AgResults Evaluation:
Zambia Biofortified Maize Challenge Project
Close-Out Assessment

May 2020



Abt Associates

In Partnership With:
Denise Mainville Consulting

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The AgResults initiative is a partnership between the Australian Government, the Bill & Melinda Gates Foundation, the Government of Canada, the United Kingdom's Department for International Development, the United States Agency for International Development, and the World Bank.

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Acronyms

FISP	Farmer Income Support Program
Kg	Kilogram
MT	Metric tonne
NGO	Non-governmental organisation
PVA	Pro-Vitamin A
PfR	Payment-for-results
VAD	Vitamin-A deficiency

Preface

AgResults is a US$152 million multilateral learning initiative. It promotes the development and dissemination of high-impact agricultural innovations for food security, health, and nutrition through the design and implementation of prize competitions that are a class of "payment-for-results" (PfR) projects. AgResults also evaluates the effectiveness of these prize competitions and incorporates evidence-based learning to refine the PfR approach.

By using PfR, AgResults goes beyond traditional aid measures to promote the adoption of innovative technologies with high-yield development impact. AgResults calls upon the ingenuity and drive of the private sector to identify and execute the most effective and efficient strategies to achieve development outcomes. It does so by providing incentives to private sector actors to develop and facilitate the uptake of innovative technologies, and overcome market failures impeding the establishment of sustainable commercial markets for these technologies or the goods they produce. It thereby aims to achieve substantial and sustained development impacts, including improved food security and food safety, increased farmer incomes, and better health and nutrition.

AgResults is funded by the governments of Australia, Canada, the United Kingdom, and the United States, and by the Bill & Melinda Gates Foundation. The funds are managed through a Financial Intermediary Fund, operated by the World Bank as its Trustee. The AgResults team comprises the Steering Committee, Secretariat, Trustee, country-specific Project Managers, and the External Evaluator. The Steering Committee oversees the implementation of AgResults and is composed of the five donors and the Trustee. The Steering Committee is responsible for strategic oversight of the initiative, including endorsement of key management decisions, approval of concepts and business plans for proposed projects, and monitoring of projects and the initiative as a whole. The Secretariat is responsible for implementing the initiative and reports to the Steering Committee. The Trustee provides financial intermediary services.

The Steering Committee appointed Abt Associates to serve as External Evaluator for AgResults. The evaluator's role is to use rigorous scientific tools to determine to what extent the prize competitions achieve their objectives to produce private sector behaviours and social outcomes different from, and better than, what would have happened in the absence of the AgResults initiative. The evaluator defines the overall evaluation framework for the AgResults initiative and an impact analysis strategy for answering common evaluation questions for each competition. The evaluator implements and analyses field surveys, conducts qualitative market analyses, and communicates evaluation findings to the Steering Committee and wider audiences. The evaluator's role is vital to the AgResults learning agenda of understanding how donors may leverage the private sector to develop and spread agricultural innovation. As funding permits, the evaluator also assesses the sustainability of each competition's benefits once the PfR incentives are removed.

The AgResults Biofortified Maize Challenge Project in Zambia tested PfR as a means of catalysing the development of a sustainable, smallholder-inclusive market for a maize variety that has higher vitamin A content than the varieties typically used in Zambia. The project was launched in 2015 and closed early three years later. Because of the project's early termination, the External Evaluator conducted a qualitative close-out assessment instead of the originally planned final evaluation. The focus of the close-out assessment was to examine the extent to which AgResults had affected the Pro-Vitamin A (PVA) maize market during its period of implementation, the extent to which it was sustainable, and if there were any unintended consequences of the termination. Denise Mainville, PhD, of Denise Mainville Consulting, LLC (a subcontractor to Abt Associates) led the assessment under the general direction of Tulika Narayan, PhD, research director. Robert Nhlane, MSc, a Zambia-based agricultural economist, supported the close-out research activities.

Executive summary

The AgResults Biofortified Maize Challenge Project in Zambia sought to test payment-for-results (PfR) as a means of catalysing the development of a sustainable, smallholder-inclusive market for Pro-Vitamin A (PVA) maize. Increased consumption of PVA maize by both farmers and urban consumers was expected to reduce the incidence of Vitamin-A deficiency (VAD)—a significant public health issue in Zambia. The challenge project's design was predicated on the understanding that demand for PVA maize was limited by a lack of information about VAD and by many Zambians' perception that non-white maize is inferior to white maize. On the supply side, by providing incentives to market PVA maize, increasing the supply base, and lowering knowledge gaps regarding the production and processing of PVA maize, the project aimed to reduce the costs and perceived risks of entering the market. The project offered cash prizes to maize millers and seed companies for every unit of milled PVA maize and PVA maize seed sold, provided that the companies reached pre-specified minimum thresholds. The AgResults project also featured a number of 'push' elements, such as marketing assistance, that complemented the PfR incentive.

The project's theory of change posited that strategically targeted cash incentives would offset the major sources of market failure that limited private sector actors' investment in the PVA maize market. The cash incentives were expected to induce private sector actors to invest at scale in the procurement, processing, and marketing of PVA maize and maize seed. This investment would create market conditions that would encourage nutritionally vulnerable smallholder farmers to grow PVA maize, which they would consume, while marketing any surplus. At the same time, this investment would ensure an adequate supply of PVA maize to develop a sustainable consumer base.

The project did not elicit sufficient response from the competitors, however; after three years of implementation, the AgResults Steering Committee acted on the Secretariat's recommendation to close the project early. It officially closed on August 31, 2018. This report provides results of a close-out assessment conducted by the External Evaluator. The close-out assessment used qualitative methods drawing on project monitoring reports and other secondary data sources, as well as in-country interviews of millers and seed companies participating in the project, AgResults Advisory Council members, and PVA maize value chain actors. The assessment's objectives were to determine whether AgResults had supported the development of a market for PVA maize, assess the sustainability of any impact, and identify any unintended consequences of the project's early termination.

Key findings

Market. AgResults played a role in the development of a niche market for PVA maize, although with limited development impact because the market tended to involve better-off smallholder farmers and urban consumers. While AgResults played a clear role in developing this niche market, it is not possible to identify the magnitude of its effect relative to the complementary role played by 'push' initiatives that were operating at the same time. HarvestPlus, in particular, played a prominent role in introducing PVA maize to Zambia farmers and shares credit for the development of the market.

Sustainability. Our research suggested that the market would be sustained in the short to medium term, with private sector respondents describing their intent to continue in the market, their specific plans for doing so, and the ready demand for PVA maize. Nonetheless, our research also suggested that under current conditions, the market would continue to operate as a niche market only, i.e., we have not found an indication that the production and consumption of PVA maize will

become mainstream. Thus, for this reason and for reasons discussed in our lessons learned, PVA maize is unlikely to reach the most nutritionally vulnerable consumers that the project sought to benefit.

Early termination. Our inquiries showed that the market experienced a short-term disruption due to the challenge project's early termination. Numerous respondents reported concern that AgResults' early termination was indicative of waning donor interest in PVA maize. However, there was strong confidence about continued commitment to PVA maize by the Zambian government. Early termination of the challenge project did not appear to undermine support for the concept of a PfR scheme, largely because that concept was misunderstood in the Zambian context.

Lessons Learnt

We have organized lessons learned along the six elements of an effective PfR approach.[1] The six elements are in italics below, followed by descriptions of the lessons we have drawn from the Zambia AgResults project.

Choosing a development problem and solution to address it

The solution to the targeted development problem should have the potential to directly and significantly impact the project's intended beneficiaries.

Vitamin-A deficiency is a significant issue in Zambia among poor rural consumers, and addressing VAD effectively could have a significant public health impact. There are programs that address VAD among other populations, such as the mandatory sugar fortification programs that target consumers who purchase sugar, and the Vitamin A supplementation program that targets pregnant women and infants. Poor, rural consumers can be missed from these programs and production and consumption of biofortified maize by rural maize farmers had the potential to reduce VAD in rural areas. However, the AgResults project did not directly target these rural consumers as beneficiaries, instead envisioning them to be indirect beneficiaries in its original design. Similarly, only a small share (approximately seven percent) of the urban and peri-urban consumers which the business plan anticipated would consume PVA maize were anticipated to be VAD-vulnerable, likewise dampening the project's potential development impact. Therefore, an important lesson is that it can be risky for a project to depend on "trickle down" or long chain of linkages to achieve a significant development impact.

The innovation should be proven to address the development problem and have a potential market.

PVA maize is an innovation that has been proven to address the development problem of Vitamin-A deficiency in vulnerable groups. Maize is a staple for many of the most nutritionally vulnerable groups in Zambia, and PVA maize is proven to address VAD. PVA maize also has strong market potential among health-conscious urban consumers, as well as among farmers who could come to appreciate its taste and nutritional benefits.

[1] The six components of an effective PfR approach were developed based on observations from the first AgResults projects.

Addressing market failure

Challenge projects are most likely to succeed when the projects' competitors can adequately alleviate the binding constraints limiting the market's development.

In Zambia, there were multiple constraints limiting the development of the market, some of which were outside the manageable interest of the private sector. The private sector competitors had little influence over the Zambian government's heavy involvement in the market for white maize, a strategic food security crop and close substitute to PVA maize. Further, while millers conducted individual promotional campaigns to build demand for their branded PVA maize products, they were in a weak position, compared to the public sector, to conduct a national campaign to increase consumer awareness of PVA maize and its health benefits. Millers themselves perceived that, as profit oriented companies, they had limited credibility in promoting the nutritional benefits of the product).

Incentivizing competitors

Competitors should see a long-term business case for the innovation and should have the numbers and capacity to form the foundation of a competitive market.

In Zambia, both seed companies and millers were adequate in number to create the foundation for a competitive and sustainable market for PVA maize. However, millers did not see a long-term business case in working with PVA maize—especially at the outset—and they had limited capacity to address key constraints to the market's development. In contrast, seed companies had both financial and business management capacity and perceived a business case for PVA maize, in particular because of existing demand for seed from government and nongovernmental organisations (NGOs) and perceived potential demand among smallholder farmers.

Crafting a theory of change

The theory of change should articulate how the PfR scheme will induce competitors to address the market constraints limiting the development of a sustainable market and reach its potential beneficiaries.

While no explicit theory of change existed for the Zambia project, the project's implicit theory of change reflected weak linkages between value chain actors. Specifically, nutritionally vulnerable smallholder farmers are not well integrated into the market for milled maize, and VAD-vulnerable urban and peri-urban consumers likewise only represented a fraction of anticipated PVA-maize consumers. This meant that large volumes of sales and extensive market penetration would be necessary for the market to reach these farmers and consumers. The incorporation of seed companies into the project strengthened linkages to farmers, although it could have had a stronger impact by specifically rewarding sales to farmers rather than all domestic entities (including government actors and NGOs).

Defining the incentive structure

The project should seek to minimise any trade-off between market impact and development impact by defining qualifying parameters for PfR awards that are linked as closely as possible to the project's intended development objective.

In the Zambia project, qualifying parameters for the PfR awards were based on sales of PVA maize and maize seed. Basing the miller prize on sales of *milled* maize may have strengthened the market impact by targeting the urban consumers that are likely to demand PVA maize. However, it weakened the development impact with poor rural farmers, who sometimes buy unmilled maize but rarely buy milled maize. The focus on milled maize also excluded many potential buyers of PVA maize—such as schools and health clinics— who also serve VAD-vulnerable consumers but often buy unmilled maize due to its lower cost. The seed company incentive favoured market impact because it rewarded sales to any domestic buyer including the government and NGOs. It could have had greater development impact if it had been more directly linked to farmers as beneficiaries. Specifically, if it had rewarded sales to commercial sales channels that marketed primarily to smallholder farmers, it may have promoted the development of a sustainable smallholder-inclusive private sector-driven market.

1. Overview of the close-out assessment

This report discusses the findings of the external close-out assessment of the AgResults Biofortified Maize Challenge Project in Zambia, which was intended to create a market for Pro-Vitamin A (PVA) maize and PVA maize seeds, thus increasing the uptake of PVA amongst rural populations who are most vulnerable to Vitamin-A deficiency (VAD). This section outlines the background, objective, approach, and theory of change for the project. Section 2 discusses the design of the assessment and questions that were at its centre. Section 3 discusses the assessment's primary findings, including the challenge project's various impacts on millers, seed companies, and other value chain actors. Section 4 contains lessons learnt with respect to the assessment questions. Section 5 presents conclusions.

1.1 Project objective

The objective of the Zambia challenge project was to catalyse the market for PVA maize by testing PfR schemes that would allow key market actors—industrial maize millers and later seed companies—to overcome sources of market failure. These market failures had heretofore prevented the emergence of a sustainable and smallholder-inclusive market for PVA maize. The project also aimed to encourage investment in the procurement, scale, and marketing of milled PVA maize and its seeds. By increasing the availability of PVA maize in the market, the challenge project intended to reach nutritionally vulnerable consumers and thereby reduce the incidence and severity of VAD nationwide.

The challenge project's design was predicated on the understanding that demand for PVA maize was limited by a lack of information about VAD and by many Zambians' perception that non-white maize is inferior to white maize. On the supply side, by providing incentives to market PVA maize, increasing the supply base, and lowering knowledge gaps regarding the production and processing of PVA maize, the project aimed to reduce the costs and perceived risks of entering the market. By increasing the willingness of maize value chain actors to enter the market, the project would help increase demand for and uptake of PVA maize.

1.2 Approach

The five-year challenge project that was initiated in 2014 was intended to test the use of PfR schemes as a means of promoting the production, processing, and consumption of PVA maize to address VAD, an important public health issue. The AgResults approach to the VAD problem in Zambia was to motivate industrial maize millers to invest in the market for PVA maize. Because of millers' central position in the maize value chain, catalysing their investment in the market for milled PVA maize at scale was expected to drive development of the PVA maize value chain as a whole. Over its implementation period, the challenge project sought to catalyse the sale of 128,000 metric tonnes (MT) of milled PVA maize to 560,000 consumers, 40,000 of whom were expected to be vulnerable to VAD (Dalberg, 2012). Farming households in Zambia, due to their poverty and relative isolation, are among the country's most VAD-vulnerable groups. The challenge project approach assumed that sustained uptake of PVA maize by farming households depends upon a viable offtake market to motivate the ongoing production of PVA maize. Farming households were expected to benefit both nutritionally and economically, by consuming a portion of the PVA maize that they grew and by having a market to which they could sell PVA maize.

In the project's initial design, AgResults provided incentives to millers across three stages: (1) an initial marketing and sales plan competition for PVA maize; (2) a per-unit prize for sales of milled PVA maize; and (3) a proportional prize competition. In 2017, the incentive was changed in two ways. First, the miller incentives were re-calibrated with lower sales thresholds for individual firms, and the requirement for a minimum level of sales at the market level was removed. Second, an incentive was added for seed companies to sell PVA

maize seeds domestically, with the aim of driving uptake of PVA maize among smallholder farming households.

In addition to the AgResults challenge project's PfR approach, a number of 'push' mechanisms promoted the adoption and consumption of PVA maize in Zambia. The AgResults project included several secondary interventions at its launch that were intended to alleviate constraints on millers' activities that were perceived to be outside of their immediate control. These interventions were intended to be temporary, and included advance market commitments to one seed company and contracts with commercial farmers to produce PVA maize in the first year. The AgResults challenge project manager also contracted a behaviour change specialist to help the competitors strengthen their PVA maize business and marketing plans.

External to AgResults were PVA maize promotion activities by HarvestPlus, a research programme on agriculture for nutrition and health. HarvestPlus was implemented by the Consultative Group for International Agricultural Research, which initially developed PVA maize as part of its staple foods biofortification programme. In addition to developing PVA maize varieties, HarvestPlus led early and ongoing efforts to introduce PVA maize to Zambian farmers and consumers and promote its uptake. HarvestPlus collaborated with numerous donor-funded and NGO initiatives to promote PVA maize uptake; collaborating organisations were World Vision, the World Food Programme, and Irish Aid, among others.

Rural consumers and smallholders were the primary audience for these push activities, though they also targeted urban consumers. Interventions included promoting the planting and consumption of PVA maize in rural areas, especially at schools and health clinics, through free or subsidised distribution of PVA maize seed, demonstration plots, and educational campaigns. HarvestPlus also trained agro-dealers countrywide, including in non-intervention areas, as a way of developing the upstream market. To ensure sufficient supply of PVA maize for millers in year 1 of the challenge project, AgResults partnered with HarvestPlus to procure 50 MT of PVA maize seed produced by Zamseed[2]—approximately 5 MT of this seed was then distributed to large-scale commercial farmers on buy-back contracts, with the remainder being distributed to emergent farmers[3] and women's groups for cultivation (Deloitte, 2015).

1.3 Theory of change

Although the AgResults Zambia challenge project's business plan (Dalberg, 2012) did not specify an explicit theory of change, an implicit theory of change can be distilled from the explanatory text accompanying the design. The theory of change outlines the causal logic by which the project's interventions were intended to catalyse investment in the PVA maize market and uptake of PVA maize by farmers and consumers, ultimately leading to reduced prevalence of VAD in Zambia.

The challenge project's incentive structure was designed to induce participating millers (and later seed companies) to invest in the PVA maize market (and PVA maize seed market) at scale. The details of these investments were left to the discretion of the competitors, but were expected to include developing supply channels, branding a PVA maize (or maize seed) product, and creating demand through a product marketing and distribution plan. It was anticipated that miller investments to create a market would in turn create demand that

[2] Zamseed later joined the AgResults competition as a seed company competitor.

[3] The term "emergent farmer" is used by the Government of Zambia to describe farmers cultivating 5-20 ha of land, they are "also associated with innovation, dynamism, superior management skills, and greater access to capital, compared to conventional small-scale African farmers" (Sitko & Jayne 2012).

would induce farmers to plant PVA maize for their own consumption and supply the newly created market with their surplus product. The project hypothesized that without this consumer market, farmers would be unwilling to grow PVA maize for their own consumption. The addition of seed companies to the competition helped to ensure availability of PVA maize seed to smallholder farmers, with potential benefits for the supply of PVA maize to millers as well as direct benefits to smallholder farmers as both producers and consumers of PVA maize. Seed companies were perceived to be enthusiastic about the market and capable of expanding the market through investment.

The addition of the seed company incentive was partially in response to the evaluation's baseline report (Abt Associates, 2015). The report noted that successful establishment of a market for PVA maize would not necessarily lead to the desired development impact of reduced VAD among nutritionally vulnerable consumers, who are primarily rural smallholder farmers, many of whom do not sell maize. The participation of VAD-vulnerable consumers in markets for milled maize, and maize more broadly, is limited, but many smallholder farmers do engage directly in the market for maize seeds. Section 4 further discusses the need to better link the project's market development objectives and its intended development impact.

1.4 Early termination and close-out assessment

At the April 2018 AgResults Steering Committee meeting, the Committee acted on the Secretariat's recommendation to close out the challenge project early. The Secretariat cited substantial challenges to the project's achievements resulting from government manipulation of the maize market. These challenges limited the private sector's activities and achievements in the PVA maize market, which undermined progress towards the project's objectives. This report presents the findings of a close-out assessment by the AgResults External Evaluation team. Data for the assessment were collected in-country within one month of the project's formal conclusion on August 31, 2018.

2. Close-out assessment design

The close-out assessment was intended to provide insights into the challenge project's impacts, the likely sustainability of activities and benefits that the project catalysed, and unintended consequences of the project's early termination. In this analysis, we contribute to lessons learnt about the potential for PfR schemes to address different types of development problems and highlight best practices for the development and implementation of challenge projects. We structured our assessment around the following questions:

- What were AgResults' effects on private sector investment in PVA maize?
- What is the likely sustainability of private sector actors' PVA maize activities following termination of the challenge project?
- What are the implications of early termination of the challenge project for
    - The PVA maize value chain?
    - Support for PVA maize and programs promoting PVA maize?
    - Perceptions of, and support for, AgResults and payment-for-results schemes?
- What lessons can we learn from the challenge project about best practices in the design and implementation of PfR schemes?

The close-out research utilised qualitative methods, with both primary (field) and secondary (desk) research. The qualitative lead, supported by a Zambia-based agricultural economist, collected primary data between September 9 and 22. The team fielded semi-structured questionnaires to gather data from interviewees. Interviewees included the challenge project management team, Advisory Council members, project competitors, and PVA maize value chain actors (e.g., seed distributors and retailers; maize processors and retailers). Respondents are further summarised in Exhibit 2-1. These interviews covered, as applicable, the respondents' activities in the market for PVA maize and their experiences with and perspectives on the market for PVA maize in Zambia, AgResults, and the early close-out decision. Due to budgetary constraints, we did not interview farmers in our close-out data collection. The report was also informed by a review of documents including challenge project manager updates, Secretariat presentations to the AgResults Steering Committee, and external research and statistical reports. Where applicable—for example in examining whether AgResults has contributed to development of a market for PVA maize and maize seed—we also drew from and built on results of our baseline assessment.

The team analysed data using qualitative methods, including thematic summaries of responses organised along the major lines of inquiry. Unless otherwise specified, all themes and major results drawn from our interviews represent majority perspectives as reported by our interviewees.

Exhibit 2-1. Qualitative research respondent sample

Respondent type	Sample obtained
Challenge project management	DC- and Zambia-based teams
Advisory Council members	7 members
Competitors	2 seed companies 5 millers
PVA maize value chain competitors	6 food retailers 2 maize processors 9 agro-input distributors & retailers

3. Findings

In this section, we describe the results of the External Evaluator's close-out assessment of the challenge project. The analyses are organised in alignment with the central evaluation questions presented in Section 2. These questions address the project's effect on markets and effect on the development problem, the complementary effects of other initiatives, the sustainability of the increased engagement in PVA maize, and the consequences of the project's early termination on markets and perceptions.

3.1 Market development and impact

AgResults played a role in the development of a niche market for PVA maize, although with limited development impact because the market tended to involve better-off smallholder farmers and urban consumers. While AgResults played a clear role in developing this niche market, it is not possible to isolate the magnitude of its effect relative to the complementary role played by 'push' initiatives that were operating at the same time.

The evaluation's baseline analysis (Abt Associates, 2015) revealed the market for PVA maize to be nascent, with its development impeded primarily by low awareness of PVA maize and its benefits among both potential suppliers and buyers along the value chain. There was little activity in the PVA maize market, and penetration of PVA maize among both farmers and consumers was extremely limited. Accordingly, there was little commercial activity in the market for PVA maize. HarvestPlus, which developed PVA maize, was responsible for virtually all activity that existed. At the baseline, only one miller was active in the market, and only two retailers were stocking PVA maize. These retailers cited high rates of inventory returns due to low sales. One retailer provided a sales report in which PVA maize accounted for only 0.3% of monthly maize sales volume.

The evaluation's close-out investigation revealed that AgResults contributed to the development of a niche market for PVA maize. At the time of the project's termination, there was a nucleus of farmers oriented to the industrial milling market (which was almost entirely dominated by millers participating in AgResults), and only middle-class, nutrition-focused consumers demanded PVA milled maize. However, these actors are less likely to be nutritionally vulnerable suggesting a smaller than desired impact on the VAD development problem.

Overall, eight participating millers purchased 993 MT of PVA maize from farmers of differing scales of production, marketing as much as 815 MT[4] of PVA maize through commercial channels (Deloitte, 2018b). Also, two participating seed companies achieved a total of 670 MT of qualifying sales of PVA maize seed (99% of which was accounted for by one company) (AgResults 2019). The results that follow characterize the involvement of major maize value chain players in the market for PVA maize. The description focuses on millers and seed companies that were directly targeted by the AgResults project, but also addresses the work of other PVA maize value chain actors.

Millers

Despite participating millers' significant investment in PVA maize, significant consolidation had occurred by the project's close-out, and only three of the original eight millers were still active in the market for PVA maize. All three reported burgeoning demand (particularly

[4] The project business plan (Dalberg, 2012, p.7) projected total sales of 128,000 MT of PVA maize meal over the life of the project, meaning that total sales were less than 1% of those projected.

among some major retailers) and detailed specific strategies to meet current and future demand.

AgResults millers generally procured PVA maize through intermediaries or directly from farmers. They advertised themselves as buyers of PVA maize, usually paying prices that were on par with those of white maize. Millers added value to the PVA maize, producing either breakfast, roller, or a hybrid (intermediate quality) meal. PVA maize was typically packaged in relatively small packages (5 kilograms (kg) or 10 kg) to allow consumers to buy it experimentally, though some millers did sell 25 kg bags of it (the usual packaging size for white maize). PVA maize was priced either at a discount or on par with white maize of similar quality.

Millers distributed the milled PVA maize through their own retail distribution networks, including retail outlets, supermarket chains, and their own depots. Millers marketed the milled PVA maize to consumers using promotional efforts (such as branded clothing and hats), informational labelling on packaging, and radio advertisements. They also participated in AgResults-sponsored 'road shows' that brought together AgResults miller and seed company competitors, as well as other PVA maize stakeholders, to raise awareness of PVA maize among local consumers and other potential PVA maize market actors.

No millers reached the minimum sales threshold that would have allowed them to receive the AgResults cash prize. However, the extent of millers' investment in the market varied. Many of the respondents interviewed at close-out were largely positive about their involvement in AgResults and participation in the PVA maize market in general, even though they ultimately did not win any of the challenge prizes.

Seed companies

Our close-out research supported our hypothesis that the seed company incentive would pique seed companies' interest in the value chain and motivate them to produce and market more PVA maize seed. However, despite increasing production of PVA maize seed, there was no evidence that the seed company incentive had a transformative effect on seed companies' investments in PVA maize seed.[5]

At the time of project close-out, AgResults had involved two seed companies, though only one had qualified for the cash reward in the final year of the project's two-year incentive period (despite producing PVA maize seed, the second company chose to sell to export buyers—as discussed in Section 3.1 of this report—and those sales did not qualify for the AgResults incentive. Both seed companies involved with AgResults were active in the PVA maize seed market prior to AgResults, yet they described AgResults as an important factor enhancing their activity in the market. They also saw the AgResults challenge project as a fruitful opportunity that helped them to establish themselves in the market for PVA seed beyond what they would have done in its absence. One seed company representative noted, for example: "We took advantage of the opportunity as a smaller company and got something out of it. We are now famously known as a provider of PVA maize." Furthermore, both companies expressed that their status as 'pioneering' purveyors of PVA maize differentiated them from other seed companies.

The seed companies, Zamseed and Kamano Seed, described their interactions with AgResults as a 'partnership' that began before the seed company incentive was introduced[6].

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[5] AgResults' early termination did not directly affect seed companies whose two-year incentive concluded before the challenge project was terminated.

[6] Although the seed companies' responses suggested that they perceived themselves to be AgResults beneficiaries from the point where they first sold seeds to AgResults, they were not, in

They referred, for example, to AgResults' purchase of seed during the challenge project's first year as instrumental to their work in the market. While the cash incentive was motivational ("The AgResults incentive pushed us to do even more"), they reported that these early purchases were also central to their achievements. For example, one seed company respondent reported: "The best result is that we were given some free money…For us, AgResults was very instrumental…AgResults bought almost 40-50 tons of [PVA maize seed]. They essentially bought it from us when we couldn't sell it. That was a good gesture." Another said "If we had never participated in AgResults it would have been a struggle. There was 50 tons of orange maize that AgResults bought, that was then distributed for free, so people planted it and got to know it. So AgResults created awareness of the product. Also, AgResults promotional materials were a help—it would have been a challenge to do it ourselves, and it likely will be a challenge looking forward."

The participating seed companies used their own production areas and contracted outgrowers to multiply the PVA seed (consistent with their procurement methods for other crops and varieties). They marketed the seed through diverse channels including the government (particularly the Farmer Income Support Program, FISP), NGOs, commercial actors (agro-input dealer distribution channels), and export buyers (particularly Angola and Zimbabwe). As part of their engagement with AgResults, Zamseed and Kamano Seed participated in AgResults-supported promotional events (that also incorporated AgResults participating millers), such as road shows. Despite the stated perception that these companies were integral to the PVA maize value chain, and indeed saw themselves as pioneers in it, the seed companies did not prioritize domestic commercial channels when faced with competing demands for the seed. Instead, demand from non-commercial sources affected seed companies' domestic commercial sales. For example, although FISP demand for seed was in flux at the time of our interviews as the program shifted to a voucher rather than an in-kind system, one seed company reported that FISP would get 90% of 2018 stock, despite private channels being emphasised in 2016 and 2017. Likewise, another seed company respondent described his decision to sell his company's PVA maize seed to the Angolan government, saying, "In the last two years we are having problems—Angolans came and bought every bit of orange maize seed. That leaves me nothing for the local market. I'm (promoting) it and talking about it, but it isn't there."

Other value chain actors

Retailers: Several retailers reported marketing PVA maize at the time of our close-out investigation, and several more reported entering the market. Supermarket chains such as Spar, Shoprite, and Choppies were the most successful retailers. They reported selling primarily to better-off, more health-conscious consumers. Diverse respondents to our interviews expressed that supermarket chains were just entering the PVA maize market when the project closed, and the challenge project manager estimated a monthly demand of approximately 1,250 MT with the incorporation of PVA maize into the product lines of several major retailers.

Agro-input dealers: Agro-input dealers (commercial seed dealers) were integral to the development of a private sector-driven value chain for PVA maize. While the proportion of seed companies' sales through agro-input dealers as opposed to other outlets varied over the course of the project, seed companies made deliberate efforts to cultivate commercial distribution networks for PVA seed. Supporting this, agro-input dealers themselves reported targeting their seed sales to smallholder farmers, encouraging them to produce PVA maize for home consumption (it was recognised as being particularly good for fresh consumption as roasted green maize). In addition, agro-input dealers referred buyers to millers, citing

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fact, included as project beneficiaries in the project design until they became competitors with the addition of the seed incentive.

anticipated purchases by them. During our close-out interviews, also, agro-input dealers in Central province reported that PVA maize was increasingly sought for production for animal feed. The orange colour was particularly desirable among egg producers because it deepened the colour of the egg yolks. This demand for PVA maize for animal feed was first evidenced early in AgResults when a large poultry producer offered to buy an existing stock of PVA maize, although development of this market was not an objective of AgResults.

Farmers: During the course of our interviews with seed companies, millers, Advisory Council members, and agro-input dealers, we also learned farmers were producing PVA maize for their own consumption, as well as for sale. Anecdotal reports of farmers growing PVA maize for the market highlighted the prevalence of small-scale (emerging commercial) and large-scale (commercial) farmers growing for the miller market. For example, agro-input dealers mentioned one farmer who had bought seed during the previous season to plant 20 ha of PVA maize. For the subsequent season, the same farmer purchased enough seed for 40 ha, citing the nearby miller (an AgResults competitor) as his intended market for the product. Likewise, one miller-competitor (Chimsoro) was reported to have produced 200 ha of PVA maize for their own use, and an Advisory Council member also reported having planted 200 ha with plans to sell it to a participating miller. Finally, one of the participating seed companies likewise reported having invested in production of PVA maize grain (not just seed) with the intent of selling to a participating miller. At the same time, seed company representatives and agro-input dealers reported farmers buying PVA maize seed to grow for their own consumption. This implies that commercial seed suppliers were also meeting demand that was more closely linked to the project's development objectives—production for consumption by smallholder farmers—even if that market segment was not a large share of total PVA maize produced.

3.2 AgResults 'pull' versus 'push' and other initiatives

Competitors reported that both pull and push aspects of AgResults were critical to their investments. At the same time, it is difficult to isolate the effects of AgResults versus other initiatives likes HarvestPlus.

An important consideration in this assessment is the extent to which the development of the value chain for PVA maize is attributable specifically to AgResults versus other donor efforts (such as HarvestPlus), and also the relative contributions of the push versus pull initiative within AgResults. It is particularly difficult to isolate the effects of AgResults versus other initiatives on the development of the market for PVA maize and the extent of its uptake. Overall, the two activities can be seen as complementary and interdependent, implying that each one's results would have been lesser without the other initiative.

In 2017, HarvestPlus reported that 875 MT of PVA seeds were produced, including carryover from 2016, of which 139 MT were sold locally in Zambia (HarvestPlus, 2018). The remaining seed was either exported to Angola and Zimbabwe or set aside for carry-over to 2018. In comparison, AgResults reported that in 2017, seed companies sold 225 MT of seeds to smallholders who were potentially motivated by the incentives (Deloitte, 2018a).[7] HarvestPlus monitoring data indicates that by 2018, it distributed PVA seeds to approximately 250,000 households in Zambia. AgResults does not have estimates of households reached and given the contemporaneous efforts, it is difficult to also isolate the households reached by the two different programs. However, HarvestPlus did not engage the maize millers, and the AgResults millers consistently reported that they would not have entered the market for PVA maize if not for AgResults. In fact, millers cited both the push and pull aspects of the AgResults initiative as being critical to their investments, activities,

[7] It is difficult to verify if the HarvestPlus reporting included sales made by AgResults, but it likely does because their reporting includes the seed companies that participated in AgResults.

and results. The 'pull' mechanism (cash incentive) provided the underlying motivation for their investment in the market. However, millers described the push activities—particularly the provision of a behaviour change specialist who worked with millers to develop their business and marketing plans—as critical to the gains that they perceived themselves to have made in the market.

Overall, the Advisory Council, challenge project management, and other high-level stakeholders described AgResults as playing a primary role in the development of a market for PVA maize. In particular, miller demand was seen as catalysing uptake by farmers, though HarvestPlus also played a role in promoting farmer awareness and uptake. These reflections were consistent with the overall intent of the project.

3.3 Sustainability

Our research suggested that the market would be sustained in the short to medium term, with private sector respondents describing their intent to continue in the market, specific plans for doing so, and ready demand for PVA maize. Our research also suggested that the market would continue to operate as a niche market, implying that the production and consumption of PVA maize is unlikely to become mainstream and unlikely to reach the most nutritionally vulnerable consumers whom the challenge project ultimately intended to benefit.

Below, we report the results of our inquiries about sustainability of the market. We investigated sustainability by eliciting our respondents' perspectives on the sustainability of the market as a whole and the issues underlying those views. We investigated these perspectives given both the market's own momentum and any potential effects of the project's early termination. We also asked private sector respondents about their own intentions regarding continued activity in the market, and, as applicable, the specifics of these plans for continued involvement.

Millers

At the time of our close-out data collection, two millers were working with PVA maize. These millers reported their intent to continue working with PVA maize and articulated their strategies for doing so. They described PVA maize as a way to diversify their product lines and gain visibility in the market. They also described their plans to procure PVA maize from local, commercially oriented small-scale farmers (preferably) or intermediaries. They reported that they would market the maize in relatively small units (5 kg or 10 kg), with sales led by supermarket outlets selling to health-conscious consumers. They planned to price the PVA maize roughly on par with white maize of similar quality.

Seed companies

The two seed companies working with PVA maize reported that they intend to continue producing PVA maize as long as there is demand for it. They reported this demand to be increasing, although growth of demand—and seed companies' production to meet that demand—is variable and ad hoc. Importantly, however, as discussed in Section 3.1, the seed companies do not prioritize domestic commercial channels when faced with competing demands for the PVA maize seed that they produce.

Seed companies reported that they are seeing steady or growing demand from international buyers (such as neighbouring governments purchasing for relief or food security programs), through FISP, and from commercial channels within Zambia. With respect to domestic commercial demand, seed companies reported that demand for PVA maize seed is holding steady or growing from some buyers (such as for domestic animal feed). Seed companies recognised, however, that AgResults-induced demand from millers was an important driver of that demand and would likely decline with the conclusion of AgResults.

Overall, the unpredictable nature of demand from non-commercial markets and seed companies' decisions to prioritize supply to those markets implies that continued supply of PVA maize seed to domestic commercial markets may be unstable. This behaviour, similar to the behaviours of the seed companies in the Uganda AgResults project, could hamper sustainability of demand. That is, seed companies are not inclined to produce *more* PVA maize to supply unpredictable international demand, but will divert seed produced for the domestic market to the international market given attractive terms. One seed company respondent reflected this, saying, "There is no way we will produce [significantly more PVA maize seed] without a market. We will produce less and sell it all rather than carry it over and face inventory costs and storage costs and loss of quality." Thus, while seed companies report strong demand and appear likely to continue to work with PVA maize seed, continuous supply to the nascent commercial (farmer) market is not assured.

Value chain

Our interviews with diverse value chain actors working with PVA maize revealed that there are farmers, agro-input dealers, seed companies, millers, and retailers intending to continue to act in the market for PVA maize for as long as they see demand. These value chain actors include several new private sector firms—including four processors and one small-scale (500 kg/hour) miller—that began working in the market relatively recently, mostly independent of any AgResults affiliation.

Several major international supermarket chains had just begun to carry PVA maize products. This is evidence of both a qualitative development—that is, a new stage in the development of the PVA maize value chain—as well as a quantitative shift in terms of substantially increased demand. Interviewees also reported that PVA maize had only recently been listed on the Zambia Agricultural Commodity Exchange where it was seeing unmet demand. Finally, several high-level respondents reported burgeoning public action that was likely to bolster the market. In particular, they mentioned intent on the part of the Ministry of Education to move PVA maize into the school feeding program, and the expectation that the Food Reserve Agency would purchase PVA maize in the coming season. While these two latter developments were notable, they were also not independently verifiable as current developments. For example, the Ministry of Education had discussed incorporating PVA maize in a 2012 report, and the Food Reserve Agency had been reported to be planning to buy PVA maize in the coming season for several years without this yet having happened.

Our interviews revealed that relatively more privileged market actors (e.g., commercially oriented small-scale farmers; and middle-class, nutrition-focused consumers) will continue to form the basis for supply and demand in the market. Continued messaging by public health agencies, along with firms' own efforts, will be key to maintaining and continuing to increase consumer demand for PVA maize. Also, it is likely that the PVA maize market will continue to exist as a niche market rather than expand to a mainstream market.

3.4 Early termination

Our inquiries showed that the market experienced a short-term disruption due to the challenge project's early termination. Numerous respondents reported concern that AgResults' early termination was indicative of waning donor interest in PVA maize. However, there was strong confidence about continued commitment to PVA maize by the Zambian government. Early termination of the challenge project did not appear to undermine support for the concept of a PfR scheme, largely because that concept was misunderstood in the Zambian context.

Here we discuss our results regarding the implications of the decision to terminate the AgResults project early on the PVA maize value chain, on perceptions of AgResults, and on support for the PfR concept. We investigated these issues primarily by asking respondents

open-ended questions about their perceptions of AgResults' termination. The line of inquiry evolved based on early responses to include respondents' understanding of the reasons behind the project's early termination, their perceptions of whether the early termination was warranted, and what effects the early termination might have. The interviews asked about the effects of the early termination on the PVA maize value chain and on public sector and donor-supported initiatives to support the dissemination of PVA maize in Zambia. The interviews also elicited perceptions of PfR schemes as approaches to developing markets for socially beneficial technologies, such as PVA maize.

PVA maize value chain

Stakeholders who were directly involved in and affected by AgResults articulated an overriding sentiment that the project's termination came at an inopportune time in the value chain's development. With respect to the implications of the challenge project's termination for the PVA maize value chain specifically, numerous millers and Advisory Council members broadly stated a perception that the market was just gaining momentum and several other ongoing efforts would have bolstered AgResults' investment.

While the challenge project's termination was broadly perceived to have disrupted the market in the short term, the same respondents who articulated this result also argued that the nucleus for a sustainable market had been established. They also stated that in the medium to long term, the market would stabilize, albeit likely at a lower level of volume than might have been seen without AgResults' termination. Despite some optimism that the market would stabilize, there was concern that the immediate market disruption would cause individualised losses for a number of value chain players. For example, several millers (who were not actively processing PVA maize) had stocks of PVA maize and expressed concern that they would be unable to dispose of them. In addition, interviews with agro-input dealers and other stakeholders revealed several cases in which individual farmers had significantly expanded their production of PVA maize. These farmers had anticipated a miller market for PVA maize, only to find that demand for the product had contracted due to the termination of the challenge project. For example, one farmer had increased his planting from 20 to 40 ha of PVA maize and an Advisory Council member had himself produced 200 ha of PVA maize in anticipation of selling it to an AgResults miller. Additionally, some millers and one major processor reported reneging on verbal commitments to buy maize from farmers due to the challenge project's termination, and several millers complained of being left holding PVA maize stock (in one case more than 100 MT). (None of these millers was actively marketing PVA maize at the time of challenge project termination, possibly because the lack of premiums made it costly to do so). Finally, one processor, affiliated with a competitor-miller, reported having invested approximately US$35,000 in packaging and branding and asserted that the early termination of the challenge project undermined his potential return on these investments, which had been expressly motivated by AgResults.

Public sector support

We asked the Advisory Council and other high-level respondents whether they thought that the close-out of the challenge project would affect donors' or others' willingness to invest in PVA maize in Zambia. If it would, we inquired what that effect might be. Responses to this question reflected a general perception that domestic stakeholders—including the Government of Zambia—remained committed to PVA maize and that this commitment was not affected by or at risk from the early termination of the challenge project. There was also a perception that donor support for PVA maize was perhaps waning, leading to concern among Advisory Council stakeholders and other respondents about future donor support for PVA maize.

The latter result—the perception that donor support for PVA maize might be waning—was largely the result of a confluence of factors, most of which were independent of the challenge project's termination. Respondents lacked a clear understanding of why the challenge

project had been terminated, and in many cases suspected that factors other than those which they recalled as justification for the challenge project's termination were actually behind the challenge project's termination. That is, there was a perception of a lack of transparency around the real reasons behind the challenge project's termination. This perception persisted despite efforts—including both meetings and written communications—by the Project Manager and Secretariat to inform Zambian stakeholders and be transparent about the challenge project's termination and the reasons behind it. Responses consistently reflected that respondents did not actually understand the reason or reasons for early termination. In some cases, they speculated on what might be the true, but unspoken, reasons for the challenge project's termination. Specifically, many Advisory Council members and competitors reported that they understood the challenge project to have been terminated due to lack of results and disagreed with this perceived justification, arguing that the market had made great strides during the project.

Respondents' concern about the future of PVA maize programming tended to centre on several concurrent developments—largely independent of the challenge project's termination—that many felt pointed to an overall withdrawal of donor support for PVA maize. These developments included the following: resignation of the challenge project manager; significant declines in HarvestPlus funding for PVA maize in Zambia; and a Bill and Melinda Gates Foundation program assessment conducted by J.E. Austin, whose field interviews were reportedly launched with the provocative question of whether there was a need to support PVA maize in Zambia. While these developments were external to the termination of AgResults, many respondents expressed concern about what they meant collectively. For example, one respondent stated, "It is considered suspect when donors lose interest."

Counterbalancing this broad result of the perceived decline in donor support for PVA maize, however, was the perception that the Government of Zambia and national-level stakeholders remain heavily committed to PVA maize. Examples of such commitment included reports that the Ministry of Health was undertaking new activities to communicate the nutritional benefits of PVA maize to consumers, anticipated purchases by the Food Reserve Agency, and FISP promotion of PVA maize.

Perceptions and support for AgResults and payment-for-results schemes

When asked about the implications of the challenge project's early termination, responses were heavily conditioned by interviewees' understanding of AgResults itself, and contingent to that, their understanding of the PfR concept. Specifically, it became apparent through the course of our interviews that most respondents did not understand the underlying concept of a "payment-for-results scheme". As such, the Zambian stakeholders did not clearly recognize that AgResults was a PfR project.

When asked how they would describe the AgResults project to someone not familiar with it, nearly all respondents described it in ways that were evocative of a value chain development project. They perceived push activities—such as project support for awareness raising, helping to create market linkages, and making sure farmers had seed—as central to AgResults' approach and activities. The 'pull' incentive, or cash prize for sales of milled PVA maize, was typically described as secondary in importance to push efforts. Several respondents commented specifically on what they perceived to be an over-emphasis on 'reporting and results' at the project level, which was often seen as misguided. These results were directly linked to the PfR incentive, and thus central to the "pull" aspect of the project. While competitors consistently acknowledged that the prize incentive motivated them to invest in the PVA maize market, several high-level respondents argued that the pull incentive itself should have come at a later stage in the market's development. That is, they argued the push activities were most critical to the establishment of the market at its most incipient stages, and that the pull incentive should have come later, after the foundation for the market was established.

In this context, the PfR scheme was perceived not as a means of creating incentives that *pulled* private sector actors into the market, but more of a way of *pulling* a product along the value chain. For example, one respondent explained that "HarvestPlus works on [the] production side, AgResults on [the] value chain". In that sense, the PfR scheme as a concept was equated to "development of a market" (i.e., creating derived demand for PVA maize). In fact, one respondent described AgResults as "a wonderful complement to the push strategy at the farm level".

While AgResults, and its underlying PfR scheme, were largely misunderstood, the project itself was broadly seen as successful, if insufficient, in creating a market for PVA maize. In fact, several interviewees speculated that its early termination could be a result of it having met its objectives. AgResults was heavily credited as playing a primary role in the creation of a value chain for PVA maize, along with many other achievements. These included:

- Raising awareness of PVA maize among urban consumers;
- Development of the supply chain;
- Stimulation of production of PVA seed and maize;
- Identification and recruitment of millers with adequate capacity; and
- Stimulation of millers' investment in the market.

Finally, there was no evidence to suggest that the support for the PfR scheme itself had been undermined, largely because of the broadly held conception of AgResults as a value chain development project.

4. Lessons learnt

In this section, we reflect on the Zambia baseline and close-out assessment results to draw out lessons learnt about best practices in payment-for-results schemes. We group the lessons around five themes—1) the relationship between the development problem and solution, 2) market failure, 3) competitors, 4) theory of change, and 5) the incentive structure. These themes build on our earlier Lessons Learnt Brief #2 (Mainville and Narayan, 2017).

Choosing a development problem and solution to address it

The solution to the targeted development problem should have the potential to directly and significantly impact the project's intended beneficiaries.

Vitamin-A deficiency is a significant issue in Zambia, particularly among poor rural consumers, and addressing VAD effectively could have a significant public health impact. That said, there is widespread variation in VAD across the country and among different consumer groups, and new evidence on the prevalence of VAD emerged after completion of the project's business plan which helped to add nuance to our understanding of how the project could best be targeted to maximize its development impact. While the challenge project's business plan cited a 2009 document which reported VAD to be widespread in Zambia affecting an estimated 56% of children in some provinces and afflicting nutritionally vulnerable consumers in both rural and urban areas (Dalberg, 2012), more recent assessments showed more limited prevalence of VAD, affecting an estimated one in five Zambian children (AgResults, 2014)[8]. Furthermore, the mandatory Vitamin-A fortification of sugar—which is consumed at higher rates in urban households than rural, and among wealthier consumers than poorer ones—and the prevalence of government supplementation programs targeted to pregnant women and children under five (Dalberg, 2012) imply that VAD rates are most likely to be highest among poor rural households, many of whom consume maize as a central food staple and who are more likely to be excluded from fortification and supplementation programs. These results suggest that the challenge project's potential impact on VAD would likely be limited to poor rural populations. However, the AgResults project did not directly target these rural consumers as beneficiaries, instead envisioning them to be "indirect beneficiaries" in its original design. The design identified urban and peri-urban consumers, who would buy and consume commercially milled PVA maize as the direct beneficiaries. The design defined smallholder farmers as "indirect" beneficiaries on the expectation they would be motivated to grow and consume PVA maize if an offtake market were available for any surplus PVA maize they produced. Similarly, only 7 percent of the urban and peri-urban consumers (and 3 percent over the long term) who were envisioned in the business plan to directly benefit from the project as buyers and consumers of PVA maize were estimated to be nutritionally vulnerable consumers—defined in the business plan as pregnant women or children under 5 (Dalberg 2012, pp.7 and 42). Therefore, an important lesson is that it can be risky for a project to depend on "trickle down" or indirect linkages in order for a significant development impact to be realized.

This limitation argues for the need to carefully define the target beneficiaries of PfR interventions and tailor interventions to reach them.

[8] Biofortification of maize has a benefit relative to industrial fortification in that it does not present the potential for toxic overexposure that is theoretically possible with industrially fortified foods (Stein et al. 2005).

The innovation should be proven to address the development problem and have a potential market.

Maize is a staple for many of the most nutritionally vulnerable groups in Zambia, and PVA maize is proven to address VAD. PVA maize also has market potential. Strong potential demand among health-conscious urban consumers, as well as among farmers who could come to appreciate its taste and nutritional benefits, could create a demand pull to support a niche market. This potential market implies the potential for consumers (including farmers) to benefit nutritionally and for farmers to benefit economically by participating in the market for PVA maize.

Addressing market failure

Challenge projects are most likely to succeed when the projects' competitors can adequately alleviate the binding constraints limiting the market's development.

In Zambia, there were multiple constraints limiting the development of the market and some binding constraints were outside the manageable interest of the private sector. The private sector could not influence the Zambian government's heavy involvement in the market for white maize, a strategic food security crop and close substitute to PVA maize. Further, while millers conducted individual promotional campaigns to build demand for their branded PVA maize products, they were in a weak position, compared to the public sector, to conduct a national campaign to increase consumer awareness of PVA maize and its health benefits. Millers themselves perceived that, as profit oriented companies, they had limited credibility in promoting the nutritional benefits of the product).

Incentivizing competitors

Competitors should see a long-term business case for the innovation and should have the numbers and capacity to form the foundation of a competitive market.

Both millers and seed companies participated as competitors in the Zambia challenge project. Millers were adequate in number to create the foundation for a competitive and sustainable market for PVA maize, but they did not see a long-term business case in working with PVA maize, especially at the outset. Millers also had limited capacity to address key constraints to market development. Specifically, they lacked the experience and management capacity needed to create a market for a novel product, particularly given the prejudices that existed against PVA maize among consumers (such as the tendency to confuse it with yellow maize, an 'inferior good') at the outset.

In contrast to millers, seed companies had both financial and business capacity (e.g., human resources, experience introducing new products) and perceived a business case for PVA maize. They perceived a business case in large part because there was already substantial demand for PVA maize through FISP and NGOs, and they also anticipated strong potential demand among smallholder farmers. There were also adequate numbers of seed companies as potential participants to develop a competitive and sustainable market for PVA maize seed, and they perceived a long-term business case for acting in the market.

In general, tepid response among potential competitors implies the need to revisit the justification for targeting them, rather than other private sector actors, as competitors.

Another lesson learnt is that there may be a rationale for public (or 'push') activities to raise awareness of an otherwise unknown but socially beneficial product, particularly when information constraints—for example the difficulty faced in perceiving the nutritional benefits

of PVA maize—limit the credibility of the private sector in promoting a product as socially beneficial. In this case, public investments, for example to support generic advertising of PVA maize and its nutritional benefits, had a role in helping to create a foundation for demand to be built on by the private sector.

Crafting a theory of change

The theory of change should articulate how the PfR scheme will induce competitors to address the market constraints limiting the development of a sustainable market.

In the case of the Zambia project, the theory of change had weak linkages between value chain actors and their interests. This is because nutritionally vulnerable smallholder farmers have limited market integration—Tembo and Sitko (2013), for example, showed that only 28% of small and medium-scale farmers were net sellers of maize[9], and farmers who buy maize preferred to purchase it unmilled due to its lower cost This limited market integration thus limited the relevance of the potential market to the potential beneficiaries of the challenge project—nutritionally vulnerable, poor rural consumers. (Reflecting this limited market integration, the business plan assumed that only about 7 percent of PVA maize would reach VAD consumers (Dalberg, 2012).)

The incorporation of seed companies, which had more direct linkages to intended beneficiaries, helped the project strengthen linkages to poor, smallholder farmers, although it could have had a stronger impact by specifically rewarding sales to farmers rather than all domestic entities (including government actors and NGOs).

Defining the incentive structure

Parameters for awarding prizes should link outcomes to the development objective and recognize trade-offs between market and development impact.

In Zambia, basing the miller prize on sales of *milled* maize weakened linkages to the ultimate intended beneficiary (poor rural farmers, who rarely buy milled maize) and limited marketing options only to buyers of milled maize. Many potential buyers of PVA maize—such as schools and health clinics—often buy unmilled maize due to its lower cost.

The seed company incentive rewarded sales to any domestic buyer—including the government and NGOs—but could have been more directly linked to the intended beneficiaries if it rewarded sales specifically to commercial sales channels. Tailoring the seed company incentive in this way would have more directly linked the outcome to the desired development impact, particularly given the evidence that the government program that purchased and distributed PVA maize seed (FISP) reached better-off farmers (Harman and Chapoto, 2017). Additionally, seed companies did not face significant constraints in scaling up production or distribution of PVA maize seed. However, they faced significant costs in developing a market base (i.e. demand) for PVA maize through commercial channels, again arguing for commercial seed sales to be the focus of the outcome as it would have promoted investments to overcome this constraint.

[9] This figure is consistent with the project business plan's observation that "At least 25% of smallholder farmers regularly sell surplus maize…" (Dalberg 2012, p.12) which is complemented in an Annex with data showing falling levels of maize sales—both as a percentage of farmers and a percentage of production—as farm size declines (Dalberg 2012, p.79).

5. Conclusion

The Zambia Biofortified Maize Challenge Project can be credited, in conjunction with the HarvestPlus project, with catalysing the development of a niche market for PVA maize, with potential for this market to be sustained if demand for the product continues to develop. That said, the market that was developed, and that was envisioned in the project design's theory of change, offers limited potential to reach the most nutritionally vulnerable VAD consumers, whose integration into maize markets is limited. Some design changes might have enhanced the results of the project without necessarily significant changes to its ultimate development impact. Such design changes include tailoring the seed company reward to sales to domestic commercial channels and rewarding intermediaries' sales of any PVA maize, not just milled PVA maize.

The early termination of the challenge project led to some unexpected results, including misunderstanding among many stakeholders about the reasons underlying the project's termination, as well as short-term disruption of the PVA maize market. Early termination did not appear to affect support for the payment-for-results concept in Zambia, however, because most stakeholders did not have a clear understanding of the mechanism.

Insights from the Zambia Biofortified Maize Challenge Project support several of the lessons learnt about best practices in the development of challenge projects, while also contributing important insights. These insights are the importance of developing a robust theory of change, selecting optimal competitors, and defining outcomes on the basis of which incentives will be awarded to most effectively promote the desired market and development impacts.

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