply chain irregularities. At the same time, there was wide recognition that improved infrastructure is bringing down transportation costs and evolving educational systems and professional development programs focused on small business are strengthening businesses and supply chains.

4 CONCLUSION

This two-part article discusses common failure modes of agricultural technology ventures in developing countries. Since the development of this taxonomy three years ago, it has been validated by technology entrepreneurs as well as academic experts in several countries across Sub-Saharan Africa and South-East Asia. Nevertheless, this taxonomy will remain a work-in-progress as additional success modes and failure modes are understood, articulated, and integrated. By far, the largest challenge faced by this study was the hesitation amongst entrepreneurs and FVC actors to share their failures and challenges. Building an open culture that celebrates failure just like it celebrates and rewards success will help strengthen this taxonomy and accelerate the design and commercialisation of agricultural technologies to empower the hundreds of millions of smallholder farmers and actors across food value chains in developing countries.

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6 REFERENCES

Barrett C 2008, ‘smallholder market participation: concepts and evidence from eastern and southern Africa’ *Food Policy*, vol. 33, no. 4, pp. 299-317, <http://science.direct.com/science/article/pii/S0306919207000607>

Barrett C 2008, ‘Smallholder market participation: concepts and evidence from eastern and southern Africa’, *Food Policy*, vol. 33, no.4, pp. 299-317, <http://science.direct.com/science/article/pii/S0306919207000607>

Barrett C, Reardon T, Webb P 2001, ‘Nonfarm income diservication and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications’, *Food Policy*, vol. 26, no. 4, pp. 315-331, <http://science.direct.com/science/article/pii/S0306919201000148>

Contractor FJ, Lorange P 2002, *Cooperative Strategies in International Business: Joint Ventures and Technology Partnerships Between Firms*, Elsevier Science, Oxford, UK

Copley A, Eckard C, DeReus A, Mehta K 2013, ‘Business strategies for agricultural technology commercialization’, NCHIA Annual Meeting, VentureWell, Washington, DC, http://researchgate.net/publication/257142640_Business_Strategies_for_Agricultural_Technology_Commercialization

Dzombak R, Mehta K, Butler P 2015, ‘An example-centric tool for context-driven design of biomedical devices’, *Advances in Engineering Education*, vol. 4, no. 3, pp. 1-32, <http://eric.ed.gov/?id=EJ1076145>

Food and Agriculture Organization of the United Nations (FAO) 2014, *Developing Food Value Chains – Guiding Principles*, Rome, <http://fao.org/3/a-i3953e.pdf>

Gomez M, Barrett C, Buck L, De Groote H, Ferris S, Gao H, McCullough E, Miller D, Outhred H, Pell A, Reardon T, Retnanestri M, Ruben R, Struebi P, Swinnen J, Touesnard M, Weinberger K, Keatinge J, Milstein M, Yang R 2011, ‘Research principles for developing country food value chains’, *Science*, vol. 332, no. 6034, pp. 1154-1155, <http://science.sciencemag.org/content/332/6034/1154>

Gustavsson J, Sonesson U, Cederberg C, Otterdijk R, Meybeck A 2011, *Global Food Losses and Food Waste: Extent Causes and Prevention*, Food and Agricultural Organization, Rome, <http://fao.org/docrep/014/mb060e/mb060e.pdf>

Maley S, Perez A, Mehta K 2013, ‘The significance of implementation strategy for scaling-up base of pyramid ventures’ NCHIA Annual Meeting, VentureWell, Washington, DC, http://researchgate.net/publication/257142953_The_Significance_of_Implementation_Strategy_for_Scaling-Up_Base_of_Pyramid_Ventures

Norman D 1998, *The Invisible Computer: Why Good Products Can Fail, the Personal . Computer is so Complex, and Information Appliances*, MIT Press, Cambridge, MA

Organisation for Economic Co-operation and Development 2012, *OECD-FAO Agricultural Outlook 2012*, OECD Publishing, Paris, http://oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2012_agr_outlook-2012-en

OECD and World Bank Group 2015, *Inclusive Global Value Chains: Policy Options in trade and complementay areas for GVC Integration by small and medium*

- enterprises and low-income developing countries*, prepared for the G20 Trade Ministers Meeting, Istanbul, Turkey, <http://oecd.org/trade/OECD-WBG-g20-gvc-report-2015.pdf>
- Osterwalder A, Pigneur Y, Clark T 2010, *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Wiley, Hoboken, NJ
- Polak P 2008, *Out of Poverty: What Works When Traditional Methods Fail*, Berrett-Koehler Publishers, San Francisco
- Russel R 2004, ‘Pumping prosperity’, *Stanford Social Innovation Review*, Stanford University, Palo Alto, CA, http://ssir.org/pumping_prosperity
- Schultz J 2010, ‘A baby incubator made from car parts’ *New York Times*, 23 November, <http://wheels.blogs.nytimes.com/neonurtures-car-parts-baby-incubator>
- Suffian S, De Reus A, Eckard C, Copley A, Mehta K 2013, ‘Agricultural technology commercialization: stakeholders, business models and abiotic stressors: part 1’. *International Journal of Social Entrepreneurship and Innovation*, vol. 2, no. 5, pp. 415–437, http://researchgate.net/publication/266385204_Agricultural_technology_commercialisation_stakeholders_business_models_and_abiotic_stressors_-_part_2
- USAID Bureau For Food Security 2011, *Agricultural Technology Adoption and Food Security in Africa Evidence Summit*, USAID, Washington, <http://agrilinks.org/agexchange/agricultural-technology-adoption-food-security-africa-evidence-summit>
- World Bank 2010, *Building Competitiveness in Africa’s Agriculture*, The World Bank, Washington, DC, http://siteresources.worldbank.org/INTARD/Resources/Building_Competitiveness_in_Africa_Ag.pdf
- World Bank 2011, *Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa*, The World Bank, Washington, DC, http://siteresources.worldbank.org/INTARD/Resources/MissingFoods10_web.pdf
- World Bank 2014, *Making Global Value Chains Work for Development, International Bank for Reconstruction and Development / The World Bank*, Washington, DC, <http://siteresources.worldbank.org/EXTPREMNET/Resources/EP143.pdf>
- World Economic Forum 2009, *The Next Billions: Business Strategies to Enhance Food Value Chains and Empower the Poor*, World Economic Forum, Geneva, <http://weforum.org/reports/next-billions-business-strategies-enhance-food-value-chains-and-empower-poor/>