Semilla Nueva Standard Report
First Semester January – June 2022

Table of Contents

EXECUTIVE SUMMARY

Overview

In 2020, Semilla Nueva launched a strategy to move from piloting sales of biofortified seeds to developing the breeding techniques, seeds, and subsidy program that would push the seed industry to begin adopting biofortified seeds at scale. By mid-2022, we can safely say that this strategy has reached a critical proof of concept. New seeds have allowed Semilla Nueva's sales to increase, subsidized seed companies are expanding their sales, and new seeds will be launched which will allow a path to adoption by hundreds of thousands of families in Guatemala, and soon, other countries. This report should be read as a series of interlocking, iterative improvements on the implementation of this strategy. We are incredibly thankful to the donors, advisers, partners and team that made it all possible–especially in the context of a growing food crisis at the world level.

Impact Evaluation

- Semilla Nueva reached **10,607** farming families in the first six months of 2022. We are well on track to reach our goal of **15,000** families by the end of the year.
- Biofortified maize was consumed by 72,128 family members (direct beneficiaries) and at least 278,533 indirect beneficiaries. Our total beneficiaries for the first semester of 2022 is 350,661, 6% higher than our total for 2021.
- Two nutrition researchers from Cornell University along with researchers from the International Center for Nutrition of Central America and Panama (INCAP) have started taking baseline measurements for our first third-party Randomized Control Trial. The study will review the nutritional intake and biological zinc and iron status of women and children who consume biofortified maize as well as conventional maize in eastern Guatemala.
- Semilla Nueva improved our economic impact data collection, addressing one of our two biggest organizational shortcomings from 2021. 58 farmers were identified who had purchased Semilla Nueva seed and planted it and another control seed side by side, allowing a representative evaluation of the impact of our seed on farmers' yields and incomes.

Sales, Marketing, and Production

- Semilla Nueva's sales increased 45% over the same period in 2021, reaching a total of 4,092 bags, our highest sales goal achieved to date. We met 81% of our 2022 target of 5,050 bags.
- Farmer targeting greatly improved by implementing new systems, protocols, and incentive programs for our team. 98% of farmers who participated in field days were in the target farmer segment, compared to 52% in 2021.
- In 2023, Semilla Nueva will need to work with a new system of distributors, given weaknesses in our current two distribution partners.
- Semilla Nueva produced 4,620 bags of F3 and 596 bags of F5. These 5,216 bags will be sufficient for our 2022 sales goal.

- The seed production quality issues mentioned in our 2020 reports appear resolved. Semilla Nueva's seed had an average 95% germination rate in the field and 92% vigor, far exceeding the average for all other commercial seeds in Guatemala (including those in the high-segment).

Collaborations–Public Policy

- Guatemala's largest national seed company, Valle Verde, continued to work closely with Semilla Nueva and its subsidy program. They reached 1,350 families the first semester, 35% more than last year, with plans to reach at least an additional 1,800 families during the second semester. With the expansion of new F5 and F7 seeds, Valle Verde hopes to more than double sales in 2023.
- Two of Guatemala's largest national seed companies began testing F5, with the goal of potentially joining the subsidy program in 2023.
- Semilla Nueva continued to donate non-commercial quality biofortified seed to subsistence farmers through partnerships with farming associations and NGOs, distributing a total of 711 44 lb. bags, a 67% increase over 2021.

Research and Development

- Semilla Nueva developed a detailed, three-year breeding plan with our Advisory Board which is available upon request.
- Semilla Nueva's micronutrient lab is now processing up to 750 samples per week. Semilla purchased new lab equipment (NIRS) to begin to evaluate protein quality, which will allow high throughput, low-cost evaluation of all nutritional traits we currently work on.
- Semilla Nueva's conventional breeding pipeline led to the launch of two new hybrids.
- 398 new hybrids were formed and are undergoing testing.
- Semilla Nueva's backcross program reached two important milestones by showing that: 1) we can convert conventional hybrids to biofortified zinc levels and 2) a line with 93% of the original DNA can be converted to high zinc.
- Semilla Nueva is working with our Advisory Board and technical partners to lay the groundwork for more cost-effective and quicker breeding technologies. Over 200 maize seeds with a known range of zinc levels were sent to CIMMYT for genetic evaluation.

Finance/Admin/HR

- As of the end of June, execution of the annual budget is 50% out of a planned 56%.
- Semilla Nueva closed our 2022 funding gap, with US$1.18M of new and renewed funding.
- Inflation rates in Guatemala have reached levels not seen since 2011[1], resulting in higher prices in field inputs and per diems for our field staff.

[1] https://www.banguat.gob.gt/page/inflacion-total

IMPACT EVALUATION

Summary

- Semilla Nueva reached **10,607** farming families in the first six months of 2022. We are well on track to reach our goal of **15,000** families by the end of the year.
- Biofortified maize was consumed by 72,128 family members (direct beneficiaries) and at least 278,533 indirect beneficiaries. Our total beneficiaries for the first semester of 2022 is 350,661, 6% higher than our total for 2021.
- Two nutrition researchers from Cornell University along with researchers from the International Center for Nutrition of Central America and Panama (INCAP) have started taking baseline measurements for our first third-party RCT. The study will review the nutritional intake and biological zinc and iron status of women and children who plant and consume biofortified maize along with women and children who plant and consume conventional maize. Results from the baseline measurements will be available in late 2022, and we hope to have final results by late 2023.
- This year the Monitoring & Evaluation and Sales teams improved the way that we collect economic income data, addressing one of our two biggest organizational shortcomings from 2021. 58 farmers were identified who had purchased Semilla Nueva seed and planted it and another control seed side by side, allowing an evaluation of the impact of our seed on farmers' incomes and yields.

Semilla Nueva is on track to reach our 2022 goal of 15,000 families using biofortified maize, with 10,607 families having planted in the first 6 months of the year

Semilla Nueva reached 10,607 farmers in the first 6 months of 2022. 1,699 of those farmers planted F5 (our new, higher-yielding seed) while 8,908 planted F3. Compared to this time last year, more farmers bought seeds (8,724 this year compared to 5,087 last year). We partnered with even more associations through our seed distribution program, and were able to give away over 18,500 pounds of seed to 1,883 families across Guatemala.

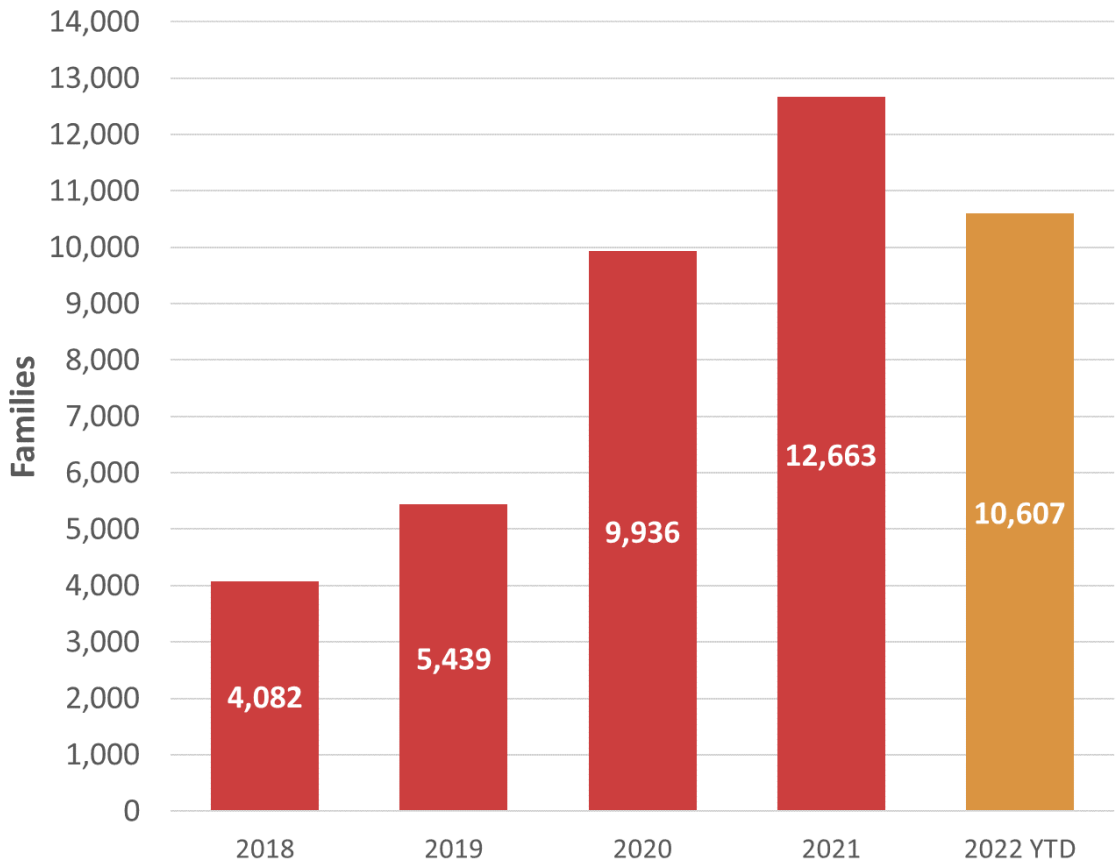

Figure 1: Families planting biofortified maize

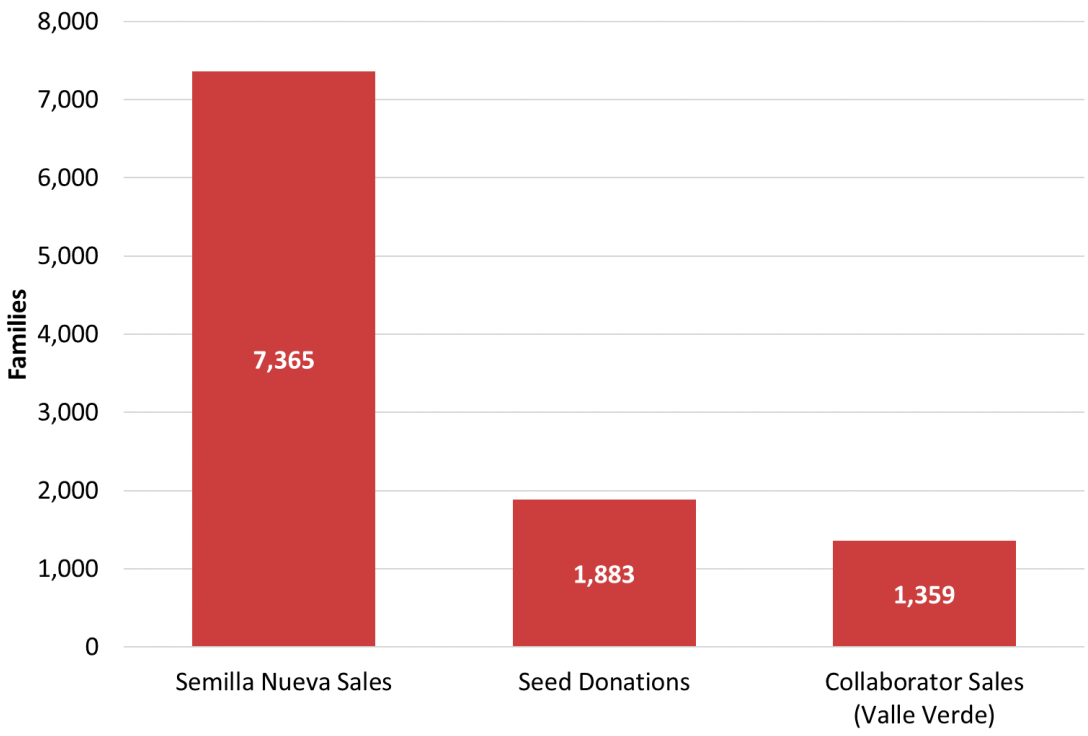

Figure 2: Seed sources for biofortified maize, Jan-June 2022

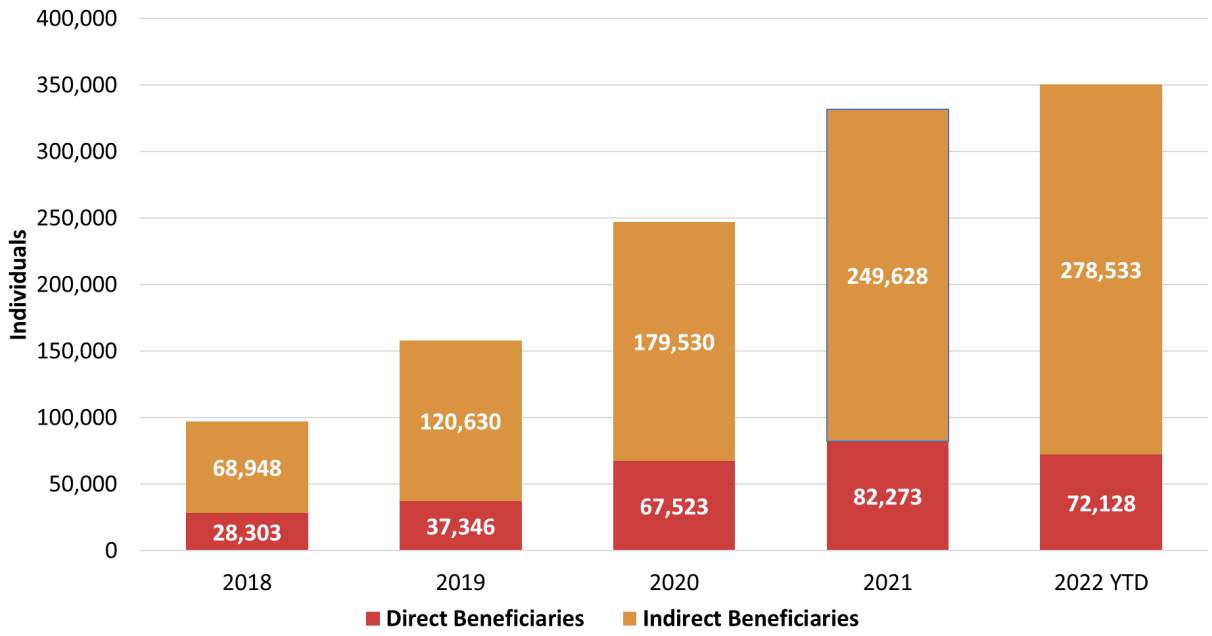

Figure 3: Direct[2] and indirect[3] beneficiaries per year

[2] Direct beneficiaries are the farmers who planted biofortified seed and their families.
[3] Indirect beneficiaries are the estimated number of individuals who consumed biofortified maize by buying from the market.

INCAP and Cornell begin our first third-party RCT on nutritional impact of biofortified maize

Building on our 2021 nutritional gaps impact study with INCAP, in early 2022 we began reaching out to leading nutrition scientists to review our results and consider how to create an improved, future study. While the 2021 study gave us key information on the impact that our biofortified maize can have on reducing nutritional gaps, the results would have been even more illuminating had we: 1) increased the sample size, 2) included a control group, and 3) included some biological measurement in addition to simply modeling nutritional intake. With that in mind, we began working with researchers from Cornell University as well as our partners at INCAP to design a randomized control trial that will look at the impact of biofortified maize on nutritional gaps and on nutritional status. INCAP will do the field work and process the dietary intake data while the Cornell team will use the collected biological data to estimate zinc and iron nutritional status.

With support from our Board of Directors, we reached out to two of the leading nutritional research scientists working on zinc and third parties studies of the impact of biofortified crops. Both Dr. Elad Tako and Dr. Saurabh Mehta work at Cornell University. Dr. Tako is a zinc specialist who has piloted a new, more accurate method for measuring zinc biological status that takes into account inflammation. Previous methods for evaluating the zinc status of individuals have been highly limited because if an individual is suffering inflammation (which is a common result of frequent infections in vulnerable populations in Guatemala), it can significantly skew results. Dr. Tako's methodology combines three biomarkers, including the LA-DGLA ratio[4], to more accurately measure zinc. Dr. Saurabh Mehta has experience in large scale nutrition study design for biofortified crops and implementation as well as experience measuring iron, zinc, and protein deficiencies in vulnerable populations. He is currently implementing a large-scale study that investigates the impact of zinc and iron biofortified millet on child nutrition in Mumbai, India. Dr. Tako and Dr. Mehta have been advising the design and implementation of this study and will process and analyze the biomarkers collected by INCAP in order to estimate zinc and iron nutritional status.

In addition to looking at nutritional status, INCAP will collect information on estimated nutritional intake and nutritional gaps of women and children using two standard methods: a 24 hour recall survey and a food frequency questionnaire (FFQ). Both methods only require interviews, which is far less intrusive than the blood and stool samples necessary for the biological status measurements mentioned above. INCAP and Cornell will thus be able to validate the correlation between these simpler interview based tools to measure nutritional intake and the iron and zinc biological status measured by blood and stool samples. Once validated, the Semilla Nueva M&E team (and INCAP) may be able to use these simpler interview based approaches to screen vulnerable populations for micronutrient deficiency in the future as well as predict the impact of our biofortified maize.

[4] Cheng, J.; Bar, H.; Tako, E. Zinc Status Index (ZSI) for Quantification of Zinc Physiological Status. Nutrients 2021, 13, 3399. https://doi.org/10.3390/nu13103399

The study was launched in May in partnership with the NGO World Vision. World Vision selected 249 vulnerable families with young children and mothers of reproductive age. Families were randomly provided with biofortified maize seeds or left to continue using their normal maize seeds. A portion of these families will be randomly selected to participate in the study. INCAP received approval from their Institutional Review Board in July. They plan to begin baseline measurements in August, and will take midline and endline measurements in early 2023, sending blood and stool samples to Cornell for analysis.

Improvements in data collection for economic impact analysis

One of our biggest areas for growth in 2021 was the implementation of a representative study on the economic impact of our biofortified maize. In the past, Semilla Nueva's field technicians identified farmers they knew who had planted both F3 and another conventional seed and measured the differences in yield and income from the two parcels. While this data was valuable, it didn't represent a random sample of the farmers who buy or use our biofortified seed. In 2021, transitions in our operations team and a lack of prioritization prevented us from identifying a large enough sample of farmers to meet our goal of a statistically significant sample.

In 2022, we were able to fix this problem. To date, we have identified and visited 58 farmers who are willing to participate in our impact evaluations. All farmers purchased F3 or F5 and have a non-biofortified seed planted on their land with the same planting density, planting date, and field management. This methodological improvement was due to two factors: improved training and management systems for our field team and a new experimental system for collecting farmer information when they purchase seed.

Incentives and new data sources allowed us to meet our goals

In order to create a sample large enough to choose from, we needed to increase the amount of farmer information that we were collecting. To do this, we re-envisioned the way that we were collecting farmer information and identified three sources to use: data technicians we hired and trained to be stationed at agrodealers, an incentive program for workers at agrodealers to collect information, and lists of farmers who attended our promotional field days.

Table 1: M&E parcels by source

Source	Total Collected	Total Verified	Qualified Farmers
Data Technician	768	330	11
Agrodealers	235	139	10
Field days	1,541	227	37
Total	**2,544**	**696**	**58**

Our data technician program largely continued an effort begun in 2020, training and stationing temporary workers in agrodealers to collect farmer data. The program was the most expensive way to gather data on farmers, costing $15 per verified farmer, or $450 per farmer who qualified for economic evaluation and agreed to participate in the program. This program will likely be discontinued in 2023 due to its high costs.

In 2022, we piloted a new program to collect data. Rather than pay temporary employees, we offered a direct financial incentive for every name and phone number that the workers at agrodealers obtained for F3 and F5 customers. The program was a success. The M&E team trained the staff at six agrodealers, who collected data from 235 F3 and F5 farmers. The program was far more cost-effective, costing $2 per verified farmer, or $27.80 per farmer who qualified for economic evaluation and agreed to participate in the program. The program was also far less labor intensive for our staff. One M&E coordinator was able to coordinate the program, which provided the same number of qualified farmers as the entire data technician program mentioned above, which required part-time management from seven field technicians.

Data from our field days were also used to identify parcels, which provided a significant supplement to the information coming from retailers.

One of Semilla Nueva's strengths is our continued experimentation. Upon finding deficiencies in our previous methodology from 2020-2021, we piloted several new alternatives and evaluated the effort required and cost for each. Based on this data, we will move to significantly expand the agrodealer partnership program in 2023. The program also has the added benefit of providing additional income to agrodealer workers, building more loyalty to the Fortaleza brand and a deeper partnership for future activities.

Data collection tool

In the past, the sales team used a combination of multiple excel sheets and the program Kobo Toolbox to collect data from farmers. Throughout the year, the team always struggled with connectivity issues while using the Kobo app. The same data was entered multiple times in multiple places, at times causing confusion over which data point was the correct one. In order to make the data collection process as effortless and efficient as possible, the M&E team designed a tool in Google Sheets that the field team has started using to collect economics data. Google Sheets proved to be the right tool for this data collection activity because it allows the field technicians to use offline editing when they are visiting farmers where there is no cell service, and it also allows the data to be entered and analyzed in real time. The M&E team provided multiple training sessions on how to use the document to collect data, and the field team has found it easy and intuitive to use, especially compared to previous years.

SALES & MARKETING

Summary

- Semilla Nueva's sales increased 45% over the same period in 2021, reaching a total of 4,092 bags, our highest sales goal achieved to date. We have met 81% of our 2022 target of 5,050 bags.
- Farmer targeting greatly improved by using and implementing new systems, protocols, and incentive programs for our team. 98.1% of farmers who participated in field days were in the target farmer segment, compared to 52% in 2021.
- In 2023, Semilla Nueva will need to launch a new system of distributors, given weaknesses in our current two distribution partners.

98% of farmers in field days came from the right farmer segment, compared to 52% in 2021

In our July-December 2021 Standard Report, we dove into one of our two programmatic weaknesses: only 39% of farmers who purchased F3 in 2020 purchased again in 2021. While Semilla Nueva's low repurchase rate was due to a number of factors, including quality control problems in 2020 which we have addressed (see *Production*, below), the primary issue was that our sales team was selling seed to the wrong farmers. Fortaleza F3 is only competitive for farmers who normally don't purchase seed or farmers who purchase the least expensive seed in the market (*the low-segment*), but only 52% of farmers attending our promotional events in 2021 were from these segments. This has been a recurring problem over the course of 2019-2021. This problem was largely due to an operations staff which came from international seed companies who were used to selling to wealthier, high-segment farmers and were unwilling and unable to identify and focus on a different farmer demographic. We ended 2021 with an aggressive commitment to change staff and strategies in order to fix this problem.

Over the first two months of 2022, Semilla Nueva changed its marketing coordinator, sales coordinator, and operations manager, and hired two new field technicians. Our COO hired a new marketing coordinator who was subsequently promoted to the operations manager role. One of our leading sales technicians became the sales coordinator. Semilla Nueva's leadership team decided that even if sales suffered in 2022, it would be better to promote to the right farmers that would allow consistent long-term purchases, rather than prioritize short-term sales over long-term customer retention. The new team created a new strategy, an in-depth training module for sales technicians, and a system of weekly KPIs and data tracking for our promotional efforts. A system of monthly bonuses based on these KPIs incentivized sales technicians to switch their strategy.

The new strategy worked. In 2022, we set a goal of having 1,400 low segment and non-hybrid farmers attending Semilla Nueva events. The sales team surpassed this goal by 19%, with 1,665 farmers from the right segment participating in our field events.

Figure 4: Field day involving the participation of low-tier farmer segment

Seed availability and visibility

The sales team also worked to address another major cause of farmers not repurchasing in 2021. 37% of farmers who didn't repurchase in 2021 did so because they couldn't find the seed at their local agrodealers. The sales team began weekly visits to agrodealers. Their monthly bonus was tied to the number of days agrodealers were out of stock. This inventory control was combined with negotiating the placement and necessary replacement of branding materials in the agrodealers we serve. The marketing team unified messaging in field days as well as new marketing materials at agrodealers.

Limited F5 production

In 2021, the operations team decided to sell only a small pilot amount of F5 seed, citing that this is a common practice at larger international seed companies. The limited production run of 500 bags of F5 was sold out within four weeks and left many agrodealers and farmers asking for more seed. F5 was well received by farmers due to higher yields and better resistance to the tar spot disease, one of the biggest problems for farmers in northern and eastern Guatemala. In the future, Semilla Nueva will launch new seeds more aggressively, especially those that have significant yield improvements above previous seeds. Demand was fostered by roughly 1,000 farmers who saw F5 in one of 29 demo plots throughout the country.

Effects from higher-priced inputs

In 2022, although fertilizers increased by an average of 244%, farmers who used our seed generally went ahead with their original planting schedules. We believe that one of the primary reasons our sales increased in 2022 was because farmers were impacted by higher input prices and sought out seed which offered a better value. Farmers have reported that they believe that Fortaleza seeds will allow them to produce enough grain for home consumption and sales, allowing them to take advantage of high grain prices due to inflation and the conflict in Ukraine's impact on gas and fertilizer supply chains. While this data remains anecdotal at this point in the year, our marketing studies in late 2022 will provide more granular data for the following report.

First semester sales summary: 81% of the year's goals

During the first semester, Semilla Nueva sold 3,503 bags of Fortaleza F3 and 589 bags of Fortaleza F5 seed (4,092 bags total) through agrodealers. Sales increased by 45% compared to the same period in 2021 and met 81% of the 2022 sales goal (5,050 bags). Semilla Nueva sold 13% more seed in the first six months of 2021 than in the entirety of 2022 (see Table 2, below).

Table 2: Fortaleza F3 and F5 bags sold by region and year

	2017	2018	2019	2020	2021	2022 (Jan-Jun)				
Region	F3	F3	F3	F3	F3	F3	F5	Total	Sales goals (total year)	Achieved
Eastern	0	512	985	1,556	2,391	2,862	386	3,248	3,390	96%
Northern	3	139	315	572	688	530	134	664	1,160	57%
Southern Coast	34	583	826	712	373	65	45	110	250	44%
Highlands	0	0	57	141	185	46	24	70	250	28%
TOTAL	**37**	**1,234**	**2,183**	**2,981**	**3,637**	**3,503**	**589**	**4,092**	**5,050**	**81%**

***Eastern Guatemala**:* In the eastern region, sales in the first six months of 2022 reached 96% of the goal for the year. Eastern Guatemala continues to be our best region, and the hiring of an additional field technician in the area contributed to the result. The departments of Santa Rosa, Jalapa, Jutiapa, and Chiquimula all had above 80% goal completion rates. This can be attributed to close community engagement, personalized technical assistance, and consistent agrodealer service from our field technicians. Additionally, this is the region for our strongest distributor operations hub. The departments of El Progreso, Baja Verapaz, Zacapa, and Izabal have room for improvement; this was the first year we had a technician in this area, and there is still opportunity to develop sales for later 2022.

***Northern Guatemala**:* Semilla Nueva's low performance in northern Guatemala was largely due to the failure of an experimental collaboration with Guatemala's largest cardamom cooperative. The organization had planned to sell 350 bags of seed, but sold less than 100. While Semilla Nueva has always wished to use cooperatives as an additional avenue to reach farmers, the potential income for these cooperatives selling seed (in the thousands or tens of thousands of dollars) is so much lower than the potential profits from exporting coffee, cardamom or other crops (in the millions of dollars) that it is difficult to get the organization to prioritize collaboration. To date, more than two thirds of sales (150 bags) have come through agrodealers, a shift we will complete in 2023. The department of Petén has a significant second sales season, and we expect the region to reach its goals by the end of the year.

***Southern Coast**:* In the southern region, Semilla Nueva's hybrids still do not have the necessary yields and disease resistance to be competitive. With the launch of F7 in 2023, we will expand our presence

in the south. We are currently working to hire a field technician in the region to launch demonstration parcels and promotional efforts in time for 2023 sales.

***Western Highlands**:* Unfortunately, our regional sales technician resigned before the beginning of the sales season. Further, our distributor for western Guatemala has a very weak presence in the Guatemalan highlands and significantly underperformed. Both factors contributed to missing sales goals in the region. A new sales technician has been hired and a new distributor is being pursued for the region.

Improvements in agrodealer management and hiring needs

Seed quality this season greatly improved, and as a result we have not had any returns or quality claims. The operations team constantly monitored inventory handling and rotation in agrodealers, which prevented seed from being left in shops for enough time for it to be damaged by heat or humidity. Despite having a successful year so far, areas of improvement and growth still exist in terms of increasing, consolidating, and developing our current sales team and improving distribution. Semilla Nueva still needs to hire a second commercial coordinator and one additional field technician. Developing the northern, southern coast, and highlands regions even further is also a goal we have for the second semester in 2022.

Marketing

In an effort to increase brand awareness and build on the unique brand attributes currently recognized and important to our farmers, the marketing team designed a simple campaign which focused on our three core Fortaleza characteristics: higher yields than low-tier hybrids or heirloom varieties, tolerance to wind and drought, and having the best tasting tortillas for home consumption. This messaging was delivered through a national mass media campaign during our peak sales season during the months of April, May, and June. A total of 571,597 SMS messages, 6,050 radio spots, fourteen newspaper ads, and five billboards reached 71% of our potential target farmers nationwide.

Field days and demo parcels

To date, field days and events continue to be our best promotional delivery tool to generate demand and brand awareness before the planting season starts. Despite having three fewer demonstration parcels in 2022, our operations team had more field days per parcel, and more participants per field day. This resulted in an attendance of 35 correct segment farmers per event in comparison to 22 in 2021. As a direct result of this execution, Semilla Nueva was able to bring in 1,737 farmers from the correct segment compared to 930 farmers in 2021. Field day farmer evaluations received a satisfaction score of 94%, and all farmers surveyed said they would be willing to participate in and recommend future events organized by Semilla Nueva.

Preparing for 2023 launch of new F7 seed

Considering F7's higher yields and disease tolerance, Semilla Nueva is planning to host launch events in regions with the most growth potential for this hybrid, the southern coast and Petén. The southern coast has a high concentration of high-segment farmers, and has always been an area of weak sales for Semilla Nueva. We expect that F7 will allow us to be competitive and adapt to these regions' conditions. The planting season in the south starts in early April; therefore demonstration parcels will be planted in November 2022 to have fields ready to show starting in early March. Additionally, each field technician at the national level will have five F7 demonstration parcels each, where we will be executing a minimum of ten field days per technician. In Petén, Semilla Nueva will continue working closely with Valle Verde and set up a demonstration parcel at their growing facilities.

Conclusion

In order to address our biggest weaknesses in 2021, Semilla Nueva made tough decisions regarding staffing and developed new systems for training and monitoring sales technicians. More than 98% of farmers attending field days came from the right farmer segment (vs. 52% in 2021). Agrodealers stayed stocked during the peak sales season because field technicians constantly visited agrodealers and immediately restocked if inventory was running low. As a result, we reached the most significant expansion of sales in the past three years.

To build on this positive momentum in 2023, there are several important areas of opportunity:

- We will expand our distribution system from two distributors to a minimum of six, roughly one distributor per key sales region.
- We will expand the total number of agrodealers from 76 in 2022 to 100, enabling a wider sales footprint, availability, and brand presence throughout all of Guatemala. The sales team will massively expand sales of F5, given its superior performance.
- The sales team will also begin a significant effort to promote our newest seed, F7 (see *Research and Development*, below). Learning from our experience with F5, we have already taken the first steps to produce enough basic seed to allow for 1,500 bags of F7 in 2023, its first sales season.

SEED PRODUCTION

Summary

- Semilla Nueva produced 4,620 bags of F3 and 596 bags of F5. These 5,216 bags are sufficient for our 2022 sales goal of 5,050 bags.
- The quality issues mentioned in our 2020 reports appear to be resolved. Semilla Nueva's seed had an average 95% germination rate in the field and 92% vigor, far exceeding the average for all other commercial seeds in Guatemala (including those in the high-segment). To date there were no reports of abnormal plants, but this indicator will be reviewed later in the year.
- Production costs for F3 seed were stable compared to previous years, only increasing by a dollar per bag.
- Semilla Nueva tested several locations and partnerships for seed production for both F3 and F5, including contracts for producing seed with the company Valle Verde. Production with Valle Verde proved the least expensive option and cut Semilla Nueva staff requirements.

Seed production increased this year

A total of six contract farmers planted 38 hectares to produce Fortaleza F3 seed between August and November 2021, representing 19% more area than the previous year. Nine hectares were farmed in eastern Guatemala, fifteen hectares were planted in the southern coast, and fourteen hectares were grown in northern Guatemala in the department of Peten. In the future, only F5 will be produced in northern Guatemala given its higher tolerance to the most important disease in the area, tar spot. A total of seven hectares of F5 hectares were produced by one contract farmer in the southern coast and an additional hectare was produced in eastern Guatemala by our R&D team.

In total, 4,602 bags of Fortaleza F3 and 596 bags of F5 were produced at a direct cost of $35 per bag, representing a $1 increase in per bag costs vs. previous years. Gross margins are negative given that we don't yet directly factor the subsidy that we offer to other seed companies into our economic calculations. If the same subsidy was applied, gross margins for 2022 would increase to $77,298.

Table 3: Historic and current Fortaleza seed production costs (US$)

Fortaleza (Total costs, $)	2017-2018 main season	2018 off-season	2018-2019 main season	2019-2020 main season	2020-2021 main season	2021-2022 main season
Seed Production Contracts	24,459	17,763	72,074	102,394	113,438	152,764
Processing Fees & Seed Treatment	4,680	2,194	9,620	12,265	13,922	17,451
Field to Processing Site Transportation	2,750	1,371	2,768	3,636	4,749	5,121
Bags, Labels & Quality Control Tests	2,500	1,653	5,780	6,222	7,073	8,781
Total Expenses	34,389	22,981	90,244	124,516	139,181	184,118
Revenue (Expected)	31,493	24,306	106,042	126,423	87,986	75,130
Gross Margin (Expected)	-2,896	1,325	15,798	1,907	-51,196	-108,987
Bags Produced	907	700	3,054	3,641	4,106	5,216
Cost Per Bag	38	33	30	34	34	35

Semilla Nueva stabilized production systems and quality control in 2021

Semilla Nueva was able to improve seed germination and vigor indicators through consistent and rigorous measurement of post-harvest grain humidity levels and improved farmer training. Our production team ensured correct seed humidity at harvest, drying, processing, and packaging. Combined with use of drier geographic regions identified in previous years, there were no significant quality control problems reported.

Semilla Nueva will produce 7,000 bags in 2022-2023 production season

Semilla Nueva's production plan for the 2022-2023 season is to have 1,500 bags of Fortaleza F3, 4,000 bags of F5, and 1,500 bags of the new biofortified hybrid, Fortaleza F7. To do this, we will need to increase seed production to 48 hectares. F7 has shown potential for more production than F3 and F5 under the same growing conditions, therefore third-party farmers and Semilla Nueva will be able to dilute production costs and increase margins for our growers next season. Semilla Nueva will also continue improving quality control protocols and production management systems through the hiring of new talent for the production team.

Summary

- Guatemala's largest national seed company, Valle Verde, continued to work closely with Semilla Nueva and its subsidy program. They reached 1,350 families in the first semester, 35% more than last year, with plans to reach at least an additional 1,800 families during the second semester through the production of an estimated 1,350 bags of F5 bags during the year's second semester.
- Two of Guatemala's largest national seed companies began testing F5, with the goal of potentially joining the subsidy program in 2023.
- Semilla Nueva continued programs to donate non-commercial quality biofortified seed to subsistence farmers through partnerships with farming associations and NGOs, donating a total of 711 44 lb. bags, a 67% increase over 2021.

Seed subsidy program with Valle Verde

Valle Verde began its second year of subsidized sales of biofortified seed in 2022. Valle Verde provided the following feedback to the program:

- Pricing has been the key to introducing the new biofortified seed to Valle Verde's main sales regions. With the subsidy, F3 currently sells for ~20% lower than the most common seed in the low-segment, HB-83, which is F3's closest competitor in northern Guatemala.
- Introducing F5 will allow for increased sales. Valle Verde's initial trials with F5 showed ~20% higher yield than F3. F5 also proved to be more tolerant to the region's most important disease, tar spot. In combination with pricing, Valle Verde expects F5 to sell well during the second semester and planted ten additional hectares of F5, nearly doubling its annual production from 2021.
- Semilla Nueva was forced to increase the subsidy cost by 10%, in order to maintain the suggested price to farmers while counteracting the impacts of inflation and the war in Ukraine on agricultural input costs.

Table 4: Valle Verde's subsidized sales of biofortified seed

	2021			2022		
	Semester 1	Semester 2	Total	Semester 1	Semester 2 (estimated)	Total
44 lb. bags sold	529	600	1,129	800	1,350	2,150

With its new biofortified seed production capacity, the company also began to sell biofortified grain, including to a USDA-funded program which is feeding 66,000 children in the Guatemalan highlands. Valle Verde has become Guatemala's primary contract producer of large quantities of biofortified grain, which will make possible new social programs for NGOs, government, and industry. Given the

success of the program and Valle Verde's initial tests of Semilla Nueva's new F7 seed, Valle Verde plans to expand from sales of 2,000 bags of seed in 2022 to 4-5,000 bags in 2023.

New seed companies begin evaluating the subsidy program

Two of Guatemala's largest national seed companies, Semillas Del Tropico and Semillas de Zacapa, have shown interest in participating in the seed subsidy program in 2023. Both have visited Semilla Nueva's parcels, met Semilla Nueva's team, and have begun testing F5 seed with their customers and staff. Semilla Nueva aims to convince both seed companies to pilot sales of 1,000 bags per company, making possible a goal of 7,000 bags sold by subsidized seed companies in 2023 (double Semilla Nueva's 2021 sales).

Partnerships with other organizations

Semilla Nueva made a conscious effort to increase its donations and help subsistence farmers to confront the current food crisis due to the war in Ukraine. Seed with lower germination rates (from the 2021 season) or smaller grain size (which most seed companies simply sell as grain) was provided to several organizations: the farming association APROCAFIL received 373 bags, the international NGO World Vision received 136 bags, and an additional ten organizations throughout Guatemala received a total of 202 bags. Semilla Nueva has 238 bags that will be distributed in the second half of 2022 to IICA, World Vision, and several farmer organizations in the Zacapa region.

In all cases, organizations have collaborated on providing lists to allow for impact studies, training to farmers on the potential of biofortified seed, and in several cases have partnered with Semilla Nueva's publicity and advocacy efforts. World Vision in particular is partnering with Semilla Nueva on our first third-party randomly controlled trial on the nutritional impact of biofortified maize and assisted in the selection of families. World Vision included data on the impact of biofortified maize in several of its publications and actively participated in encouraging the Guatemalan Ministry of Agriculture to create a new policy for biofortified seeds. Nearly all NGOs are also participating in Semilla Nueva's economic impact and food security impact evaluations as well.

This is Semilla Nueva's third year of providing non-commercial seed to NGOs. It requires nearly no additional costs and has created a significant amount of impact for farmers, partnerships with NGOs and public goodwill that we hope to utilize for our larger public policy goals.

Figure 5: Farmers from El Yalú, Sumpango, and Sacatepéquez receiving seed donations

Figure 6: Farmers from El Tunino, Sumpango, Sacatepéquez participating in technical workshop before receiving seed

Figure 7: Farmers from San Miguel Dueñas, Sacatepéquez with their seed and technical pamphlet

RESEARCH AND DEVELOPMENT

Summary

- Semilla Nueva developed a detailed, three-year breeding plan with our Advisory Board which is available upon request.
- Semilla Nueva's micronutrient lab is now processing up to 750 samples per week. Semilla purchased new lab equipment (NIRS) to begin to evaluate protein quality, which will allow high throughput, and low-cost evaluation of all nutritional traits we currently work on.
- Semilla Nueva's conventional breeding pipeline led to the launch of two new hybrids (F7 and F9).
- 398 new hybrids were formed and are undergoing testing.
- Semilla Nueva's backcross program reached two important milestones by showing that: 1) we can convert conventional hybrids to biofortified zinc levels and 2) a line with 93% of the original DNA can be converted to high zinc.
- Semilla Nueva is working with our Advisory Board and technical partners to lay the groundwork for more cost-effective and quicker breeding technologies. Over 200 maize seeds with a known range of zinc levels were sent to CIMMYT for genetic evaluation.

Micronutrient lab enters stable operation

Semilla Nueva's micronutrient lab continues to operate at high efficiency, allowing the R&D team to evaluate up to 750 new varieties of maize per week for iron and zinc. In March 2022, the lab was visited by Dr. Zewu Chen, the founder of Z-SPEC and inventor of the new high-precision HD-XRF equipment that has made our lab work possible. Dr. Chen reviewed the machinery and process and installed improved software to further increase the machine's accuracy. Semilla Nueva also identified and purchased a new Near-Infrared Spectrometry (NIR) machine that will allow low cost and high throughput evaluation of protein quality of our samples. The NIR equipment should be installed in late 2022 and will allow additional quality control for our current commercial seeds, the ability to verify nutritional quality for third parties, and ensure that our breeding process optimizes both micronutrients and protein quality.

Semilla Nueva prepares to launch our first self-developed hybrids and begins testing on 398 more

Out of over 250 hybrids created in 2020 for testing in 2021, two showed both the yields and nutritional quality necessary to compete with the best seeds in Guatemala's market. These two seeds, now named F7 and F9, will undergo promotion and final testing in the fall of 2022. The R&D team is producing enough parental seed to allow the production of approximately 1,500 bags of F7 and 500 bags of F9 for 2023 sales.

The figure below illustrates the results that allow Semilla Nueva to select new hybrids. Hundreds of new hybrids were tested between 2020-2022, and only two provided both the yield and zinc levels

necessary for advancement. As is shown below, F7 and F9 had yields that were above the best-selling seed in the high segment (DK390) and zinc that was higher than our current F3 and F5 seeds. Both are also QPM and will have high levels of protein quality. The information on the interaction of different parental seeds on both yield and nutrition allowed Semilla Nueva to create a new generation of 398 experimental hybrids which are currently undergoing testing. Several of these hybrids include new backcrossed lines to further improve nutrition and yield.

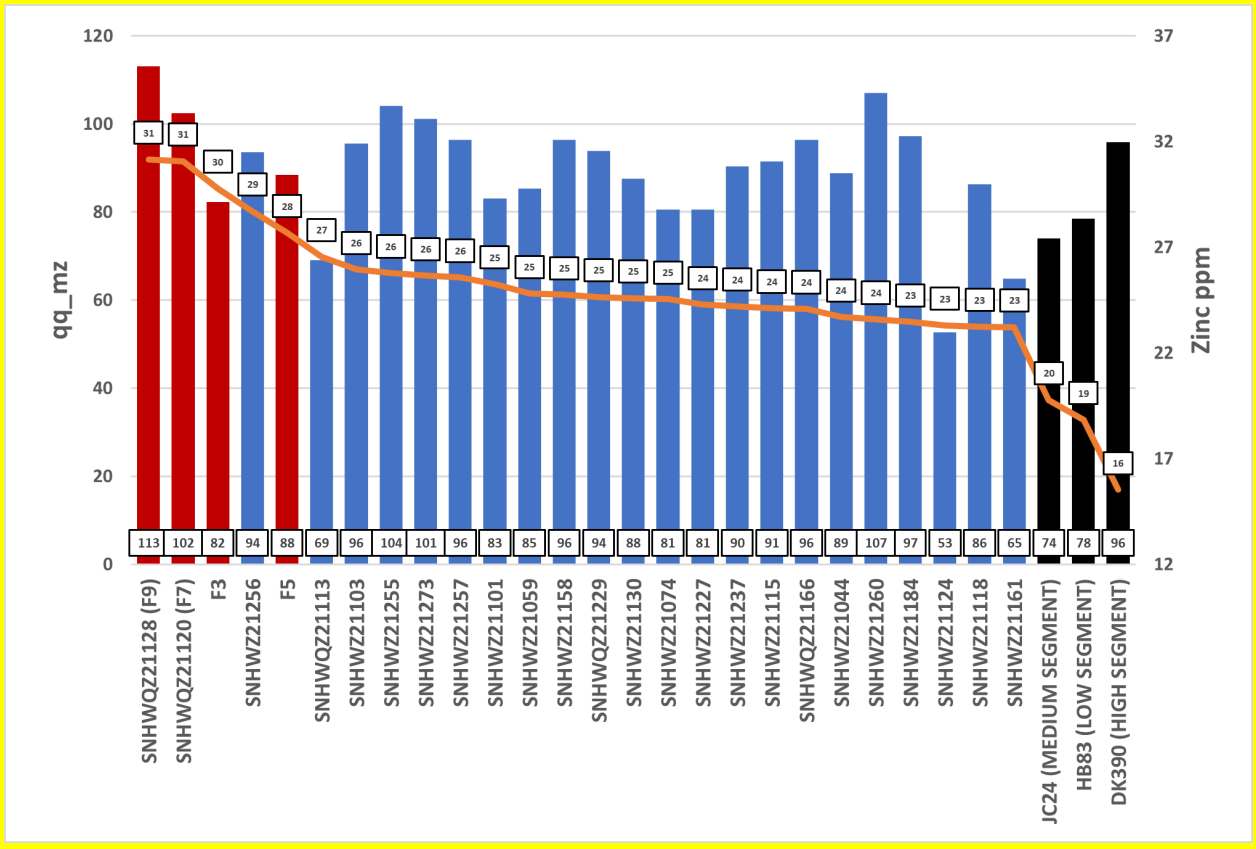

Figure 8: Results of 2021-2022 screenings of new hybrids. Zinc content is shown as a line and yields as bars. Materials shown in red are commercial Semilla Nueva materials, materials shown in blue are experimental, and black bars represent the primary commercial seeds in the market.

Backcross efforts show initial proof of concept

During 2017-2019, Semilla Nueva identified 10 conventional lines that formed hybrids with the potential to compete in yield and disease resistance with the best materials from international seed companies in Guatemala. Semilla Nueva selected the most competitive lines with high zinc and protein quality to use as donors and began a backcross process with these 10 lines. Initial results show that the backcross approach is feasible. Figure 9 below shows the zinc levels of over 200 backcrossed lines in both the BC1F2->F3 and BC1F3->F4 generations (75% of the DNA of their original line). Original zinc levels of two selected donor lines (in blue) and two lines being converted (recurrent parents in red) are also visible.

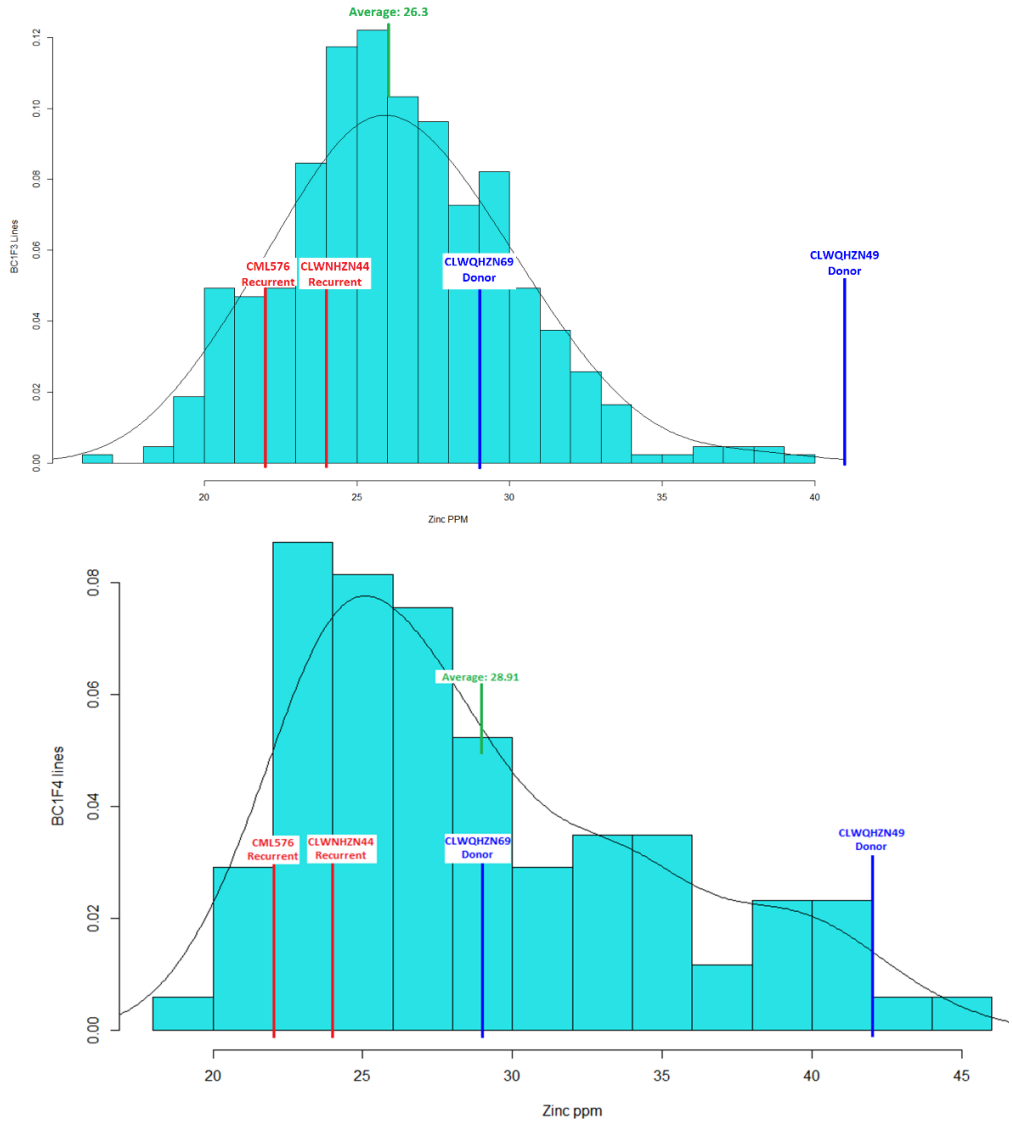

Figure 9: Histogram, zinc levels (ppm) of backcrossed lines

This figure shows that a portion of the backcrossed lines that we created reach (and some surpass) the zinc levels of both original high zinc lines. These tendencies continue from one generation (BC1F2->F3) to the next (BC1F3->BC1F4), with further segregation possible (evidenced by individuals in the second group reaching 45ppm). Semilla Nueva has seen this trend in all backcrossed lines to date, meaning that backcrossing itself is feasible with large enough populations (but requires a significant investment of time and resources).

Further, Semilla Nueva completed the development of the first line we consider to be "fully" backcrossed (93% of the original DNA but with higher nutrition). 53 lines were formed that reached this stage (BC3F2), of which 5 showed more than 35 ppm of zinc, a higher nutritional level than our current hybrid F3. The line which was backcrossed is one of the most promising in all of CIMMYT's

newest hybrids, offering excellent yield, disease resistance, and climate resilience—and will be used in new hybrids being generated.

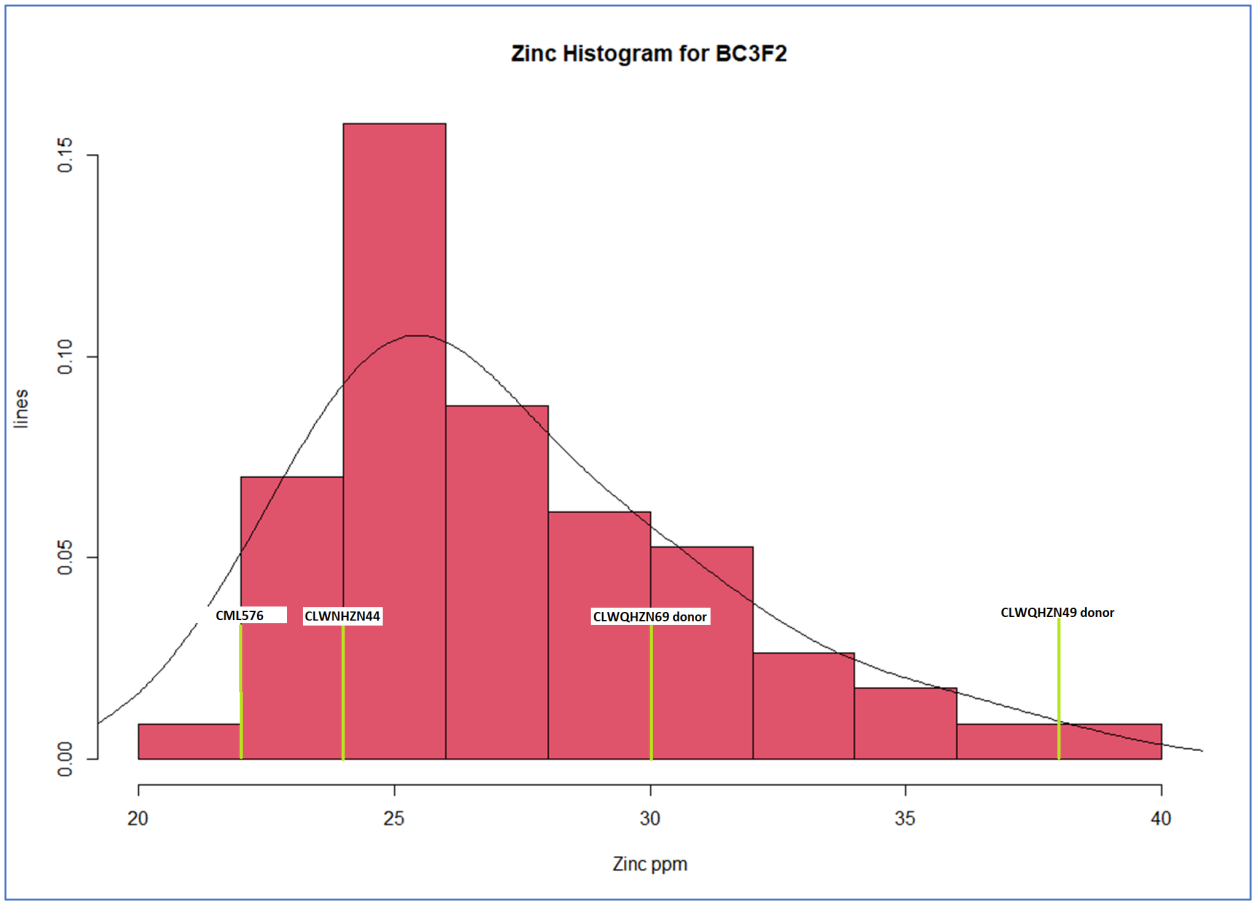

Figure 10: Histogram, zinc levels (ppm) of BC3F2

Additional evidence of the feasibility of our approach has been achieved by reforming hybrids from these backcrossed lines. Two of the lines being backcrossed form a simple cross of a conventional hybrid which is highly sought after for its yield, grain size, grain color, and disease resistance. Over a dozen backcrossed lines were crossed in a semi-diallel crossing pattern. Zinc levels of the F1 simple hybrids are shown in Fig. 11. As is evident, zinc levels for the resulting hybrids are far above our goal level (35ppm) in several cases, and significantly higher than the original F1 hybrid (F17 female in black).

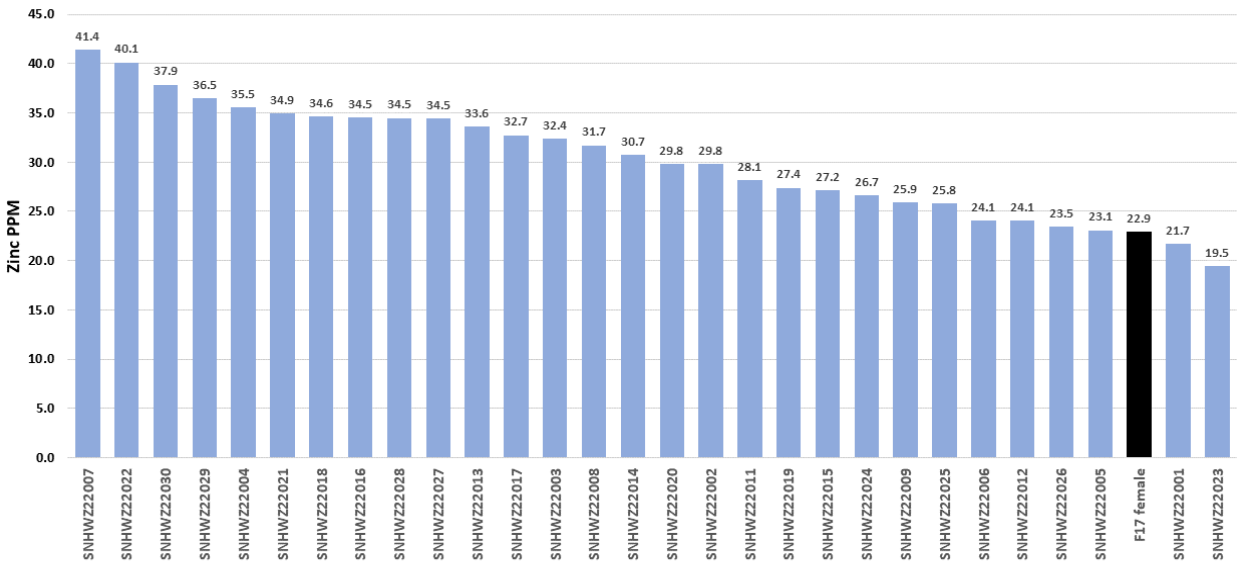

Figure 11: Zinc content of F1 single hybrids from zinc converted lines, compared to original single female hybrid (black)

The same pattern can be also perceived in the formation of commercial triple hybrids which are currently being tested for release. The original hybrid, F17, (discussed in depth in our 2018-9 standard reports) did not have the necessary zinc for launch (see the black bar below). The new partially backcrossed hybrids (blue bars below) have shown far higher zinc, in some cases close to double that of the original hybrid.

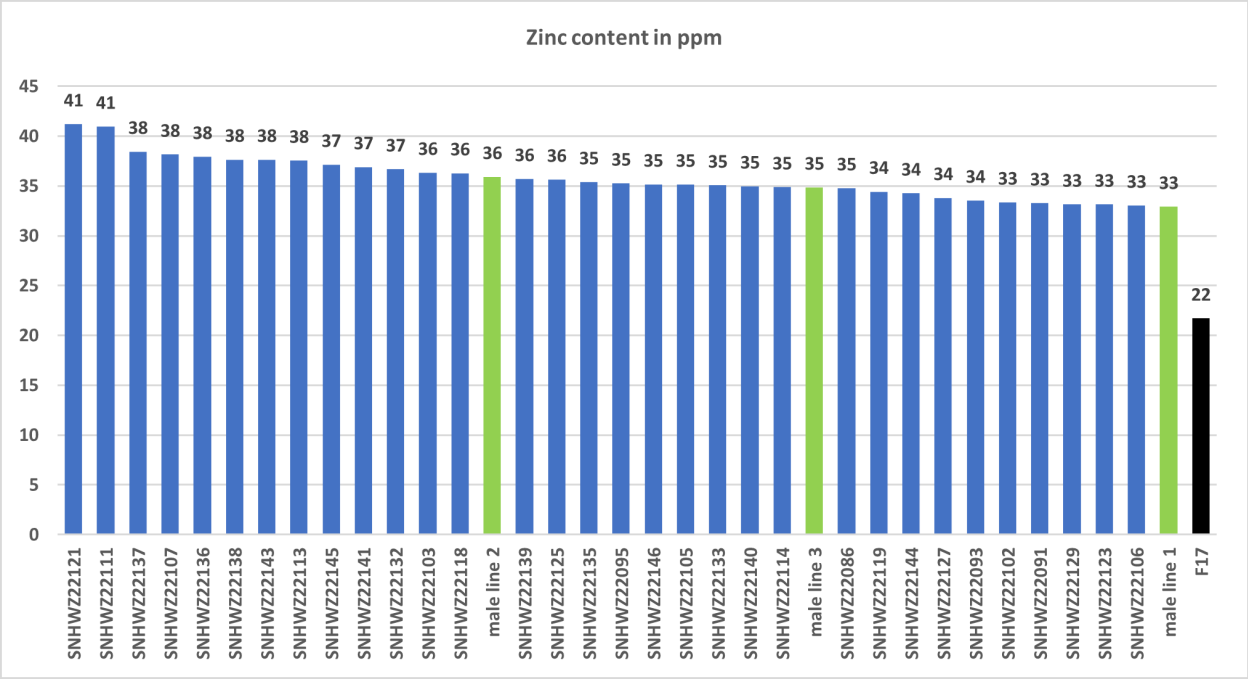

Figure 12. Zinc content in triple hybrids from Zinc-converted-lines, compared to the original triple Hybrid F17.

This data is one of the most important proof points of Semilla Nueva's model to date. If Semilla Nueva can take a highly competitive non-biofortified seed and then breed in nutrition in an efficient and predictable way, this opens the possibility of an expansion to other countries and eventually making biofortification an industry standard process for countries with high maize consumption and malnutrition.

Semilla Nueva partially converts lines to have bigger, whiter maize grains

In several regions of Guatemala, maize buyers pay farmers slightly less for biofortified maize because the grain is smaller and slightly darker. Semilla Nueva has thus far compensated for this penalization by launching higher-yielding seeds at lower prices. The R&D team also worked on developing a process to convert high protein quality and high zinc seeds to have bigger and whiter grains. We reached our first proof point for this work in June 2022, harvesting lines for our new F7 hybrid which maintain 75% of their original DNA while having far larger and whiter grains. Nutritional evaluation of these new lines is pending, so these results must be seen as initial. Below, you can see one of the original parental lines for our new F7 hybrid (top) as well as two rows of lines that have maintained larger and whiter grain while having 75% of the same DNA as the line above (BC1F2). We hope to repeat this process to reach lines with larger and whiter grain that maintain 93% of the original DNA before creating new hybrids based on these lines. Ultimately, we hope to launch a new commercial hybrid with these improved characteristics by 2025.

Figure 13: Original line (top) vs. backcrossed lines (middle and bottom)

Semilla Nueva begins two partnerships to identify the genes responsible for higher nutrition

Semilla Nueva sent DNA samples of over 200 backcrossed lines with different nutritional levels to begin genetic analysis to our partner CIMMYT for genetic analysis. Data evaluation will be completed by Semilla Nueva's Advisory Board (including Nouvelle France Genetics). In addition, Semilla Nueva and Bayer are concretizing a partnership under their *Open Innovation* program which could also accelerate the process. Bayer will be covering all lab costs and all data will be made openly available to the scientific community. If successful, this approach could allow a significant reduction in the price of converting any maize seed to become biofortified and lay the groundwork for the use of more advanced gene editing techniques to further radically reduce costs.

FINANCE/ADMINISTRATION/HUMAN RESOURCES

Summary

- As of the end of June, execution of the annual budget is 50% out of a planned 56%.
- Semilla Nueva closed our 2022 funding gap, with US$1.18M of new and renewed funding.
- Inflation rates in Guatemala have reached percentages not seen since 2011[5], resulting in higher prices in field inputs and per diems for our field staff.

2022 budget vs actual

Semilla Nueva's 2022 approved budget is US$2.3M, a 17% increase from 2021. As of June, the budget execution is 50% (US$1.048M) out of a planned 56% (US$1.295M) for this semester. The 6% underspending is mainly due to positions not yet filled.

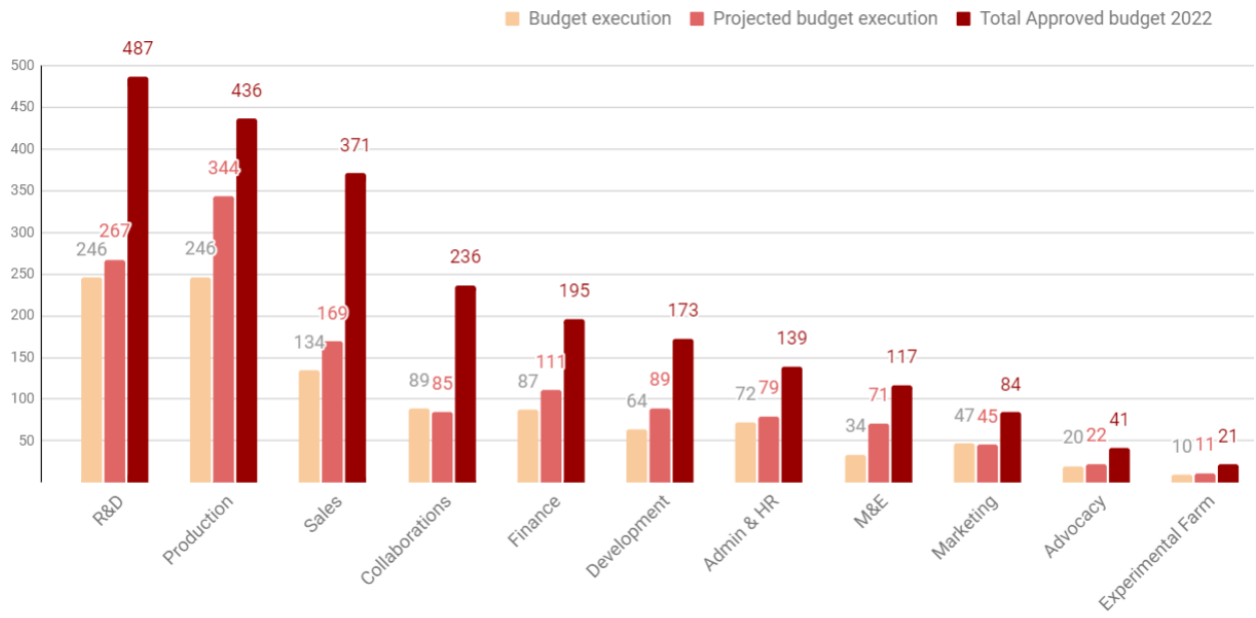

Figure 14: Semilla Nueva 2022 budget vs. actual (US$1,000's)

In the first half of 2022, five existing donors renewed funding for a total of US$1.18M, one of which doubled their support, and we have three new donors in our portfolio

Five of our donors – The Harbourton Foundation, The Arvy Foundation, Carson Foundation, The Eric Martin Fund and The Mulago Foundation - all renewed their funding agreements, Mulago doubling their support with a two-year surge agreement. We have also expanded our portfolio, welcoming The Pulte Family Charitable Foundation, Focus Central America Foundation, and Praxis, adding another US$95k in annual funding.

In total, US$1.275M unrestricted funding was secured, closing the 2022 funding gap.

[5] https://www.banguat.gob.gt/page/inflacion-total

The inflation rate in Guatemala reached 7.6% by the end of June, 1.8% higher than last month

The categories mostly affected according to the Guatemalan Consumer Price Index are transportation, food, and agro-inputs such as fertilizer. The costs for core activities such as production and field days have increased, as well as the transportation and freight fares. Semilla Nueva has compensated by decreasing expenditures elsewhere, especially through postponing the hiring of certain open positions.