# An Analysis of the Hidden Variables Influencing the Challenges and Opportunities of Implementing R&D and Value-Chain Agricultural Public–Private Partnerships in the Developing World

# Prepared for the Syngenta Foundation of Sustainable Agriculture and International Development Research Centre

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### 1.0. Introduction

This is a working paper designed to provide background information on public–private partnerships (PPPs) in agriculture designed to alleviate hunger and poverty in the developing world. There are four objectives to this paper: first, to provide information on the characteristics of PPPs not otherwise available in the public domain in order to provide a practical perspective on what is required to create and operationalize these organizational structures; second, to illuminate the incentives, constraints, enablers, and hidden costs associated with creating and managing agricultural PPPs in the developing world; third, to determine the characteristics that separate upstream research and development (R&D) PPPs from downstream value-chain PPPs; and fourth, to compare and contrast the findings of this paper to previous research on this subject.

The term public–private partnership (PPP) refers to any collaborative engagements between public, private, and not-for-profit actors or institutions (Kernaghan, 1993: 57–60). PPPs allow for the division of labour and authority and a sharing of human and financial resources under a single organizational structure in the pursuit of common goals and outcomes (Vieira and Hartwich, 2002: 30–31). The pooling of public and private resources in a PPP structure adds value to any given process by exploiting the comparative advantage of each partner (Van de Meer, 2002: 123–37). Specifically, PPPs facilitate collaboration between heterogeneous partners by developing trust, which engenders the creation of interdependencies and the formation of networks of shared interests, which together lower the transaction costs of collaboration (McQuaid, 2000: 9–11).

For the purposes of this analysis, we distinguish two main categories of PPPs. First is the R&D PPP, and second is the value-chain PPP. The R&D PPP is focused on developing upstream breeding technologies to develop higher-yielding varieties through enhanced abiotic and biotic

stress resistance (Boettiger, 2011). The objective of R&D PPPs is to facilitate the transfer of private sector technology to developing world countries in order to compensate for their lack of scientific capacity (Pray, 2001: 2–7). This PPP exists as a technology transfer mechanism, linking private sector assets with developing world technology needs. The R&D PPP is a structure that protects the private sector's IP investments by creating and implementing a regulatory regime that uses IP tools such as plant variety protection and patents to facilitate R&D-based technological innovation (Kock, 2011). This PPP provides both an incentive for innovation and a means to attract investment by offering a structure and process that captures the benefits of the value-added R&D process (Ibid).

Conversely, the purpose of the value-chain PPP is to link local developing world farmers into global distribution systems for both inputs and outputs (Boettiger, 2011). The value-chain PPP seeks to create local networks as a means of developing the capacity to export commodities to developed world markets. Essentially, the value-chain PPP organizes the "bottom billion" into local and regional value and supply chains in a process of integration into the global economy. Due to the lack of efficient markets and stable political systems, the value-chain PPP develops local capabilities to provide end-users with assurances of product quality and safety, compensating for the lack of economic and political transparency (Poulton and MaCartney, 2012: 2–3). Additionally, value-chain PPPs develop local governance capacities to facilitate the creation of rules-based and transparent supply-and-demand markets.

The methodology used is interviews with the people directly involved in the PPPs. Therefore, the content of this paper reflects the opinions and viewpoints of experts and practitioners actively involved with agricultural PPPs in the developing world. This provides the readers of this paper with insiders' perspectives on the challenges and opportunities associated with agricultural PPPs. To facilitate open and free discussion, the interviewees and their organizations were promised confidentiality, meaning their statements could not be traced back to them or their respective organization. This contributed to determining the format of this paper; in place of a number of discrete case studies, this paper focuses on the big picture in order to recognize patterns that occur in multiple PPPs.

There are a number of factors that may influence the interpretation of the results, and these warrant review. A total of 90 individuals working with 67 PPPs were contacted for interviews. Based on the responses, 20 individuals with 9 PPPs—involving 10 private sector and 8 public sector organizations—were interviewed for this research paper, representing a small sample size. While this may be due to a limited timeline in which to complete the interviews, there appears to be a reluctance of PPP practitioners to speak to the research community, even under conditions of strict confidentiality. This influenced the trajectory of this paper, as the original intent was an analysis of value-chain PPPs only. The low response rate from people

involved in value-chain PPPs meant that in order to conduct rigorous analysis, responses from people in both value-chain and R&D PPPs are included. Of the PPPs covered by the survey, the majority are based in Africa, but all are global in structure and process.

None of the PPPs examined for the paper have reached long term sustained operations; each one is a work in progress, a matter that will be explored in section 3. PPPs are a relatively recent phenomenon in the developing world. The PPPs in this study were drawn from a database available on the Syngenta Foundation for Sustainable Agriculture website.<sup>1</sup> The majority of the partnerships have been formed within the last 5–7 years, suggesting that the majority of agricultural PPPs in the developing world are still in relatively early stages of development.<sup>2</sup>

The organization of this paper is as follows: The PPP is grounded in the theory of knowledge development and the theory of innovation, both of which are critical to understanding how PPPs manage innovation systems directed to developing agriculturally oriented technological solutions to hunger and poverty in the developing world. An analysis of the incentives, constraints, and enablers of PPPs contained in the public literature is reviewed, providing the basis for the questions used to illuminate the hidden characteristics of PPPs. An overview and analysis of the survey responses is provided. The survey questions are found at the end of Section 2.

# 2.0. PPPs in Agriculture Contextualized

One method of contextualizing the advent of the PPP is to examine the differences between the vertical concept of governing through the state and the horizontal concept of governance through heterogeneous networks. Specifically, it has been hypothesized that the culmination of neo-liberalism, austerity, the advent of the internet, and globalization has rendered the state-dominated mode of governing through laws and hierarchy impotent and has replaced it with a new model of governance (Weiss, 2000: 6–12). This new model of governance should not be viewed as a revision of the existing system of governing, but as a new system of "self-organizing networks," or governing in the absence of a central authority (Rhodes, 1995: 1). Therefore, governance is not synonymous with governing, but rather represents a radical departure from historic processes associated with centralized government. We are in an era defined by the emergence of distributed governance involving interdependence, new non-state actors, and obfuscated boundaries between previously clearly delineated sectors (Ibid). Collaborative governance depends on the use of problem-focused PPPs that facilitate the exchange of knowledge between the public, private, and voluntary sectors (OECD, 2000: 3–4).

<sup>&</sup>lt;sup>1</sup> http://www.syngentafoundation.org/

<sup>&</sup>lt;sup>2</sup> The 90 PPPs were drawn from a database of about 200 PPPs developed by the SFSA. The database is online, incorporating the start date of each PPP at: http://www.syngentafoundation.org/index.cfm?pageID=745.

One area where collaborative governance has become an emergent process is in the production of new knowledge. It has been hypothesized that there are two forms of knowledge development, one vertical, known as Mode I, and one horizontal, Mode II (Gibbons et al., 1994). Mode I knowledge development is a vertically oriented process dependent upon the development of theoretical knowledge in autonomous and isolated institutions (Ibid). Mode I knowledge development is synonymous with Rhodes's definition of hierarchal governing. Mode II knowledge is horizontal and problem focused, occurring in "heterogeneously organized" networks characterized by the dialogic nature of the process, one that is dependent on a high level of interaction between the members of the problem- and solution-focused network (Ibid). The feedback loops created by the perpetual network interactions facilitates the governance-oriented nature of Mode II knowledge development (Nowotny et al., 2003: 8–12).

Economic growth is dependent on innovation—a process of recombining existing knowledge into new forms of knowledge to generate new wealth-creating economic processes. Joseph Schumpeter is credited with defining innovation as the introduction of a new good or the enhancement of an existing good, a new method of production, the creation of a new market, the discovery and exploitation of a new supply of input materials, or the creation of a new organizational structure (Schumpeter, 1939: 59–61). Schumpeter's definition of innovation reflects a process where something new is created or adopted from an existing stock of knowledge. This provides a foundation for an analysis of the competing paradigms that attempt to explain the processes that govern innovation. This perspective looks at the three Ps of innovation: "special people" performing "special processes" located in "special places" (Leadbeater, 2005).

The "special people" innovation paradigm suggests that economic growth is dependent upon creative people seeking to be on the leading edge of technological, social, and organizational change (Florida, 2002: 1–3). This perspective suggests human and social capital underscore economic growth. Florida's three Ts—technology, trust, and tolerance—facilitate innovative recombinations of existing knowledge into new ideas. Related to this concept is the role of social and policy entrepreneurs, who, through their efforts and locations within private and public organizations, identify and implement new ideas that drive the innovation process (Campbell, 2004: 74–76; Faminow et al., 2009: 3). These individuals use their ability to negotiate and transcend the boundaries between state, business, and society to become agents of change and influence by positioning themselves to recognize new opportunities and having both the will and the capacity to mobilize change within institutions and networks. In international development organizations, social entrepreneurs are characterized by their ability to identify and/or create technological solutions to poverty; they possess the requisite ability to create networks to effect positive change (Faminow et al., 2009: 3–5).

The second perspective on innovation, the special processes, is also referred to as the innovation systems paradigm. The special processes approach posits that interdependencies between networks of firms, governments, and learning institutions generate economies of scope that engender innovation (Etzkowitz and Leydesdorff, 1995; 2000). This view hypothesizes that universities center knowledge development networks by forging links with and between government and industry (Etzkowitz and Ranga, 2009). The innovation systems theory proposes that collaboration creates the interdependencies between institutions that foster innovation. A related perspective suggests that innovation is now global and that the key to innovation-driven economic growth is developing an institutional capacity to connect local and regional capabilities to global flows of knowledge, which occur in the form of advanced technology protected by intellectual property rights (Bathelt, 2004: 31–33; Phillips, 2002). The innovation and global innovation systems viewpoints acknowledge the need for a new hybrid form of organization to link the heterogeneous partners into functioning innovation systems (Bathelt, 2004: 33; Etzkowitz and Ranga, 2009: 4).

The special places theory of innovation is based on development of clusters of firms and industries that lead to the development of national and regional economies of scale (Porter, 1990: 17). Clusters depend on four interrelated factors in order to develop a comparative advantage that generates economies of scale. The first factor is the competitive structure of a cluster that forces industries to innovate or perish. The second is a strong consumer market that provides the conditions necessary for creating competition. Third is the existence of supporting industries to create upstream and downstream value chains to drive the innovation process. The fourth factor is the recognition that special places are dependent on thick labour markets, highly developed infrastructure, and deep and established capital markets for sustained investments. Special places develop economies of scale by continued competition and by developing interdependencies between markets, and supporting industries and labour markets.

The above analysis provides a framework for contextualizing the role of PPPs in creating and managing effective agricultural research and development (R&D) innovation systems that attempt to organize researchers, organizations, and farmers into networks that create and transfer new forms of knowledge-based technology to facilitate agriculturally driven economic growth. PPPs have become the central actor in managing R&D agricultural innovation systems. PPPs use voice, trust, and reciprocity as methods of engendering collaboration. They take on the role of an intermediary by coordinating the financial, R&D, and governance activities between the public, private, and voluntary sectors (Hall, 2006: 3–7). This improves the efficacy of R&D by facilitating a more efficient rate of technology transfer, which leads to higher yields and lower input costs for producers (Hartwich et al., 2007: 55–61). The trust, transparency, and accountability developed by the horizontally configured PPP generate the higher knowledge

and technology absorption rates (Spielman and von Grebmer, 2004: 16–38). As PPPs center agricultural R&D innovation systems, they provide an institutional structure for managing the introduction of transformative agricultural technologies (Hall et al., 2010: 25–27). This suggests that PPPs are "innovation brokers" because they create linkages between developers and users of technology and provide the physical nucleus of heterogeneous configured networks (Klerkx et al., 2009: 2–4). Essentially, PPPs have become the focal point for coordinating the financing, development, and diffusion of new knowledge required for agricultural technological innovation. As innovation brokers in agricultural R&D systems, PPPs facilitate technological innovation by synchronizing the activities of the public, private, and voluntary sectors.

For their formation and for the achievement of successful and enduring operations, agricultural PPPs depend on a number of interrelated factors. One method of contextualizing the formation of PPPs is analyzing the incentives that motivate organizations, public and private, to form PPPs. Private sector organizations join PPPs to collaborate with the public sector to gain access to raw and undeveloped germplasm stocks and to local and regional knowledge systems developed by the public sector (Byerlee and Fischer, 2002: 8). This suggests that the private sector joins PPPs as a means of developing new markets in the developing world by accessing networks created by public sector institutions (Ibid: 8–10). Additionally, the private sector lacks detailed knowledge of "orphan crops" such as millet, cassava, and sorghum, so engaging in PPPs provides private sector firms with access to public experience and technology to help broaden their technical and scientific knowledge of the major crops that provide sustenance for over one billion people (CropLife International, 2009).

Similarly, the public sector's motives for joining PPPs mirror those of the private sector: the public sector seeks access to the seed development and distribution systems of the private sector in order to access cutting-edge breeding technologies and private funds (Spielman and von Grebmer, 2004: 17–18). Essentially, the public and private sectors require the technological and knowledge assets of their counterparts, a reflection of the incapacity of either sector to work alone in developing innovative technological solutions to poverty in the developing world.

Despite the many incentives to facilitate the creation of PPPs, there are a number of constraints that impede collaboration. One constraint concerns the potential for the misuse and abuse of proprietary technologies by both the public and private sector in a PPP. Specifically, the private sector may attempt to utilize public domain technologies for private gain; additionally, privately held intellectual property rights (IPRs) in the form of breeding technologies and finished varieties can be transferred, accidently or intentionally, to competitors or farmer groups, both of which can inflict damage to a firm's bottom line by threatening its market position (Spielman et al., 2007: 49–54). A second major constraint concerns the inability of the global IPR regimes to prevent the unintended and illicit transfer of proprietary technologies and knowledge

between organizations and countries; this inability inhibits collaborative ventures (von Braun, 2007: 11). A third major constraint inhibiting the development of PPPs is a dearth of experience among potential partners in developing and implementing PPPs, suggesting PPPs require a specific skill set that can only be derived through experience (Hartwich et al., 2007: 46–47). A fourth major constraint is the hidden costs of collaboration related to the time and resources required to establish trust and eliminate competition for the limited resources within the PPP (Hall, 2006: 14–15). A fifth major constraint on developing and implementing successful PPPs is the focus on short-term and medium-term results, which are generally measured by return on investment (Ferroni, 2010). The constraints identified are compounded by the lack of successful PPPs in agricultural development.

To effectively counterbalance the incentives and constraints of developing PPPs, a number of enablers have been identified in the literature. The first and probably most prominent enabler is access to sustained financing to provide the time and resources necessary to develop the relationships and the structure necessary for the long-term viability of a PPP (Warner and Kahan, 2008). A second and related key enabler requires the design of the PPP, where possible, to be capable of attracting private sector financing, suggesting that PPPs need to be profitable at some point (Ibid). A third enabler is to employ third-party entities to act as brokers between the partners to help them develop a set of goals and a plan to attain those goals in order to prevent conflict between the partners from interfering with the objectives of the PPP (Hall, 2006: 14). Fourth is to employ non-profit specialized international organizations, such as the International Organization for the Acquisition of Agri-Biotechnology Applications (ISAAA), which by design works to link the technology needs of developing countries with the technology and germplasm stocks of public and private organizations in the developed world (ISAAA, 2012). In addition to ISAAA, the Public Sector Intellectual Property Resource for Agriculture (PIPRA) and Cambia both perform a similar function by providing access to agricultural technology and organizational assistance to developing world entities seeking to build up the capacity to use the technology. This includes workshops on IP management, commercialization strategies, and forming public-private partnerships. Finally, a stable macro-political economic environment has been identified as a prerequisite for multi-sector collaboration in agricultural R&D in the developing world (World Bank, 2008).

The following analysis section is structured around asking six questions derived around the incentives, constraints, and enablers of agricultural PPPs. The six questions are:

- 1) What are the incentives to join a PPP?
- 2) What are the constraints to joining a PPP?
- 3) How have PPPs overcome these constraints?
- 4) What are the key enablers of PPPs?
- 5) What are the hidden costs associated with working with PPPs?
- 6) What is the most important lesson you can offer on PPPs?

# 3.0 Summary and Analysis of the Responses to the Questions

The ideas and concepts reported in this section are based purely on the observations from the interviews. Responses are summarized and general themes identified in order to provide sufficient detail to engender debate about the role of PPPs in agriculture, while preserving the confidentiality of respondents.

# 3.1.1 The incentives to join or form a PPP, private sector respondents

There are two primary themes in the answers to this question. First, many developed world private corporations have policies and/or cultures of "goodwill" towards development projects in the developing world. Sometimes this can be the result of a specific board directive, or a corporate policy that mandates and/or encourages employees and divisions to engage in charitable activity. It was suggested in the interviews that adopting a culture of goodwill means that corporations receive many benefits from these activities, including, but not limited to, happy employees, enhanced public image, and new relationships in the developing world, indicating that there are multiple factors driving corporate charity. It was noted by more than one respondent that charity work is just good public relations. In many cases, PPPs have been created due to the personal initiative of individual employees who recognized opportunities where commercially developed technologies could be transferred to subsistence crops without compromising the market positions of their employers. It was suggested by a number of respondents that Corporate Social Responsibility (CSR) has also become a motivating factor for corporations to engage in developing world agricultural PPPs, as many of the large agri-food companies are publicly traded and depend on the investment community for their financial well-being. There are now systems in place, such as the Dow Jones Sustainability Index, that track the CSR activities of companies, and this type of monitoring provides an incentive for

action, as their investors, in response to public pressure, now require a positive public image as a condition of continued investing.

Similarly, philanthropic activities in developing world PPPs garner positive press and social media releases. It was noted by more than one individual that by donating technology and money, and by lending employees to developing world PPPs, corporations create an image of supporting sustainable agriculture, something that is becoming a long-term consumer trend regarding food product choices. More than one interviewee suggested that the market position of corporations depends on supporting sustainable agriculture just as much as on price and quality, which indicates a response to long-term consumer trends favouring sustainability and equitable development. Additionally, there is a powerful "feel good" logic governing the incentives that drive private sector companies to engage in developing world PPPs. Again, a number of respondents, all drawn from the private sector, commented that this makes employees feel good about their jobs and themselves, and therefore enhances employee morale.

A second theme in the corporate incentives to join PPPs is commercial. The developing world represents the new frontier as both a consumer market and a commodity supplier. Multiple private-sector interviewees indicated that engaging in PPPs permits companies to develop local capabilities in the developing world by organizing farmers into coherent value chains, essentially incorporating the developing world into the global agricultural economy. This also allows corporations to access local knowledge and resources for their long-term strategic needs. Respondents from R&D PPPs indicated that learning about and acquiring local plant species was a powerful incentive for collaborating in PPPs, as the genetic material contained in plants can be a scientific asset and may hold commercial potential for expanding developing world markets. Interviewees from value-chain PPPs indicated that they require local knowledge as a means of learning how to work with the "bottom billion," as the developing world represents the new markets for both customers and suppliers, and, therefore, the major global source of growth. Furthermore, given the insights these partnerships offer on local and regional operating conditions, both political and knowledge-oriented, engaging in PPPs also reduces the risk of investing into new countries and products.

Informants from the private sector involved in value-chain PPPs stated that the PPP model was best suited for establishing value- and supply-chain networks, and they suggested that moving their food processing and manufacturing to the developing world lowered costs and increased efficiencies. It was noted by many that working with PPPs was an expensive and timeconsuming process. However, the long-term economic benefits were deemed worthy of the initial investments, as PPPs form the structural basis for local relationships necessary for creating value and supply chains. Developing-world PPPs are the focal point for developing new markets, supply chains, and R&D networks. One respondent from an R&D PPP indicated that establishing developing world PPPs provided the organization with first mover advantages; another respondent from an R&D PPP stated that PPPs provided a means of catching up to their competition.

One common underlying theme is that the developing world has become strategically important to the long-term aspirations of corporations involved in the agri-food sector, and PPPs are the best means of opening up this new economic space by providing a structure to learn how to work with the developing world. It was suggested by more than one informant that PPPs, due to their collaborative structure, provided a means of creating coherent networks where there was a discernible absence of economic and political stability. It was noted that forming developing-world PPPs gives companies access to the networks that have been established by national and international aid agencies such as GIZ, IDRC, and USAID, in this way speeding up the learning process by leveraging public knowledge with private sector assets. As most of the primary crops grown in developing world are not important in global markets and are generally not of interest to the of the majority of private sector, PPPs provide corporations with access to public technologies that are required to operate effectively in the developing world.

## 3.1.2 The incentives to join or form a PPP, public sector respondents

As was noted above for the private sector, multiple informants from the public sector indicated that the public sector joins PPPs to gain access to private technologies, especially new technologies such as BT- and HT-resistant varieties. By collaborating with the private sector, the public sector can gain a deep understanding of what knowledge and technologies the private sector has. This, in turn, permits both public and private entities to create a scientific division of labour to tackle various disease-related crop problems in the developing world. This leads to an acceleration of research programs, getting new technologies into the hands of developing world farmers more quickly and efficiently. It was noted by numerous public-sector respondents that most PPPs exist because neither the private nor the public sector possesses the requisite capabilities to respond to the technological needs of developing world farmers. In the developing world, the public sector needs the expertise of the private sector to set up regulatory systems, as corporations have a plethora of experience in establishing standards for the introduction of new technologies, especially biotechnology. Their expertise and experience covers the spectrum of dealing with new technologies, including regulatory and biosafety technologies, all critical to the successful introduction of the new plant varieties. A number of informants suggested that the public sector needs the product introduction capabilities and the knowledge of the private sector.

Although the public sector is adept at developing new technologies, especially for subsistence crops, it lacks the experience of the private sector in bringing new technologies to the market, or, in the case of the developing world, to the local farmer. One respondent noted that the process of successfully launching a new product, both GM and non-GM, takes years, usually more than a decade. This person noted that the greatest indicator of success of PPPs in the developing world was having experience with previous failures in product development and launches, something the private sector has experience with.

# 3.2 Constraints in joining or forming a PPP

From the private sector perspective, there are three major constraints to joining or forming a PPP in the developing world. The first major impediment concerns intellectual property rights (IPRs). From the perspective of an R&D PPP, corporations are heavily invested in IPRs, the right to specific genetic traits as an example, and PPPs can threaten these investments by permitting the intellectual property (IP), in the form of food, to be exported from the host country or region in the PPP to the developed world markets, threatening their market position and profits. One informant, with decades of experience with R&D PPPs, indicated that the absence of a global IPR regime means that corporations must monitor and, when necessary, prosecute the illegal use of its IPRs on a country-by-country basis, thus incurring large expenses.

Similarly, because joining PPPs increases a company's risk of losing its IPs to competitors, valuechain PPPs experience IPR impediments. In value-chain PPPs, several individuals stated that it is difficult to work with multiple private sector partners because it is difficult to prevent proprietary process and product knowledge from being transferred to competitors. It was stated by more than one informant that in value-chain PPPs, keeping trade secrets and profit margins from being transferred was virtually impossible. Trade secrets include non-codified practises on both the farm level and at the value-chain level. It also includes software applications related to managing value chains and personal contacts that are important to managing farm-based value chains in multiple countries. This is an area of study that is outside the scope of the current paper, and warrants further attention.

The second major impediment blocking private sector partners from joining PPPs pertains to control issues: who is in charge of the PPP? PPPs depend on multiple steering committees, which obfuscate the chain of command and leadership functions. Many PPPs answer to not-for-profit donors or development agencies, not to the private sector. Put simply, it was suggested by a number of informants that the private sector does not always understand how PPPs operate. The private sector engages in many contracts and bi-lateral agreements with PPPs, but these are often accomplished on a project–by-project basis, meaning the experience usually is not transferred to the operating standards of an organization. This point was addressed by

multiple respondents, who suggested that a lot of the private sector experience in dealing with PPPs is embedded within individuals, not the corporation.

It was brought up on a number of occasions that the private sector moves at a faster pace than its public sector counterpart. Additionally, a number of interviewees indicated that the blurring of authority within a PPP creates multiple objectives among the partners, with some activities directed towards farm-level operations, such as increasing farm incomes, while others seek value-chain development directed towards creating and maintaining export markets. These are not mutually exclusive, but rather create a conflict in the use of limited resources.

The third constraint identified from the interviews relates to cultural differences between organizations. These cultural differences can be related to public vs. private operating standards. The public sector is often oriented towards activities defined in a contract, and the private sector is usually focused on results, with the activities dependent upon acceptable outcomes that are generally measured in commercial terms. It was suggested by a number of informants that the process and activities change repeatedly in order to achieve the desired outcomes. Cultural differences, including language and norms, can also be understood as differences between developing and developed worlds. This is compounded by time zone differences and the lack of an on-site private sector subsidiary magnifying any communication problems related to culture or language. Fourth, a number of interviewees stated that most private sector entities lack experience in dealing with orphan crops, such as cassava, millet, and sorghum, that are common to the developing world; this implies that PPPs must go through a time-consuming learning curve.

Respondents from the public sector identified four major constraints to joining a PPP. First, according to many interviewees, there are a limited number of researchers and scientists trained and focused on crop-based R&D PPPs in the developing world. This limited research capacity limits the number of projects in which the scientists can engage at any given time. One issue that came up repeatedly was that each project requires an inordinate amount of administrative attention, which further dilutes the limited amount of qualified people to work with R&D PPPs.

During the interviews for this paper, it became obvious that the community of researchers working on developing world PPPs was small; everyone knew or knew of people involved with the PPPs related to crop research. A similar constraint was identified with value-chain PPPs, which do not depend on scientists and researchers as R&D PPPs do; rather, they are dependent on value-chain PPP specialists who are experts on local conditions, such as product and local knowledge, but also possess expertise in establishing value-chain PPPs. They are knowledgeable about acquiring public and private financing and about identifying incentives within private sector organizations to facilitate their interest in joining PPPs, and they are capable of matching

export commodities with developed world opportunities. Again, based upon the interviews, it was suggested that there appears to be a global shortage of individuals who are experienced in setting up value-chain PPPs. Second, it was noted in multiple interviews that it is difficult for public sector institutions and not-for-profit research centres to identify relevant technologies and identify genuine and honest private sector partners. This difficulty is compounded by public scrutiny of private sector motives for engaging in PPPs, suggesting that negative perceptions of the large agro-biotech firms by the public sector may prevent the development of effective PPPs. Third, public and not-for-profit institutions are constrained by a lack of funding. Fourth, multiple respondents indicated that many public institutions lack experience in dealing with private sector partners, similar in concept to the issues raised with the private sector in the above paragraph.

## 3.3 How have PPPs overcome the constraints?

Interviewees identified five methods for overcoming the constraints to building effective PPPs in the developing world. First, start simple by focusing on building relationships with the partners. A number of individuals stated that the PPP is best constructed by building friendships through face-to-face interactions; this builds trust and develops the basis for long-term relationships. The objective of developing relationships is to prove the process works. It was advised to start simple and leave the formal agreements and lawyers to the last stage of developing a PPP, after the objectives, process, division of labour, and financing arrangements have been agreed upon.

Second, the most important aspect to build successful PPPs is to employ PPP experts from developmental agencies and/or donor agencies who have experience with establishing developing world PPPs; this is to say, experience matters. PPP experts act as translators to bridge the differences between public and private sector standards, and they help overcome cultural differences between the developing world and the developed world partners. One item of significance did stand out. None of the informants from R&D PPPs suggested a requirement for PPP experts. This was an item of significance only from interviews with respondents who work with value-chain PPPs, again suggesting there are large differences between the two types of PPPs related to the experience and expertise required to start operations.

Third, remain focused on the ultimate objective: increasing the incomes and health of developing world farmers through agriculture. This objective is best accomplished by focusing on mission-critical items starting at the highest level of the structure of the PPP. Fourth, due diligence matters; it is prudent to research the technologies involved, as well as the potential partners and their means and motives. Fifth, a majority of the people interviewed suggested that personal commitment matters, as this can overcome problems associated with complexity and culture.

#### 3.4 The hidden costs associated with working with PPPs

Respondents identified six hidden costs associated with PPPs. First is the hidden cost of time. PPPs depend on a many meetings as part of the consensus-building process. It takes an enormous amount of time to connect the various partners and systems into a single organizational format. This entails merging public- and private-sector personnel and possibly divisions into a PPP, which includes members from a varying number of developing world countries, each with their unique cultures, languages, and organizational idiosyncrasies. The majority of the PPPs analyzed contained a minimum of three partners, with many having up to fifteen partners drawn from the public and private sectors and a multitude of countries. It was noted by many interviewees that this complexity engendered an unpredictable, difficult-to-forecast, and time-consuming process of getting to understand the dynamics of the partners in the PPP. It was noted by multiple respondents that prior to joining a PPP, it is impossible to predict with any accuracy the amount of time an organization will need to devote to the partnership.

Compounding this problem is the issue of accounting for the opportunity cost of the time devoted to building a PPP, as this does not show up on a balance sheet. This is a critical hidden cost for both the public and private sectors, something that was repeatedly discussed by the majority of the interviewees. This matter is intensified by the fact that the major donor agencies, both public and not for profit, do not permit the recovery of in-kind contributions, an issue that expands on one of the major constraints discussed in question number two.

The second hidden cost, related to the hidden cost of time, is the amount of intercontinental travel required for building an effective PPP. As noted, PPPs depend on committee meetings for their survival and success; therefore, travel becomes a hidden and unpredictable cost. Not only is travel required to build a successful PPP, the amount of travel increases when it comes to field trials of new crop varieties in the developing world. The larger the geographic footprint of the PPP, meaning the greater the number of country partners, the larger and more unpredictable the travel costs are for field trials, a necessary component of any successful cropbased R&D PPP. It was noted in the interviews that there is little financial room for trial and error in the process leading up to and including field trials.

The third hidden cost, which is related to the uncertainties associated with time and travel, is the poorly understood problem of complexity with PPPs. As PPPs develop, their structures and processes change, frequently through the addition of new partners, and these changes lead to new objectives and missions as new partners bring in new ideas and new opportunities. These elements of change both add to the complexity of the PPP and can cause mission drift, making it easy to lose focus on the strategic objectives of the original partnership. This in turn adds to the cost of the PPP. The fourth hidden costs are related to financial reporting, writing grant proposals, and the never-ending process of acquiring funding. The reporting and documentation requirements vary depending on the structure of the PPP. However, it was noted by a number of informants that each type of partner has unique reporting requirements, creating documentation challenges for the constituent partners. Public sector donor agencies, such as GIZ, USAID, and IDRC, and not-for-profit centres, such as The Gates Foundation and the Rockefeller Foundation, have unique reporting requirements that necessitate the need for complex and expensive documentation systems and in turn present expensive challenges for the PPP and its partners. It was noted by more than one private sector partner that the level of specificity created expensive burdens that added unforeseen costs that are hard to justify. Again, the donors do not permit the billing for such indirect costs.

It was noted that larger private sector partners have R&D budgets measured in the nine- or tenfigure range, absolutely dwarfing the size of grants from the donors. Despite this, their financial accounting systems need to be revised to accommodate the donor and PPP requirements, something noted in the constraints section. Many interviewees also commented on the high transaction costs associated with PPPs. This was related to both the reporting needs and to the time and energy spent looking for funding. Additionally, most private sector partners lack experience with writing grant proposals. There were also hidden costs associated with the verification of results from developing world accounting systems as donors and private sector partners noted that most developing world partners are not up to accepted accounting practices in the developed world.

The fifth hidden costs are the vagaries associated with managing IPRs. The majority of cropbased R&D PPPs depend on technologies from private corporations, public agencies, universities, and even individuals. As there is no global IPR regime, freedom-to-operate (FTO) issues are a hidden cost that is difficult to predict in advance. Generally, FTO searches involve the use of private attorneys and require IPR searches in multiple jurisdictions. In one PPP, a total of 43 IPRs were required, taking years of effort and expense. It was identified that the "golden rice" project is a great example of how FTO issues can dictate the pace and outcome of PPPs. This remains an impediment to developing R&D PPPs for the developing world, as it takes time and money to hunt down legal access to required technologies. This is a hidden cost that is unique to the R&D PPP.

The sixth and final hidden cost is the lack of infrastructure in the developing world. In many cases with R&D PPPs, it was necessary to construct roads, build laboratories, buy scientific equipment, and train scientists and technicians to fulfill the objectives of the R&D PPP. The individuals interviewed from value-chain PPPs noted that accurately forecasting infrastructure needs was even more complicated and therefore harder to predict. It was suggested that with

value-chain PPPs, the profit margins of the export commodity are low to begin with, so scale is important. However, to be successful, it is best to start small and develop a working model before trying to achieve scale operations.

In value-chain PPPs, both traceability and transparency are required by consumers in developed world markets. So value-chain PPPs must engage with and/or build civil society capacity to achieve transparency and traceability. This requires people on the ground developing educational outreach programs to reach as many farmers as possible, as soon as possible. The interviewees stated that this is a large expense that is difficult to predict accurately. In one way, the value-chain PPP faces a financial and organizational hurdle at the beginning of operations that a R&D PPP faces only after the successful development of a plant variety. The value-chain PPP must develop a network at the beginning of operations in order to reach as many farmers as possible.

This problem is compounded for value-chain PPPs that are focused on tree-based commodities, such as coffee and nuts. These trees can take years to mature before they are ready for production. These issues were brought up by a number of informants. Furthermore, they noted that it is difficult to justify large-scale expenditures because most expenses are related to education, capacity development, and creating farmer organizations, none of which leads to quick returns on investment. This was a problem area mentioned by several people involved with value-chain PPPs: to achieve scale, the value-chain PPPs require large scale investments, but donor agencies require tangible results in order to continue funding. This creates a measurement problem.

One respondent stated that one way to receive future funding is to bring funders on location to demonstrate what their funds had created. It was further noted that many value-chain PPPs operate in more than one country. This requires developing governance systems with multiple governments, which adds both cost and complexity to the process. One informant indicated that operating in multiple countries aided transparency because it forced other governments and organizations to conform to outside standards of operation. However, this added to both the cost and complexity of developing the value-chain PPP. It is difficult to predict and forecast what infrastructure and capacity needs will be required until the PPP has developed. As noted above, most PPPs have a significant gestation period where the objectives mature as the PPP grows and develops, adding to both the uncertainty and complexity of developing world PPPs.

#### 3.5 The key enablers of PPPs

The first and most prominent enabler identified by respondents was the role of specific people in the creation and success of PPPs. In one case study, an R&D PPP was the result of a single individual's efforts spanning almost three decades, from their university years through their professional career. This individual, while working for a not-for-profit, developed the initial technology, recognized the need for further technological development, and initiated a longterm relationship with a private sector partner. Furthermore, over the span of three decades, this person arranged for funding from almost every possible large-scale donor, including national governments, the private sector, and, most recently, The Bill and Melinda Gates Foundation. This project is in process.

Each PPP analyzed for this paper was the result of the personal initiative of an individual, without whom these PPPs would not currently exist. In two cases, individuals in the private sector recognized that a technology owned by their employers had the capability to resolve a crop-based disease or nutritional problem in the developing world. They launched what can be best described as a crusade to transfer the identified technology to solve a crop-related problem; the PPP in these cases is a direct result of acquiring partners to develop the technology and finance the process of building the capacity in the developing country to get the technology in the hands of farmers. Another PPP—a value-chain PPP in multiple countries—was the result of a PPP expert from a national development organization recognizing a non-obvious commercial opportunity for farmers. This PPP was entirely dependent on the product, process, and industry knowledge of this person who understood industrial profit margins and had a deep knowledge of how to create a value-chain PPP. Again, without the personal zeal of one person, this large-scale PPP would not exist.

In other case studies, public researchers recognized the limitations of their programs and began building relationships with the private sector and with donor agencies to bring their technology to the farmers. In each case, the actions of the key individuals formed the basis for a compelling story of initiative, effort, and belief to solve the hunger and poverty problems. It also exposes how dependent these PPPs are on these particular individuals; without their efforts, it is questionable whether these particular PPPs would have ever formed. It must be emphasized that these efforts took place over a period of decades, essentially over the professional careers of these individuals. In two cases, the PPP was a result of one individual handing the "file" to a new employee who then took the project over. In one case, the developer of a technologybased PPP has remained in their position to continue working and nurturing the PPP. Therefore, based upon the case studies and interviews for this paper, the key enablers are people who see possibilities that are not always obvious. A second enabler identified by respondents is funding and expertise from donor and national development agencies. Without funding or PPP expertise, most PPPs will not get off the ground. They are simply too expensive and too complex to be organic or driven by demand from farmers or farmer cooperatives in the developing world. They require outside assistance in the form of money, technology, PPP expertise, product knowledge, and, most importantly, the ability to develop networks around the PPP. PPPs should be best understood as linking organizations that connect special people, special places, and special processes to develop technologically and market-based solutions to hunger and poverty in the developing world. In each case study, the PPP was the nucleus for developing world-based national or regional value chain, or the focal point for a global network of individuals and institutions dedicated to working with agriculture development in the developing world.

In this analysis, all the global institutions dedicated to agricultural development in the developing world were identified as key enablers. These include SFSA, IDRC, GIZ, USAID, MonsantoFund, The Rockefeller Foundation, and the Howard G. Buffett Foundation, among others. Each organization brought funding and expertise, ranging from scientific to institutional knowledge of crop-based development in the developing world. Based on the interviews, one organization did stand out: The Bill and Melinda Gates Foundation, a recent addition as of 2007. The Bill and Melinda Gates Foundation was identified in a number of case studies as being the difference between failure and continuance of operations. The Bill and Melinda Gates Foundation added billions in funding in the aggregate to agricultural development. Additionally, the Bill and Melinda Gates Foundation has developed a staff of development experts that brought a wealth of knowledge to crop-based R&D and value-chain PPPs, including, but not limited to, eliminating or reducing FTO issues around plant and process-based technologies. Essentially, the Bill and Melinda Gates Foundation, due to the scale of its operations, has clarified global rules or norms on freedom to operate issues, making it easier for PPPs to effectively engage the public sector, including universities, and the private sector on technology matters.

A third key enabler identified in the interviews was an institutional willingness to experiment by operating outside of their comfort zones. This is related to the first enabler, people. Organizations, both public and private, must be willing to allow employees both to devote time to personal projects on institutional time and to use institutional resources. PPPs are an evolving concept built around collaboration. The focus on the role of individuals in the creation of both R&D and value-chain PPPs challenges the literature, as it is not an item that has received much attention; essentially, the literature is silent in this regard. This suggests that PPPs are not an institutional response to the challenges of alleviating developing world poverty through agriculture, but rather the result of people recognizing the limitations of the current industrial organization of the global agricultural and developmental structure. In one aspect,

the combination of people, places, and processes closely matches the theory of innovation outlined in the introduction. This suggests that individual entrepreneurs in both the public and private spheres are the driving force behind the development of PPPs in agricultural development in the developing world. This warrants further research.

## 3.6 The most important lessons learned by practitioners of PPPs

It was suggested by the majority of respondents that the problems with food insecurity and poverty are beyond the capabilities of the public and private sectors acting alone; therefore, PPPs are the only viable means of creating sustainable technological solutions using agriculture to eliminate poverty. PPPs are a growing phenomenon and represent a new organizational model of collaboration built upon personal relationships. Experience has demonstrated that PPPs have had the greatest impact on poverty reduction when they merge the capabilities of the public and private sectors with the donor and development agencies to deliver agricultural technologies and processes to farmers. Most people interviewed for this paper noted that PPPs are structures that take years, if not decades, to yield sustainable operations on the ground in the developing world. PPPs are most successful when they start on a modular basis, by taking simple steps to build relationships and developing trust among the partners before engaging in more sophisticated steps related to the end goals of the PPP.

PPPs depend on commitment and leadership from their partners. Many respondents indicated that, where feasible, PPPs are most efficiently constructed by people with experience in developing PPPs; these people understand local conditions, the methods of acquiring funding, and how to effectively engage the private sector. It was noted by more than one interviewee that successful PPPs are driven by commercially viable goals. Under optimal conditions, PPPs create value chains that connect developing world farmers or farmer cooperatives with global agricultural markets. It was suggested by a number of informants that PPPs depend on a massive commitment of time and energy, and most partners grossly underestimate these needs. On a similar note, to be successful takes years of work, but PPPs are constantly undermined by the short-term approach common among donor and development agencies. Specifically, most funders require annual reports and targets to assure continued funding, and even under the best circumstances, funding is limited to five-year intervals. It was noted that, in the developed world, it can take over a decade to develop and introduce a new R&D-based crop technology.

It was suggested that the short-term approach to funding creates conditions where projects stop and scarce resources are applied to other needs, resulting in an abundance of incomplete projects and a situation that stymies the potential of the PPP. Therefore, in the developing world, with the infrastructure-deficit environment, PPPs should be designed on 10- to 20-year timelines. It should be reiterated that *none* of the PPPs studied for this paper should be

considered successful, because they are still in the developmental stages and have not realized the goals they were designed to meet. This suggests that there is a lack of knowledge governing the creation and implementation of PPPs.

PPPs are spread across continents and therefore time zones; to be effective, they depend on well-structured reporting systems that incorporate a clear outline of goals, procedures, responsibilities, and timelines. A monitoring system facilitates progress. As PPPs involve people drawn from a diverse array of organizations and cultures, it was noted that spending time in their partners' organizations and countries facilitated the relationship-building process by creating an awareness of the working conditions of the respective partners. It cannot be over-emphasized that one person can make a difference, and that commitment from both people and organizations is the key determinant of success with African PPPs; persistence matters.

#### 4.0 Lessons Learned

This section summarizes the specific lessons taken from the interviews summarized above. The first lesson is that PPPs result from building relationships, networks, technological solutions, and capacity. As noted throughout this paper, PPPs depend on people and personal relationships. Trust, communication, and face-to-face relationships have been identified as the key drivers of PPP creation. Additionally, as noted, all of the PPPs analyzed for this paper were based upon the zeal and initiative of specific individuals, not as a result of policy or institutional parameters. Relationships that form the bonds of a PPP also permit the PPP to develop the capability to become the nuclei or node that constitutes the center or origins, depending on type of PPP—R&D or value-chain—of heterogeneously configured networks.

All the PPPs studied are, in one form or another, the glue that holds together networks of dissimilar organizations. This suggests PPPs engender the development of horizontally configured networks of organizations with shared interests in delivering technological solutions to small-scale farmers. The technological solutions are a result of the exchange of ideas and creation of new knowledge through the networks of individuals and organizations linked together by the PPP. To deliver the innovative technological solutions to developing world farmers, both R&D and value-chain PPPs must develop the capacity to effect change. This includes developing the physical, scientific, and governance capacity to permit small-scale farmers to absorb the technology and link to global networks, but it also refers to developing the internal capacity to perform these quite varied and complex tasks.

The second lesson relates to complexity. As PPPs are an evolving phenomenon, there are no hard and fast rules governing their development, and there is a discernible lack of models to emulate. The PPPs discussed by the respondents interviewed for this paper were created to address serious global problems of hunger and poverty in the developing world that, to date,

are beyond the ability of either the public or private sectors' ability to solve. Complex problems require complex responses. As PPPs are new structures that are not modelled on either public or private organizations, they present unique challenges.

It is difficult to overstate the complexities associated with the dynamics of building relationships with multiple dissimilar partners. One informant stated PPPs are like being in a marriage with at least three unique partners; put another way, this is uncharted territory. The informant noted that the key to a successful marriage is a long courtship. This means PPPs are expensive and time-consuming, yet hold great promise. Borrowing a phrase from Donald Rumsfield, PPPs should beware of the "unknown unknowns," which are plentiful within PPPs. Despite the best efforts of planners and forecasters, respondents noted the difficulty in determining with any accuracy the hidden variables that will add to the complexity of establishing and maintaining a successful PPP. These hidden variables include, costs, reporting issues, how the structure and process of the PPP may evolve with additional partners and new missions, and the trial and error process of developing new technologies, including the expenses of managing issues surrounding IPRs.

Despite the above-described challenges, practical solutions to developing and implementing successful PPPs have been developed. First, there are experts embedded in a multitude of national, donor, and international organizations and agencies that are familiar with the vagaries of PPPs. Organizations such as the Bill and Melinda Gates Foundation, GIZ, USAID, to name a few, possess a vast amount of knowledge and experience with creating and managing PPPs. As discussed, many PPPs would not exist if not for the activities of PPP experts who bridge the differences between the public and private sectors, and understand the dynamics of acquiring funding from the multitude of funding agencies. Secondly, a clear understanding of the incentives may also present a clear picture of potential constraints to successful operations. Understanding the motivations of all parties that seek involvement with PPP is critical: what does the PPP offer that is unobtainable in the absence of collaboration? Third, structure matters. Development of a plan with clear timelines and specific responsibilities, all directed to targeted outcomes, is highly encouraged. Developing the plans and timelines with the understanding that achieving sustainable operations will take years of effort and funding and will require the support of PPP experts and organizational commitment.

#### 5.0 Strategic Implications and Summary

The interview results for this paper lend credence to the descriptions of the multiple functions of an agricultural PPP. There can be no doubt that PPPs perform the role of an intermediary by linking heterogeneously configured organizations into functioning R&D innovation systems. This conforms closely to the Mode II form of knowledge development, where networks have replaced the vertically organized public and private sector R&D structures as the primary developers of new knowledge. The partnerships in this analysis are also the innovation brokers described earlier, as they provide a structure for the development and implementation of technologically driven innovative responses to poverty and hunger that appear to be beyond the ability of either the public or private sectors to address. In this approach and based on the interviews, the PPP is the structure that connects special people with special processes in special places. This suggests that innovation depends on collaboration, something the PPP is suited for. It further suggests that innovation is dependent upon social entrepreneurs and creative institutions that permit organizational boundaries to be challenged. Therefore, this analysis indicates that PPPs are good strategic choices because they provide a structure that mobilizes ideas, individuals, and institutions for the development and implementation of agriculturally oriented and technologically driven solutions to poverty and hunger at the farm level in the developing world. PPPs connect farmers to global markets and global technologies in a manner that public- and private-sector organizations appear to be incapable of accomplishing in the absence of collaboration; this pattern acknowledges limitations to these individual sectors in combating global hunger.

Four items stand out regarding how this analysis relates to the current literature. First, the emphasis by the interviewees on the hidden costs associated with implementing PPPs warrants deeper analysis. The literature generally refers to hidden costs as a constraint preventing the formation of PPPs. However, most respondents referred to hidden costs from an operational perspective, after the PPP has been formed. The overriding theme from the interviews is that hidden costs are a difficulty that can be managed. However, hidden costs add to both the expense and complexity associated with developing world R&D and value-chain PPPs.

As noted, none of the PPPs from which the respondents were drawn have achieved successful operations, according to the opinions of those interviewed. This brings on the question, are hidden costs of PPPs a factor in the slow fruition of achieving positive results? Based on the discussions for this paper, the answer is yes, the hidden costs identified here are a factor in the longer-than-anticipated gestation periods. This is a subject that merits further research and discussion, as there is little discussion of this issue in the literature. It bears repeating that agricultural PPPs are a new and growing phenomenon in the developing world, also contributing to the paucity of working models or successful examples.

The second item that warrants further analysis is the role of enablers in creating PPPs. Specifically, an analysis of the critical role of individuals with the formation of R&D PPPs and the role of specialists in creating value-chain PPPs is not found in the literature. As this current paper demonstrates, people matter; without the initiative and insight of key individuals, the PPPs that are part of this analysis would not exist. The ramifications of this are profound, as this suggests that policies and institutions are secondary to the role of individuals in identifying innovative, organizational and technological solutions to poverty and hunger. The literature does acknowledge a role for social entrepreneurs in driving organizations in new directions, as earlier discussed. However, this requires more attention; it may also confirm that the public and private sectors, for various reasons, are not capable of developing and implementing solutions to hunger and poverty.

The third item of interest is the role of technology and knowledge in value-chain PPPs. Value chain partnerships are dependent on process technologies and non-codified forms of knowledge that influence the ability to generate profits in low-margin commodity exports. Based on the observations brought up in the interviews, value-chain PPPs may face limitations in both scale and scope due to the inability of competitors to work together as a number of respondents noted the difficulty in preventing the transfer of proprietary process and product knowledge to competitors. Value-chain PPPs may be more complex than the literature suggests and possibly more difficult to start up than R&D PPPs; they require a different non-scientific knowledge to achieve operations. In place of scientific knowledge, value-chain PPPs require a technically oriented facilitator who understands local conditions, the operating characteristics of large food distributors, processes of acquiring start-up funding, and global trading patterns. The facilitator should have the requisite ability to identify export opportunities in multiple countries.

Fourth, while both R&D and value-chain PPPs center heterogeneous networks critical to delivering technology and capacity to poor farmers, each PPP may need a functioning network at opposite stages of their development. Based upon the responses for this paper, the R&D PPP begins operations on a linear basis by forming relationships depending on its technology needs, generally starting with one partner, and then expanding operations as the process matures and the technology is ready for field trials and distribution to farmers. Conversely, the value-chain PPP, by design, immediately begins by developing heterogeneous configured networks to develop the capacity to educate farmers and to provide farmers and farmer cooperatives with the ability to link with distant and technically sophisticated developed world marketplaces. This suggests that the start-up costs of a value-chain PPP will greatly exceed those of an R&D PPP.

This paper adds to the knowledge of agricultural PPPs in six ways. First, this research illuminates how time, complexity, financial reporting, and acquiring financial support are hidden costs of implementing and sustaining PPPs. Second, this paper expands the knowledge of the relationships between both R&D and value-chain PPPs and network configuration. Third, the requirement for different types of networks at different stages of the development of the PPPs suggests that the value-chain PPP requires higher start-up costs. Fourth, we now know more about the critical role individuals occupy in creating R&D PPPs and the role of PPP specialists in the formation of value-chain PPPs. Fifth, value-chain PPPs face unique challenges managing non-codified knowledge and trade secrets, limiting the number of private sector partners per partnership. Sixth, based upon interview data, there appears to be a short-term capacity shortage of scientists, researchers, and PPP specialists involved with developing world agricultural PPPs that may inhibit the growth of new partnerships.

Additionally, this paper amplifies previous research on the incentives and constraints influencing the formation of both types of PPPs. Most of the issues brought up in the interviews are consistent at some level with existing literature. This suggests that the existing body of research on PPPs has identified many of the issues that practitioners of PPPs specified as critical to the understanding of PPPs. However, in addition, there were the above noted six issues that were identified that provide new focal points for new research efforts.

There are a number of factors limiting this paper that provide future research trajectories. First, this is a qualitative analysis conducted with a "silo" perspective, limiting the ability to draw explicit inferences, meaning the contextualized lessons cannot be extrapolated. Second, as discussed, there are a number of biases, including geography, sample size, and the absence of successful and operational PPPs, that may influence the interpretations of this study. These limitations provide opportunities for new research methods. This paper, and the study of PPPs, can be greatly extended by the use of social network analysis to statistically and graphically illuminate the relationships between the different institutions as well as the different processes that govern and shape the relations between organizations. PPPs are part of a large, complex global system of institutions, actors, and relationships that have emergent properties based on feedback loops. This means it is not possible to sub-divide the system into its component parts for analysis without eliminating critical elements that are necessary to the understanding of how the system functions; as such, alternative research methods are required. In the absence of new methods such as social network analysis, it will be extremely difficult address the strengths and limitations of R&D and value-chain PPPs in alleviating poverty and enhancing food security in the developing world.

There is no off-the-shelf approach or process for developing and implementing PPPs. There is a lack of standard practices and an absence of a global institutional method of absorbing and

transferring lessons from previous PPP experiences. Without this type of institutionalized support, PPPs remain a boot-strap process operating in an institutional vacuum. In the continued absence of institutionalized global learning networks, each PPP will be a standalone process, meaning it will be difficult to develop economies of scale on a global level with agricultural PPPs; this significantly limits their potential for alleviating poverty. Developing and implementing PPPs, based on this analysis, constitute more of a black art rather than a science. However, it is clear that both public and private sectors see huge potential in improving incomes and livelihoods, for smallholder producers while simultaneously improving food and nutrition security for the world's poor as the number and variety of partnerships continues to grow. Creating the institutional capacity to achieve the development objectives of PPPs in agriculture remains a global challenge.

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