AgResults Zambia Biofortified Maize Challenge Project – Final Report

2014 – 2018

Submitted August 12, 2019

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INTRODUCTION

In Africa, more than 500,000 women and children die each year due to Vitamin A deficiency, which causes blindness as well as possible stunting in children. In Zambia, approximately 31% of children and 21% of women are affected by this preventable condition. The Zambia Biofortified Maize Challenge Project (2014-2018) used a Pay-for-Results (PfR) prize structure to incentivize commercial millers to source, produce, and market Pro-Vitamin A (PVA) maize meal and boost consumer demand to increase PVA maize consumption.

To increase the supply of PVA maize meal, AgResults offered a prize to incentivize commercial millers to purchase PVA maize from farmers and mill and sell maize meal to urban and peri-urban consumers to increase awareness and consumption.

In 2018, due to the lack of market response and ongoing enabling environment challenges, AgResults decided to terminate the Project. Despite its early termination, the Project still resulted in rich learning around what works and what does not work when designing and implementing a PfR approach to tackle maize biofortification. This final report describes the Project's goals, approach, and lessons learned.

Project Goals

1. Reduce Vitamin A deficiency among Zambian urban and peri-urban populations
2. Stimulate sustained demand for smallholder farmers to grow PVA maize by creating a market among millers
3. Motivate millers to diversify their product offering and produce and commercialize biofortified PVA maize meal
4. Generate an innovative new product introduction model
5. Measure the impact of the pay-for-results (PfR) mechanism to incentivize the private sector to promote a new product that reduces Vitamin A deficiency

Overall Project Results

- **Prizes:** Two participating seed companies sold 670MT of PVA maize seed over two seasons and received $266,673.50 in prizes.
- **Intake of Vitamin A:** Smallholder farmers retained 60-70% of PVA maize for home consumption.
- **Future of the Market**: Since the project ended, three millers have established agreements with retailers for PVA maize meal.

Lessons Learned

- It is difficult to implement a prize competition that seeks to address both supply and demand challenges at once.
- Using a Pay-for-Results competition to target a staple food commodity is risky because commodity markets are often vulnerable to fluctuating policies and political interventions.
- A prize competition that requires significant consumer behavior change must allow adequate time for mindsets and habits to change.
- Marketing a new product with a potential stigma may prove too heavy of a lift for competitors, who must consider whether the potential return on investment is enough to justify the effort.

PROJECT THEORY OF CHANGE AND ORIGINAL DESIGN

AgResults' broad Theory of Change (ToC) hinges on the idea that, if appropriately incentivized, the private sector will respond by creating and scaling new technologies to benefit smallholder farmers. In Zambia, the PfR incentive aimed to support earlier efforts by HarvestPlus to promote the adoption and consumption of PVA maize.

In 2012, as part of an effort to address Vitamin A deficiency in Zambia, HarvestPlus, a multi-donor agricultural health and nutrition program coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI), released three hybrid seed varieties of

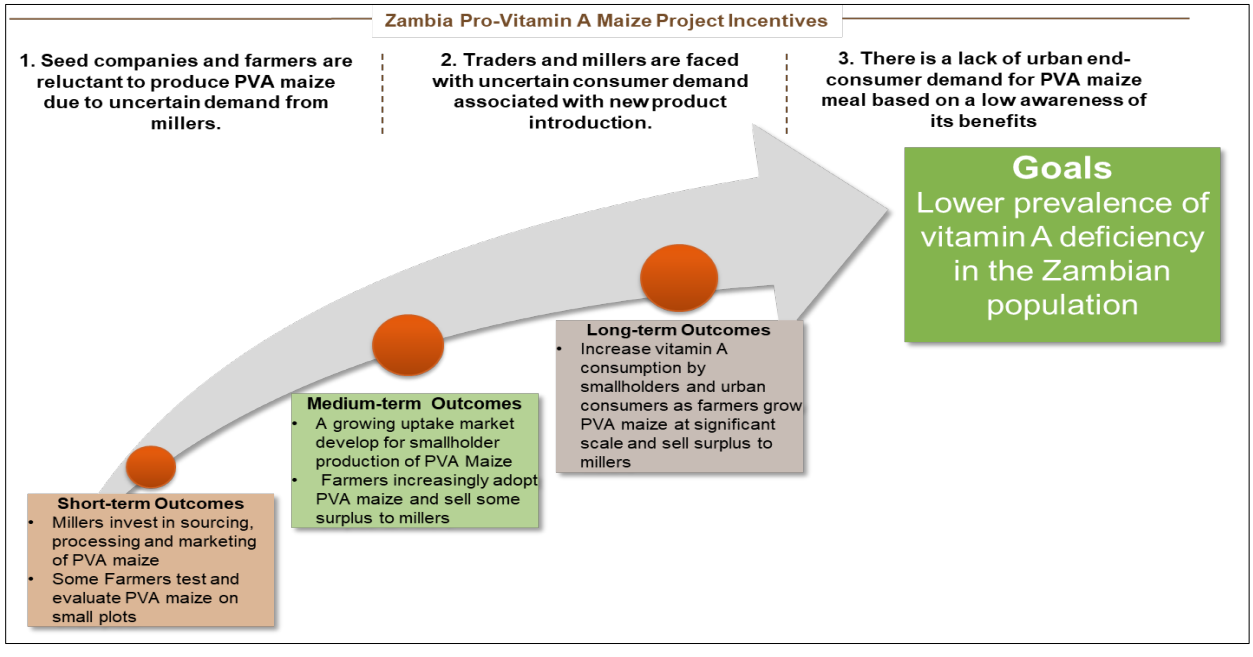
PVA maize. For more information, see Figure 7 in the Appendix. Unlike the dominant white maize varieties, PVA maize is non-GMO and contains high levels of beta-carotene — an organic, red-orange pigment found in certain plants and fruits that is the precursor for the body to convert it to Vitamin A. HarvestPlus had the mandate to raise awareness regarding the health and nutritional benefits of PVA maize among SHF. These efforts were concentrated in rural areas and focused on promoting the adoption among SHFs of the new PVA maize hybrids.

In support of HarvestPlus' efforts, AgResults designed the Zambia PfR prize incentive to motivate commercial milling companies to invest in sourcing, production, and marketing of biofortified PVA maize meal. First, by targeting sales to urban and peri-urban buyers, the millers would raise awareness of the benefits of PVA maize meal, creating a new market. Increasing the demand for this maize would then encourage smallholder farmers to increase the supply of PVA maize to meet the growing demand.

As a result, additional millers would enter the market, and traders would begin to build market links between growers and millers. Importantly, farmers would see the opportunity to grow and sell PVA maize while also saving a portion for home consumption. Since smallholder farmers in Zambia typically keep 50-60% of their maize for home consumption, the amount of biofortified maize retained and consumed at home would reduce the prevalence of Vitamin A deficiency. AgResults hoped that the incentive would motivate millers to establish production agreements with farmers to produce PVA maize and increase the supply of the maize while marketing PVA maize meal to increase demand.

Figure 1 shows how these efforts would overcome uncertain demand and low awareness of PVA maize.

Figure 1: Zambia Biofortified Maize Project Theory of Change



Original Contest Design and Timeline

The Project, which started in October 2014, aimed to stimulate demand by incentivizing commercial millers to produce and market PVA maize meal.

Because of their influence in the agricultural sector, AgResults chose commercial millers as the prime target for the PfR incentive. A market analysis conducted by the Project showed that industrial millers were best-positioned to organize the supply of PVA maize at scale and influence demand. Millers also appeared to play a central role in maize delivery: In Zambia, over 800,000 tons of maize grain — almost one-third of all maize produced in the country — passes through the industrial millers for processing. Figure 2 provides more information on the original contest design and timeline.

Figure 2: Original Prize Structure and Timeline

Year	Stage	Threshold (Payout)	Activities
Launch Phase	Project Launch (Oct 2014 - June 2015) and Stage 1: Miller Application Process and Selection	Selected marketing and sales plans ($50,000 per miller)	• Oct 2014: Launch Activity to raise awareness of upcoming competition • Oct 2014 - Jan 2015: AgResults contracted 45MT of PVA maize seed produced by participating seed company to ensure Year 1 supply of PVA maize for millers • Nov - Dec 2014: Interested millers submitted marketing and sales plan to multi-stakeholder committee on how they will source, produce, market, and sell PVA maize meal • Jan - Feb 2015: Four millers selected and each awarded grants of $50,000 to cover costs of implementing business plan, marketing, and market penetration efforts
Year 1	Stage 2: Per-Unit Sales Prize (May 1, 2015 - April 30, 2016)	1,000MT in individual sales ($50 per MT sold)	Millers eligible for a per-unit prize of $50/MT of PVA maize meal sold after surpassing initial individual threshold of 1,000MT of PVA maize meal sold • May 1, 2015: Competition begins • June 2015 - Sept 2015: Maize Harvest 1 • July 2015 - April 2016: PVA maize meal sales • April 2016: Prize distribution of $50/MT
Year 2	Stage 3: Proportional Prize Competition (Years 2-4: May 1, 2016 - April 30, 2019)	20,000MT in collective sales ($750,000 pool, awarded proportionate to sales)	• Millers compete for proportional prize of $2.5 million prize pool disbursed annually over Years 2-4 • Additional millers may join at any time • All millers must collectively sell minimum target of PVA maize meal before awards are disbursed • After reaching initial target, millers compete until end of the contest year, when individual total sales are tallied and proportional prize is allocated • Finalized targets are set after Year 1 so competition benefits from learning during per-unit subsidy stage (preliminary targets put forth in business plan) **Repeating yearly timeline:** • June - Sept: Maize Harvest • July - April: Maize meal sales • May: Prize distribution
Year 3		40,000MT in collective sales ($1,000,000 pool, awarded proportionally)	
Year 4		60,000MT in collective sales ($750,000 pool, awarded proportionally)	

VERIFICATION

All AgResults projects include a verification process to ensure that the competitors are meeting the prescribed thresholds that make them eligible for prizes. Although the contest design changed in Zambia, the verification process remained the same. From August 1, 2015 – June 30, 2018, the Project engaged in product quality verification and sales verification.

Product Quality Verification

General safety and quality of the PVA maize meal would be verified by a combination of visual checks as well as a scientific test to ensure minimum level of Vitamin A content in outgoing maize meal.

Sales Verification

Sales would be verified by a combination of self-reporting by competitors and auditing by a third-party verifier. A third-party audit of sales was necessary to corroborate the information provided by participating millers in self-reports. The verifier was responsible for auditing sales by visiting mills and tracking a sample of downstream sales.

FROM THEORY TO REALITY: IMPLEMENTATION

The Original Design in Action

In 2015, the Project entered "Stage 1: Application Process and Selection," accepting proposals from four millers on how they would introduce PVA maize and raise awareness among farmers. Each miller received a US$50,000 marketing and promotion grant and began conducting community-based marketing campaigns to identify farmers growing PVA maize.

Figure 3: Target States for Project

After the millers launched their marketing campaigns, the Project entered Stage 2 of implementation. Figure 3 illustrates the states that the Project targeted, and the locations of participating millers. The four participating millers targeted a PVA maize sales threshold of 1,000MT in the first year before receiving a $50 subsidy on each additional ton of PVA maize meal sold. However, due to a poor harvest produced by drought conditions, uncertain consumer demand and limited government support for PVA maize distribution, none of the participating millers reached the sales prize threshold.

Revised Contest Design

In 2016, following the poor harvest and low performance, AgResults revisited the original Project design to adjust the incentive structure and to address a disconnect between supply and demand of PVA maize. First, the incentive structure was deemed unrealistic because it asked millers to work collectively to reach shared sales thresholds to receive a prize. Millers in Zambia are not accustomed to working together and were reluctant to take that risk. The millers were also reticent and unaccustomed to operate outside of

their traditional business model and to proactively market a new product to the new market segment of urban and peri urban consumers.

Second, the PVA maize market was struggling due to a disconnect between supply and demand, further aggravated by chronic fluctuations and uncertainty regarding government policy. Initially the Project assumed that the millers would readily enter into advance market commitments with farmers to produce PVA maize. This concept never materialized since the large farmers with irrigation would rather produce seed and other more lucrative crops than commercial maize. In addition, millers were not accustomed to advanced purchases since they found it easier to purchase maize at the factory gate during the harvest season or source from the local Food Reserve Agency (FRA) depots with minimum financial risks and transport costs.

AgResults tried to increase the severely low PVA maize supply by providing a substantial quantity of seed and distributing it to small and medium farmers and women's farmer groups. However, poor weather conditions during that season reduced the crop volume, and when the maize was harvested, due to the distance of plantings from millers' facilities, it was too expensive to transport. Under these circumstances, smallholder farmers opted to keep the PVA maize for home consumption and sell any white maize they produced to the local FRA depot without a transport expense.

To address these challenges, the Project carried out extensive stakeholder consultation and made several changes to the competition. First, to encourage smallholder farmers to grow PVA maize and increase the supply, AgResults added a prize to encourage seed companies to produce, promote, and sell PVA maize seed to farmers, particularly in the areas close to miller production facilities. Previously seed companies had little to no incentive to promote PVA maize seed; in contrast, the white maize hybrids were much better known and more lucrative.

Second, the Project redesigned the prize structure to include a tax bracket-style incentive and more realistic sales thresholds. The prizes would increase as the volume in the brackets increased to incentivize higher levels of production and sales. As Figure 4 shows, the prize would then drop in the final bracket (3000-6000MT) to discourage a single competitor from monopolizing the market by purchasing all the available PVA maize. By reducing the payment beyond a certain threshold, competitors could still receive a prize for their investment but would not find it compelling to dominate the entire market.

The amount of money a company could win was calculated as:

1) a base threshold payment based on the total sale threshold reached of PVA maize seed or meal sold, and
2) an additional per unit payment for each metric ton of PVA maize seed or meal sold above the applicable thresholds

For instance, if a seed company sold 60MT of PVA maize seed in Sales Period 1, they would receive an award payment of US$17,700 [US$14,700+($300*10)]. If companies failed to reach the initial prize thresholds, they would not receive any payment. The seed company prize structure would only cover two sales periods whereas the millers would have three sales periods since the second and final seed sales period would provide the maize needed for the third and final sales period of the millers. Figure 4 and 5 provide examples of the new incentive structure for millers and seed companies based on Sales Period 1.

Figure 4: Example of Revised Prize Structure for Millers (Sales Period 1: April 2015 – March 2017)

Millers Sales Period 1: April 1, 2015 - March 31, 2017			
PVA Maize Meal Sold	Per MT Prize	Base Threshold Payment	Payment Structure
0 - 249	0	0	None
250 - 499	US $25	US $6,225	US $6,225 + ($25*MT Sold)
500 - 749	US $30	US $12,475	US $12,475 + ($30*MT Sold)
750 - 999	US $50	US $19,945	US $19,945 + ($50*MT Sold)
1,000 - 1,999	US $70	US $32,395	US $32,395 + ($70*MT Sold)
2,000 - 2,999	US $80	US $102,325	US $102,325 + ($80*MT Sold)
3,000 - 6,000	US $40	US $182,245	US $182,245 + ($40*MT Sold)

Figure 5: Example of Revised Prize Structure for Seed Companies (Sales Period 1: June 2016 – May 2017)

Seed Companies Sales Period 1: June 1, 2016 - May 31, 2017			
PVA Maize Seed Sold	Per MT Prize	Base Threshold Payment	Payment Structure
0 - 49	0	0	None
50 - 74	US $300	US $14,700	US $14,700 + ($300*MT Sold)
75 - 99	US $350	US $22,200	US $22,200 + ($350*MT Sold)
100 - 124	US $425	US $30,950	US $30,950 + ($425*MT Sold)
125 - 199	US $500	US $41,757	US $41,757 + ($500*MT Sold)
200 - 350	US $550	US $78,875	US $78,875 + ($550*MT Sold)

Based on the two different prize structures for millers versus seed companies, Figure 6 below summarizes the revised timeline of activities and prize distribution.

For more information on the millers' prize structure for Sales Periods 2 and 3 and the seed companies' prize structure for Sales Period 2, see Figures 8 and 9 in the Appendix.

Figure 6: Revised Prize Structure and Timeline

Phase	Millers	Seed Companies
Sales Period 1	• March 2015 - August 2016: Competitor selection • June - Sept 2016: Harvest • June 2016 - Feb 2017: Maize marketing season • Oct 2016 - Jan 2017: Planting season • Aug 2016 - June 2017: Sales verification • July 2017: Prize award	• June 2016 - May 2017: Sales period • Sept 2016 - July 2017: Sales verification • August 2017: Prize award
Sales Period 2	• March 2016 - August 2017: Competitor selection • June - Sept 2017: Harvest • June 2017 - Feb 2018: Maize marketing season • Oct 2017 - Jan 2018: Planting season • Aug 2017 - June 2018: Sales verification • July 2018: Prize award	• June 2017 - May 2018: Sales period • Sept 2017 - July 2018: Sales verification • August 2018: Prize award
Sales Period 3	• March 2017 - August 2018: Competitor selection • June - Sept 2018: Harvest • June 2018 - Feb 2019: Maize marketing season • Oct 2018 - Jan 2019: Planting season • Sept 2018 - July 2019: Sales verification • August 2019: Prize award	N/A

Overall Results and Project Termination

In early 2017, Sales Period 1 of the redesigned prize, the two participating seed companies sold 452 MT of seed and received $181,427 in prizes. In Sales Period 2, regional demand for PVA maize seed increased and competed with the local market. Due to the increased competition of regional demand for PVA maize seed, only one seed company participated, selling 218MT and receiving $85,246.50 in prizes. Meanwhile, millers continued to face challenges sourcing PVA maize and selling PVA maize meal; none of them sold enough maize meal to qualify for a prize.

Low performance stemmed mainly from government policies that caused maize prices to fluctuate and limited PVA maize availability close to the millers' facilities. These policies touched on three topics:

- **Food Reserve Agency (FRA)** – Government food reserve depots across the country simultaneously provided farmers with a market premium for white maize. In addition, local purchases of maize at the depots eliminated transport costs to the SHF. They did not purchase nor supply PVA maize. As a result, farmers were more interested in selling their maize to the depots than incurring higher transportation costs to sell to millers. This distorted miller purchases in the production areas since millers could also purchase white maize at a subsidized price at their local depots without having to pay for transportation, further skewing the market and making it difficult for millers to purchase PVA maize. In partnership with key stakeholders, the Project Manager advocated to include PVA maize in the FRA depots to increase availability and accessibility of PVA maize across the country and reduce the millers' transportation costs. Although by the end of Sales Period 2, FRA agreed to pilot PVA maize at a few locations during the Project's final year, this was too late to benefit the millers.
- **Export Ban** – A 2016 drought in Southern Africa left Zambia with a maize surplus while the availability of maize in neighboring countries dwindled. To keep farmers from exporting their maize at a higher price, a move that would have then reduced maize supply in Zambia, the government imposed an export ban from April 2016 to May 2017. During the export ban, the price of maize in neighboring countries jumped to USD$250-$350/MT while the domestic price of maize was USD$180-$220/MT. The price differential motivated farmers to hoard their maize in the hopes that the government would lift the export ban. In May 2017, the government lifted the export ban, but this coincided with a regional bumper crop, which dropped the price of maize to USD$120-$150/MT in Zambia. As a result, the farmers who held on to their maize lost money beyond recuperating their production costs.
- **Maize Market** – After the export ban was lifted, low prices led to a market standstill: Rather than sell their maize at the market price set at USD$120-$150, farmers hoarded their harvest, hoping that the official government price would eventually increase. However, the domestic and regional bumper crop discouraged the government from raising the purchase price of maize, reducing the availability of both white and PVA maize. With less maize available, the millers struggled to source the amount of maize needed to reach the Project's sales threshold. Through this period, farmers held onto their PVA maize and sold their white maize, which was easier to sell commercially. Given these enabling environment challenges, millers instead decided to focus on their primary source of volume and income — white maize.

There was also a behavioral obstacle related to farmers' view toward PVA maize: Zambian smallholder farmers remembered receiving yellow maize during the famine in 2008 and associated PVA maize with the "animal feed" they were given as assistance aid. This resistance was deep-seeded and hard to change. Even with both the Project and HarvestPlus working to increase awareness — the latter since 2010 — this shift did not happen in time for the prize to work.

Overcoming this stigma also required behavior change among the millers since they were used to selling maize meal as a commodity. As such, their model was not structured to create consumer awareness or actively market their products. With white maize, as with most commodities, there was minimal differentiation or segmentation, with competition based mainly on brand loyalty or price. Because PVA maize meal was not priced differently than white maize meal, wholesale chains did not see the benefit of investing resources to actively market a new product, especially when consumers were not seeking out that product. When the Project facilitated a workshop for millers on incorporating social and behavior

change (SBC) principles into their marketing approach and provided marketing grants, the millers expressed great interest, but it took time for that to translate into investments in new strategic marketing activities.

In 2018, due to the lack of market response and ongoing enabling environment challenges, AgResults decided to end the Project early. Despite its early termination, the Project still resulted in rich learning around what works and what does not work when designing and implementing a PfR prize competition approach targeting a politicized commodity.

External Evaluation Framework and Assessment

In parallel to project implementation, the AgResults External Evaluator independently evaluates the PfR prize competition approach to assess whether each prize competition addresses the underlying market failures and engages the private sector in the market for agricultural technologies while positively impacting smallholder farmers. Abt Associates, in partnership with Denise Mainville Consulting, serves as the External Evaluator for AgResults and employs a common evaluation framework to examine how each Challenge Project incentivizes the private sector to overcome market failures and improve smallholder farmer welfare.

Evaluation Approach

For each Project, evaluators apply rigorous qualitative and quantitative methods to test hypotheses about private sector and smallholder behavior. In Zambia, Abt designed a mixed methods evaluation with expanded qualitative research, as detailed in the evaluation design report. The quantitative analysis involved a before-after comparison of PVA maize purchase in urban markets not targeted by other interventions. The evaluators conducted two baselines, one before the Project started and again before the Project introduced the prize competition for seed companies. Since the Project ended early, the evaluation team did not conduct an endline survey or full final qualitative assessment. Instead, Abt conducted a close-out assessment (forthcoming).

Evaluation Findings

The evaluation team's early research before Project launch brought forward the following key learning points:

- **Targeting of Direct Impact** – First, because the Project focused on increasing sales of milled mealy meal, which is usually bought by urban consumers, it would mainly impact consumers who are not typically poor or Vitamin A deficient. On the other hand, smallholder farmers, who were more likely to be Vitamin A deficient, were not the primary beneficiary group. Rather, they were only one market segment that the market for PVA maize meal would serve as it developed.
- **Farmers' Role in the PVA Maize Market** – Second, the prize competition did not prioritize the incorporation of smallholder farmers into the commercial market chains for PVA maize. Instead, the competition aimed to indirectly impact them as PVA maize consumers if the farmers produced PVA maize and kept some for home consumption. The Project did not reward millers for buying from the farmers.

In part, these early findings motivated the Project to modify its incentive structure and incorporate price incentives for seed companies to sell PVA maize seeds. This directly engaged smallholder farmers in the

PVA maize value chain by making them primary beneficiaries and increased the Project's chance of influencing their Vitamin A Deficiency (VAD) status.

Findings from the close-out assessment touched on three topics:

- **Market** – During the Project's three years, AgResults helped develop a niche market for PVA maize. While AgResults played a clear role in developing this market, it was not possible to isolate AgResults' effect relative to the effect of "push" initiatives, such as HarvestPlus.
- **Development Impact** – Relatively more privileged market actors (e.g., commercially-oriented small-scale farmers and middle-class nutrition-focused consumers) were likely to form the initial foundation for supply and demand in the market. This meant that in the near term, the Project's intended development impact — increasing PVA maize consumption to reduce Vitamin A deficiency among nutritionally vulnerable consumers — was likely to be modest.
- **Sustainability** – Farmers, agro-input dealers, seed companies, millers, and retailers intended to sustain their engagement in PVA maize after AgResults' termination. While early termination of the Project meant a short-term disruption in the nascent market, there was a perception among most respondents that the market was "taking off," as evidenced by several international supermarket chains beginning to carry PVA maize products and reports of PVA maize having unmet demand on the Agricultural Commodity Exchange.

Learning

Despite its early termination, the Project resulted in rich learning around what works and what does not work when designing and implementing a PfR approach to tackle maize biofortification. Below are the main lessons that emerged from AgResults' work in Zambia:

Key Lessons Learned

1. It is difficult to implement a prize competition that seeks to address both supply and demand challenges at once.
2. Using a Pay-for-Results competition to target a staple food commodity is risky because commodity markets are often vulnerable to fluctuating policies and political interventions.
3. A prize competition that requires significant consumer behavior change must allow adequate time for mindsets and habits to change.
4. Marketing a new product with a potential stigma may prove too heavy of a lift for competitors, who must consider whether the potential return on investment is enough to justify the effort.

1. It is difficult to implement a prize competition that seeks to address both supply and demand challenges at once.

Design Assumptions

Incentivizing millers would address both supply and demand, and the existing seed supply was enough to supply the market for PVA maize meal.

What We Learned

Because a prize competition needs time to galvanize demand or provide adequate supply in the market, this approach can struggle to simultaneously address supply and demand challenges in a short period of time. A prize competition aiming to scale up delivery of a solution should target a

viable product that already has either adequate supply or demand. The prize can then act as the incentive for the private sector to innovate how it either increases awareness of the product among potential consumers or how it meets existing consumer demand. If a prize target does not meet this criterion, the competition may not overcome supply- or demand-related challenges.

In Zambia, we attempted to incentivize a proven product with low supply and limited awareness and demand: Existing practices of sale and distribution of PVA maize seed to smallholder farmers were minimal and mainly through government input subsidy packs or within the targeted districts to which HarvestPlus provided donation seed packets. The farmers who grew PVA maize lived in remote areas, making it difficult for millers to source maize and not cost effective to transport the maize to the millers' facilities. Without sufficient seed sold to farmers close to the millers, millers could not access enough maize to hit the sales targets to qualify for the prize. Furthermore, millers' standard business model did not include targeted marketing and product differentiation, so the millers struggled to create demand for a product that few people knew about. Even with a redesign, the contest could not synchronize both sides within a short period.

2. Using a Pay-for-Results competition to target a staple food commodity is risky because commodity markets are often vulnerable to fluctuating policies and political interventions.

Design Assumptions

PVA maize uptake would be enhanced through a supportive policy environment.

What We Learned

Because commodity prices are subject to government controls, a PfR competition incentivizing adoption or sales of a commodity often has limited influence. Government controls can deter private sector actors from properly investing in sales and distribution of these products. In Zambia, the influence of the Food Reserve Agency and the government's export ban severely impacted the potential of the PVA maize market. The Project Manager committed significant time addressing concerns of political interference by pushing for the inclusion of PVA maize under FRA maize purchases, which ensured price parity between white and PVA maize. Even with this effort, the Project never overcame all related political and economic obstacles because of the strong governmental grip on this staple crop. Practitioners must weigh the costs versus benefits of a PfR project that specifically targets a product that can be politicized and can be so unpredictable.

3. A prize competition that requires significant consumer behavior change must allow adequate time for mindsets and habits to change.

Design Assumptions

In part through HarvestPlus' work, PVA maize was a known commodity, and due to the nutritional benefits, Zambians would naturally embrace purchasing and consuming PVA maize meal.

What We Learned

Prize competition interventions should consider the extra time and resources needed to transform market systems when adopting of the new product requires behavior change among consumers. A thorough market and enabling environment analysis before project launch can shine a light on these

issues, but practitioners must continue to monitor behavior trends throughout implementation and employ product sensitization tactics as needed.

Zambian smallholder farmers initially resisted growing and consuming PVA maize because they thought that it was the same as the yellow maize "animal feed" that they had received during the 2008 famine, a perspective that only emerged after the project was up and running. The project attempted to retroactively overcome this hurdle by encouraging millers to incorporate social and behavior change (SBC) principles into their marketing. After the project provided training and marketing grants, millers needed time to invest in these new activities, and even then, consumer mindsets shifted gradually. If the competition had been structured with more time to change these behaviors, consumers might have eventually become more receptive.

4. Marketing a new product with a potential stigma may prove too heavy of a lift for competitors, who must consider whether the potential return on investment is enough to justify the effort.

Design Assumptions

The prize would incentivize millers to buy and sell PVA maize.

What We Learned

When a prize competition requires a company to significantly adapt its business model to market the targeted product, competitors may be reluctant to enact these shifts unless they can see the economic benefits. Millers in Zambia were unaccustomed to marketing their products because white maize meal is a well-known commodity among all households and does not require marketing. The need to develop consumer awareness of PVA maize forced millers to move outside of their traditional business model, increasing their costs and reducing incentives to participate in the Project. If there were obvious benefits to adjusting their business model, millers may have done so. However, embedded behaviors meant Zambians were hesitant to change their consumption patterns. At the same time, the enabling environment around maize as a commodity was not welcoming to the addition of PVA maize. Because of these factors, the prize competition did not provide a convincing enough case for the participating millers to invest in drastic business changes.

Conclusion and Looking Ahead

Despite the early closure and the lack of miller participation, the Zambia Biofortified Maize Challenge Project shaped the country's PVA maize market. The two participating seed companies sold 670MT of PVA maize seed over two seasons, which equates to a minimum yield of 67,000MT of grain. In addition, the Project worked with three additional seed companies that had received PVA maize parent seeds with high levels of beta-carotene; two of these seed companies have produced their seeds and one began selling seed on the market in 2019.

Results and Observations

- **Prizes:** Two participating seed companies sold 670MT of PVA maize seed over 2 seasons and received $266,673.50 in prizes.
- **Intake of Vitamin A:** Smallholder farmers retained 60-70% of PVA maize for home consumption.
- **Future of the Market**: Since project end, three millers have made agreements with retailers for PVA maize meal.

Due to government policies, smallholder farmers saw a drop in the price of both white and PVA maize over the life of the project, a shift that impacted home consumption of PVA maize. The reduction in price forced many smallholder farmers to hoard and increase the amount of PVA maize they would use for home consumption. The Project noticed that as smallholder households learned about the benefits of PVA maize, they were retaining 60-70% of the maize for home consumption, instead choosing to sell off their white maize. This increase in home consumption has improved smallholder farmers' intake of Vitamin A.

Finally, although millers did not receive a prize, by participating in the Project, some of them established relationships with farmers producing PVA maize and entered into agreements with retail outlets to sell their PVA maize meal. After the Project ended, three of the millers notified AgResults of the agreements they have made with multiple retailers, a sign that there may still be a future for the PVA maize market.

Although the Project was terminated early, the Pay-for-Results mechanism motivated the private sector seed companies and millers to increase their awareness of PVA maize and, for some, to incorporate it into their business model. Overall, the Zambia Biofortified Maize Challenge Project provided many insights into designing and implementing a PfR prize competition, illustrating how this development finance mechanism can shape private sector actions — as long as government and broader institutional factors are taken into consideration.

APPENDIX

Secretariat and Evaluator Learning Materials

Secretariat	
Adaptive Design in Zambia: Lessons from the Zambia Biofortified Maize Challenge Project (Sept 2017)	This Lessons Learned article analyzes initial project design decisions and the adaptation that followed as part of the AgResults Zambia Biofortified Maize Challenge Project. As challenges emerged - including a disconnect between supply and demand, variations in government policy, and an unrealistic incentive structure - the project had to adjust to get into a better position to achieve its objectives and sales goals.
Evaluator	
Final AgResults Evaluation Design: Zambia Biofortified Maize Pilot (July 2015)	This evaluation design presents how evaluators will assess if the project motivates industrial maize millers to invest in and drive expansion of the PVA maize market. The report presents the structure-conduct-performance framework, pre-post comparison design, and data collection methods (qualitative interviews; quantitative survey of low-income urban consumers).
AgResults Evaluation: Zambia Biofortified Maize Pilot Baseline Report (April 2016)	The baseline evaluation report uses data from 212 interviews of maize market actors (including smallholders, rural non-farming residents, retailers, and millers), as well as 1,013 interviews with urban shoppers. It presents findings about market actors' and consumers' awareness, production, purchase, and consumption of pro-Vitamin A maize.

News and Blog Coverage of Zambia Biofortified Maize Challenge Project

- Expert Analysis: Three Insights Implementing Prize Competitions in Zambia and Kenya (April 22, 2019)
- AgResults Awards $181,437 in Prizes to Private Sector Seed Companies in Zambia (October 24, 2017)
- AgResults and PVA Maize Market Stakeholders Met to Discuss Challenges at First Zambia Lessons Learned Event (September 7, 2017)
- AgResults Presents Biofortified Maize to Zambia President (June 2, 2017)
- Biofortified Maize Offers Zambian Children a New Lease on Life, and Their Eyesight (April 4, 2017)
- Where There Are No Orange Maize Markets… (February 10, 2017)
- PVA Maize Promoted at the Zambia Agricultural and Commercial Show (August 28, 2015)

- Notes from the Field: Challenges with the Quality of Pro-Vitamin A Enriched Orange Maize in Zambia (March 23, 2015)
- AgResults Selects Four Millers to Launch New Biofortified Provitamin A Maize Meal Product in Zambia (February 6, 2015)

Supplementary Figures

Figure 7: Hybrid Seed Types

Seed Company	Hybrid
Kamano Seed	**GV662A** variety with **6ppm** of Provitamin A
Zamseed	**GV664A** variety with **7ppm** of Provitamin A New **GV671A** variety with **11ppm** of Provitamin A
SeedCo	**GV665A** variety with **7ppm** of Provitamin A
AFRI Seed	**GV672A** variety with **11ppm** of Provitamin A
Advanta Seed	**GV673A** with **9ppm** of Provitamin A

Figure 8: Revised Prize Structure for Millers: Sales Period 2 and Sales Period 3

Millers Sales Period 2: April 1, 2017 - March 31, 2018			
PVA Maize Meal Sold	Per MT Prize	Base Threshold Payment	Payment Structure
0 - 499	0	0	None
500 - 999	US $30	US $14,970	US $14,970 + ($30*MT Sold)
1,000 - 1,499	US $35	US $29,970	US $29,970 + ($35*MT Sold)
1,500 - 1,999	US $40	US $47,435	US $47,435 + ($40*MT Sold)
2,000 - 2,999	US $60	US $67,395	US $67,395 + ($60*MT Sold)
3,000 - 4,599	US $70	US $127,335	US $127,335 + ($70*MT Sold)
4,500 - 9,000	US $30	US $232,265	US $232,265 + ($30*MT Sold)
Millers Sales Period 3: April 1, 2018 - March 31, 2019			
PVA Maize Meal Sold	Per MT Prize	Base Threshold Payment	Payment Structure
0 - 749	0	0	None
750 - 1,499	US $30	US $22,470	US $22,470 + ($30*MT Sold)
1,500 - 2,499	US $35	US $44,970	US $44,970 + $35*MT Sold)
2,500 - 3,249	US $40	US $79,935	US $79,935 + ($40*MT Sold)
3,250 - 3,999	US $60	US $109,895	US $109,895 + ($60*MT Sold)
4,000 - 5,999	US $70	US $154,835	US $154,835 + ($70*MT Sold)
6,000 - 12,000	US $30	US $294,765	US $294,765 + ($30*MT Sold)

Figure 9: Revised Prize Structure for Seed Companies: Sales Period 2

Seed Companies Sales Period 2: June 1, 2017 - May 31, 2018			
PVA Maize Seed Sold	Per MT Prize	Base Threshold Payment	Payment Structure
0 - 49	0	0	None
50 - 99	0	0	None
100 - 124	US $350	US $34,650	US $34,650 + ($350*MT Sold)
125 - 199	US $425	US $43,400	US $43,400 + ($425*MT Sold)
200 - 299	US $550	US $75,275	US $75,275 + ($550*MT Sold)
300 - 600	US $650	US $130,275	US $130,275 + ($650*MT Sold)