Resolving the Post-Harvest Loss Paradox:

Private Sector Solutions and Aid Agency Engagement

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Abstract

Excessive amounts of post-harvest loss (phl) in developing countries has recently regained attention as a serious issue. Such excessive losses have been known to exist for decades. The continued existence of this problem is frustrating in light of numerous pilot efforts that document availability of technology solutions, typically with a positive value proposition for both potential users and for suppliers. Further, these technologies are routinely employed in developed country settings.

The resulting PHL paradox is that, despite evidence of the value proposition, private sector actors don't tend to emerge to take advantage of the economic benefits associated with technology solutions to post harvest loss. This paper identifies the means by which institutional voids (absent or under-developed foundational structures and systems enabling market transactions) contribute to the existence of the PHL paradox. Further, employing case-based research results, the paper identifies the key catalytic role aid agencies entities can play to foster creation of markets. Effective markets can become the vehicle needed to make needed technologies available–in both in the short- and long-run. Three managerial implications are described.

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In recent years, post-harvest loss (PHL)–the amount of food lost between that which is grown and that available for consumption–has been identified as a significant problem. This is especially the case for agricultural systems in developing countries. A commonly cited reference point, attributed to a UN FAO report, is that about 1/3 of total agricultural production is lost because of post-harvest loss (Gustavsson et.al., 2011). This is not a new problem: excessive loss has been recognized for decades. Indeed in 1975 at a UN Conference on food security, then US Secretary of State Henry Kissinger stressed society's need "to reduce the tragic waste of losses after harvest from inadequate storage, transportation, and pest control" (Kissinger, 1975).

While this problem is not new, it seems to be stubbornly persistent; even though:

- Technologies and practices are available which can effectively reduce post-harvest loss,
- Appropriate technologies, although unfamiliar where post-harvest loss levels are high, generally are "low-tech" in terms of their application, and
- Numerous pilot projects have demonstrated the significant economic benefits which can accrue to adoption of loss reducing technologies and practices.

The resulting PHL paradox is that, despite evidence of the value proposition, private sector actors don't tend to emerge to take advantage of the economic benefits associated with technology solutions to post harvest loss. Without such actions the products and services needed for sustained mitigation of post-harvest loss aren't available. This is in contrast to developed country contexts, where well-functioning markets result in new technologies creating a value proposition that fosters action by managers and entrepreneurs.

Purpose of this article:

This article reports findings of an on-going research project focused on the role of enterprise and markets in sustainably reducing post-harvest loss.[1] The purpose is to suggest that the factors necessary

[1] This project is financially supported by the Rockefeller Foundation through its YieldWise Initiative and by the Ed Snider Center for Enterprise and Markets at the University of Maryland.

to mitigate the PHL paradox are not confined solely within the economic parameters controlled by private sector actors. To accomplish that goal, the article will:

- Identify what economists call institutional voids as a major factor contributing to the existence of the PHL paradox.
- To illustrate, with experience from actual cases, how aid agency actors can effectively intervene to overcome such voids by creating for-profit, private sector solutions and, in so doing, enable sustained interventions to effectively reduce post-harvest loss.

Markets and Institutional Voids:

As consumers, we are active participants in markets whether we buy food produced by farmers at the village market, or the grocery store. Economists consider markets to be areas of economic activity where buyers and sellers come together (physically or virtually) and the forces of supply and demand affect prices. While markets have been robustly observed since the dawn of civilization, the processes through which markets are created and evolve are less observable and less well-understood.

Much of what we understand regarding the emergence of markets is based upon experience within developed economies and is focused on the purposeful actions undertaken by potential buyers and suppliers. However, surrounding each market is a set of factors that facilitate or impede the ease by which buyers and suppliers can conduct transactions. Economists refer to these factors as institutions and they are quite varied in nature. The availability of credit both for suppliers to operate and buyers to make purchases is one such factor. Regulations, contract and labor laws, and safety requirements are others. Infrastructure, such as the quality of roads and access to wireless, affect the ease by which markets can operate. Although varied, institutional voids occur when the foundational structures and systems enabling market transactions are absent or under-developed. These voids preclude potential demand from being addressed through entry by potential suppliers, even though possibly rewarding value propositions may exist. We note that although the term void suggests complete absence, in actuality institutions generally exist to some extent. In this context, institutional voids exist when deficiencies in institutional effectiveness inhibit private sector initiatives from establishing needed markets.

Case study settings:

This paper explores the process by which targeted interventions overcame institutional voids to establish important markets in two developing country settings. Because our focus is the PHL paradox, the primary case focuses on establishment of the market for grain-storage metal silos in Central America during the 1980s and 90s. However, we also draw insights from our examination of the initiation of mobile money in Africa during the early 2000s—this other case relates to a similar paradox in the context of a technology solution to a financial need. Each will be briefly described in the following paragraphs. (More detailed descriptions can be found in Shah, et.al. (2017).)

In each setting, an aid agency initiated efforts that resulted in market creation to address specific needs in the developing world. Prior to these efforts, no firms satisfying these needs operated in these markets, and, accordingly, no industry satisfying these needs existed in these regions.

Metal Grain Silos: In the mid-1970s, a critical issue affecting Central American countries was unsuitable storage infrastructure. This resulted in grain losses of up to 30% of the harvest. Socio-economic challenges resulted because small farmers had to sell their crops cheaply at harvest and then later buy grain for personal consumption at higher prices (Schneider, 1997). Spurred by these needs, the Swiss Agency for Development and Cooperation (SDC) initiated the Postcosecha (Spanish for post-harvest) program in Central America. Conducted from 1980-2003, the program identified potential entrepreneurs from the local population of farmers and artisans, who then received significant support from SDC to help develop their business capabilities and engage within the emerging industry ecosystem. Figure 1a illustrates the diffusion path for metal silos across four countries. These sales take-off and diffusion curves are characteristic of market evolution (Agarwal and Bayus, 2002). Notably, the adoption of metal silos increased even after SDC's project ended in 2003. Across the four countries, metal silos accounted for 21 percent of the stored grain by 2009; resulting in an estimated savings of almost 100 million US dollars from reduction in post-harvest loss over the program period. Further, the program effectively created almost 900 metal silo producers, accounting for 15 million US dollars of gross profit (Fischler, 2011).

Mobile Banking: Among the correlates of poverty identified in the United Nations Millennium Summit, a key factor in Sub-Saharan Africa was the lack of stable financial institutions. Less than 20 percent of households in the early 2000s had a bank account, impeding not only consumption and savings activities, but also making it difficult to secure financial credit to engage in entrepreneurship or business activity (Hughes & Lonie, 2007). Recognizing this need, the U.K. Department of International Development (DFID) created the Financial Deepening Challenge Fund. In 2003, DFID engaged with Vodafone, an established multinational firm in telecommunications, who matched the DFID funds with people, technology and complementary resources to develop M-Pesa (M for mobile; pesa is money in the Swahili language). This innovation effectively combined mobile communications with banking services (Hughes and Lonie, 2007). Figure 1b depicts the take-off and growth in the number of registered users for M-Pesa through 2014. By 2009, M-Pesa had reached 65 percent of Kenyan households (Buku & Meredith, 2013).

Implications for decision makers:

Recognition of the effect of institutional voids provides insights which decision makers can employ to overcome the PHL paradox. This discussion will cite experiences from the two case settings noted above to illustrate the following three implications:

- Pilot projects often don't scale
- Initial assumptions should yield to insights from field experimentation
- Focus on circumventing the institutional voids that matter

Again, more complete analyses supporting these insights are provided in Shah, et.al. (2017).

Pilot projects often don't scale:

When a technology or practice that is novel in a particular setting is being considered as a means to address a widespread problem, it is prudent and practical to undertake pilot efforts to test the viability

of the innovations.[2] Therefore aid agencies and other entities routinely conduct small-scale pilot efforts as a key initial step. Particularly in applications where the new technology provides economic benefits, it is presumed that the demonstration of such benefits will foster scaled adoption of the innovation.

Of course, not all pilot efforts are successful. An even more frustrating experience is when the results of the pilot efforts are attractively positive, but scaled adoption does not follow. The concept of institutional voids is an informative lens in which to consider this latter circumstance. It is natural for the primary focus of a pilot effort to demonstrate that the technology works and, if it does, document the benefits of employing it. Although the term, institutional void, probably isn't used, it is very likely that the detrimental effects of those factors are recognized. Where necessary, the external resources within the pilot project are employed to successfully overcome those detrimental factors. However, overcoming the institutional voids in the pilot effort doesn't eliminate those voids overall.

The SDC effort in Central America for the reduction of PHL led to establishment of a market for metal silos to store grain. Further, it illustrates how such an intervention can mitigate institutional voids, even after the project ends. Central to the notion of a market is that both buyers and suppliers are needed. After testing the technology's effectiveness, the SDC pilot documented that small-hold farmers would benefit by purchase and use of this technology. However, no suppliers existed. The pilot project itself had provided the silos for use in the pilot but no system for effective supply was present. Indeed a prior effort undertaken several years before (not conducted by SDC) had shown similar potential benefits. However, market development failed when inadequate materials were used to construct the silos, leading to spoilage of the stored product.

Figure 2 illustrates the need for development of a supply chain that can effectively operate beyond the limited timeframe of the pilot project. The horizontal bar depicts that supply chain for the agricultural product of interest–from production to the market (or to consumption in the case of subsistence farmers). Often attention is focused on this supply chain, because its effective operation is the means by which the farm family generates its food supply and/or income. However, for PHL reduction in the supply chain, the use of metal silos needs to expand to farmers not in the pilot project. Therefore, attention needs to also focus on how a supply chain for metal silos can be created, because this complementary supply chain is not likely to emerge spontaneously.

Indeed in the Central America setting, numerous factors (institutional voids) had to be overcome in order to develop a functioning metal silo supply chain:

- Government import tariffs raised the price of sheet metal needed for the silos.
- The one, large-scale potential supplier had a cost structure which precluded effective service for small-holder farmers.
- While rural artisans and farmers had the potential to be small-scale suppliers, they lacked the experience, training and managerial capacity needed to become effective suppliers.

The SDC response was to undertake a careful and extensive effort to establish a supply chain for metal silos based upon small-scale suppliers – the tinsmiths. After careful selection, candidate tinsmiths were

[2] Interventions to reduce post-harvest loss often combine introduction of a new-to-the-setting technology and practices. For simplicity, only the term technology will be employed here even though it is recognized that practices likely will be affected as well.

trained both in the practice of physically building silos. As importantly, the candidates learned the skills necessary to establish a business which would effectively serve small-hold farmers. Efforts were undertaken to achieve reduced tariffs and to link tinsmiths with appropriate sheet metal suppliers. As suppliers, tinsmiths were responsible and rewarded for building, distributing, marketing and customer service. The SDC maintained a quality control presence as the market emerged to ensure farmer satisfaction and to enable feedback to generate supplier improvement. The incentive to grow the individual tinsmith business led to expanded and sustained adoption of metal silos far beyond the parameters of the pilot efforts and beyond the end of the overall project.

Initial assumptions should yield to field experimentation:

Intervention by aid agencies with the goal of reducing post-harvest loss seldom occur spontaneously or without serious planning and review of prior initiatives. Further the implementers in the field generally are led by experienced development professionals. Despite those factors, in-the-field experimentation is necessary to identify those institutional voids of particular relevance and to learn how to most effective respond to those challenges. Examples of the need to learn from experimentation can be found in both of the settings of interest in this paper.

Relative to the grain storage setting, the first step SDC initiated was to understand grain storage requirements by conducting in-home visits with rural families. They researched and tested several storage technologies under real-life conditions (Bravo-Martinez, 2009), including dry racks, traditional and stilt raised storehouses (Schneider, 1997). After several years of experimentation, during which the program was called to question due to lack of concrete results, a breakthrough came with the use of the sheet metal silo which nearly eliminated storage losses. Interestingly, the technology had been used by farmers before, but their use had been discredited and discontinued due to poor manufacturing quality and improper handling (Schneider, 1997, p. 5). Also, because of the absence of an effective supply chain, the high costs of the silos initially limited the viability of the technology for the small-hold farmer (Cherrett, 2005). Nonetheless, SDC determined that if properly constructed and appropriately sourced/priced, metal silos provided the best benefits-to-costs outcomes.

In the mobile money setting, given the success of micro-finance efforts in developing countries, the initial focus of the M-Pesa effort was to employ mobile banking technology in support of microfinance projects. Engaging with clients of the micro-finance partner Faulu, pilot efforts gained insights on the loan repayment process: borrowing entrepreneurs meet in small groups each week to submit cash to a treasurer. Given few local banking institutions, depositing the cash in the bank often involved long bus journeys in a country where highway robbery is not uncommon, so some entrepreneurs had to accompany the treasurer as bodyguards (Hughes & Lonie, 2007). As importantly, the pilot projects unearthed key latent needs. Kenya's urban migrant workers needed to "send money home" to their rural families (Buku & Meredith, 2013). As a result, even though Faulu's clients were recruited to help identify microfinance loan processing needs, experimentation and entrepreneurial behavior *by the clients* revealed alternative uses of M-Pesa. The pilot recruits were highly creative, using it to repay other people's loans in return for services and for trade payments between businesses. Larger businesses used M-Pesa as an overnight safe because agent shops were open later than banks. Several people used M-Pesa for safekeeping during journeys by depositing cash in one area and withdrawing it at destination, and sent airtime purchased with M-Pesa to relatives across the country as a form of remittance (Hughes & Lonie, 2007, p. 76). These uses continued months after the pilot program officially

ended on May 1, 2006. Meanwhile, coordination challenges created concerns regarding scalability and viability of the primary focus on microfinance activities.

Taken together, Vodafone and Safaricom realized the true value proposition: M-Pesa could help consumers manage *their personal finances* (Allen, 2013; Hughes & Lonie, 2007). "For Safaricom, the big opportunity was to extend its service into a completely new kind of business as a Payment Service Provider… For Vodafone, it became clear that the M-Pesa system formed the basis of a low cost International Remittance Service [a $300 billion business] (Hughes & Lonie, p. 77)." DFID was supportive of the pivot (Allen, 2013); likely because the repositioning provided even better outcomes towards the goal of enabling universal access to financial services to the unbanked poor.

In both settings noted here, experimentation proved to be essential. While documenting that the underlying technology would work in a technical sense, the greater value was in identifying key institutional voids, which, if not addressed, would limit the sustained implementation of the technology. For metal silos, such voids related to the absence of an economically viable supply chain. Relative to M-Pesa, voids were discovered which caused a fundamental shift in focus from microfinance to managing personal finance.

Experimentation, particularly that which results in learning that challenges original program assumptions, needs the active support of leadership. In the two settings described here, program leaders had strikingly similar philosophies regarding discovery and experimentation:

- **Metal Silos:** Schneider (1997) notes "*the project observed and studied with precision the post-harvest activities of* small *farmers to understand them as part of a farm production system"* and says "*the deciding step, however, was taken by the farmer, in that he weighed the advantages and disadvantages and finally decided whether he saw the change as an improvement and therefore adopted it (p. 11-12)."*
- **M-Pesa:** Hughes and Lonie (2007) state *"sitting in a comfortable office in England and deciding what Africa needs is an approach doomed to failure. The market is littered with first-world solutions that have utterly failed in emerging economies,"* and acknowledge, *"We had no roadmap, but created solutions as we went and persevered when a pilot slated to take several [2] months took almost two years (p. 64, 68-69)."*

<u>Focus on ***circumventing*** the institutional voids that matter</u>

Economic activity in developing countries, almost by definition, is constrained by a multitude of institution voids that often time appear nearly insurmountable to the external observer. An important finding from metal silos and M-Pesa is that successful intervention involved devising work-arounds that allow the focal market to function, even if not remedying the institutional void for the economy at large. We refer to this behavior as circumvention.

Both the metal silo and M-Pesa efforts illustrate means by which institutional voids can be mitigated through specific work-arounds. Here, two examples are described for each effort.

Lack of affordable raw materials and the lack of a supply chain to produce, distribute and service metal silos in rural areas were two key impediments to scaled adoption. Import tariffs on imported sheet metal were a key factor raising the cost of raw materials. SDC, in collaboration with government actors,

were able to reduce tariffs for sheet metal employed to make metal silos. The lack of suppliers for metal silos required more extensive and longer-term action. Identification of trusted farmers and artisans in rural areas, with the potential to become tinsmiths was only a first step. Education and training for those the potential artisans included the physical actions need to construct silos and the managerial capabilities to establish businesses producing and marketing silos. Further, for a number of years during the project, SDC undertook a quality control function in the supply chain to ensure the silos farmers purchased performed at an adequate level.

A key similarity between the metal silo and M-pesa examples is the almost complete lack of a market prior to the intervention. Prior to M-pesa, the financial sector in rural Kenya was underdeveloped, fraught with inefficiencies, and lacked adequate statutory and legal frameworks. The project lead entities (UK-DFID, Vodafone and Safaricom) collaborated with the Central Bank of Kenya to create sensible rules and regulations focused on the provision of mobile money services. Further the financial service needs of rural Kenyans are extensive. However, the M-pesa project identified the high priority factors (facilitating urban to rural remittances, the potential for theft, and short banking hours) and developed products to resolve those high priority institution voids.

In each instance, the institutional void addressed was symptomatic of economy-wide deficiencies, whether in education, regulation, or legal/statutory frameworks. However, rather than attempt to "solve" the general deficiency, the aid agencies and their partners undertook targeted actions to successfully overcome the challenge in their sector.

Concluding remarks

Reducing the excessive amounts of post-harvest loss (phl) in developing countries has the potential to increase farmer incomes, enhance food security and lessen the environmental efforts of agriculture. While possibly more urgent today, the reality of the prior sentence is not new. The continued existence of this problem is frustrating in light of the numerous pilot efforts that both document technology solutions to can reduce post-harvest loss AND offer a positive value proposition.

Such pilot efforts are essential. However we need to ensure that pilot efforts move beyond a purely technical focus and the assumption that an attractive value proposition will guarantee scale adoption. More creative solutions which resolve institution voids, not just for the pilot, but also in the markets for products and services that must be developed. Collaboration of aid-agencies and private sector actors can effectively circumvent those institutional voids during the market creation process.

Figure 1: Diffusion of technologies (Metal Silos, Honduras and M-pesa, Kenya)

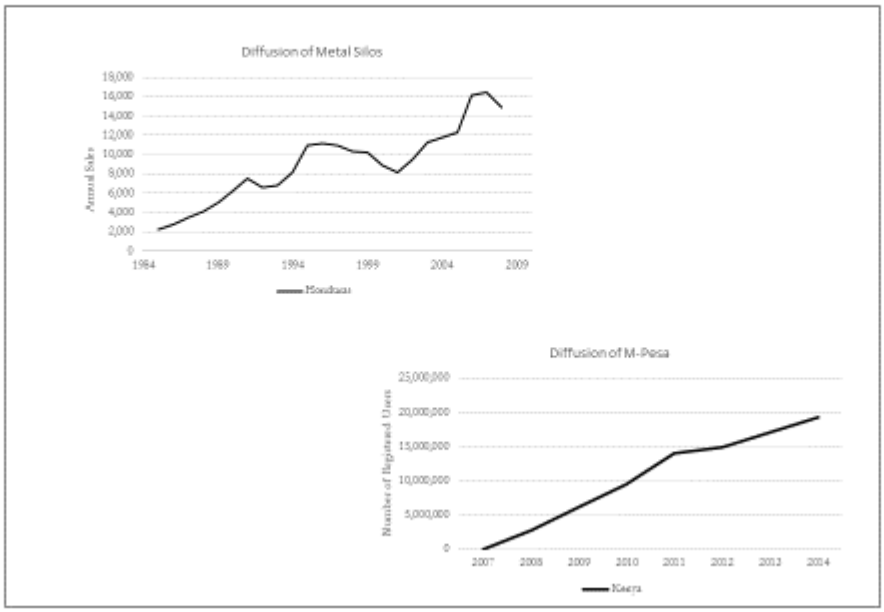
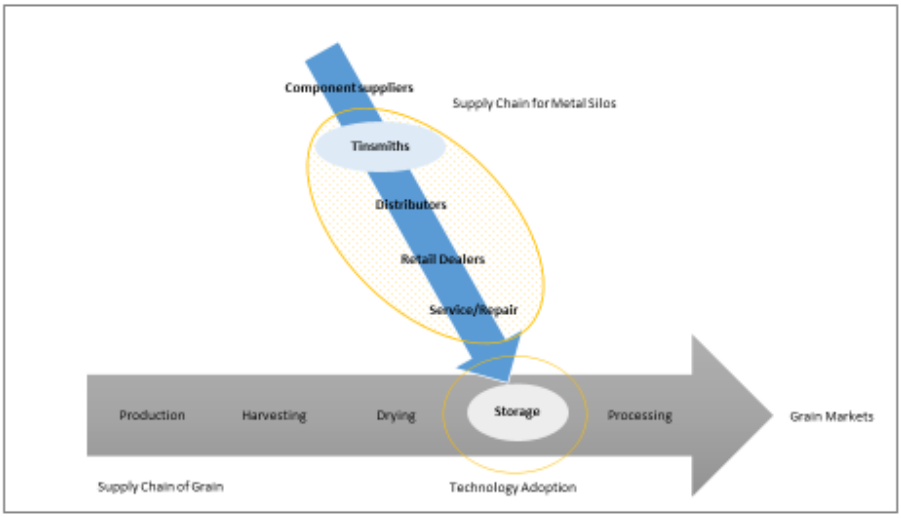


Figure 2: Components of the supply chain for technology of interest (Sonka, et.al., 2015)



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