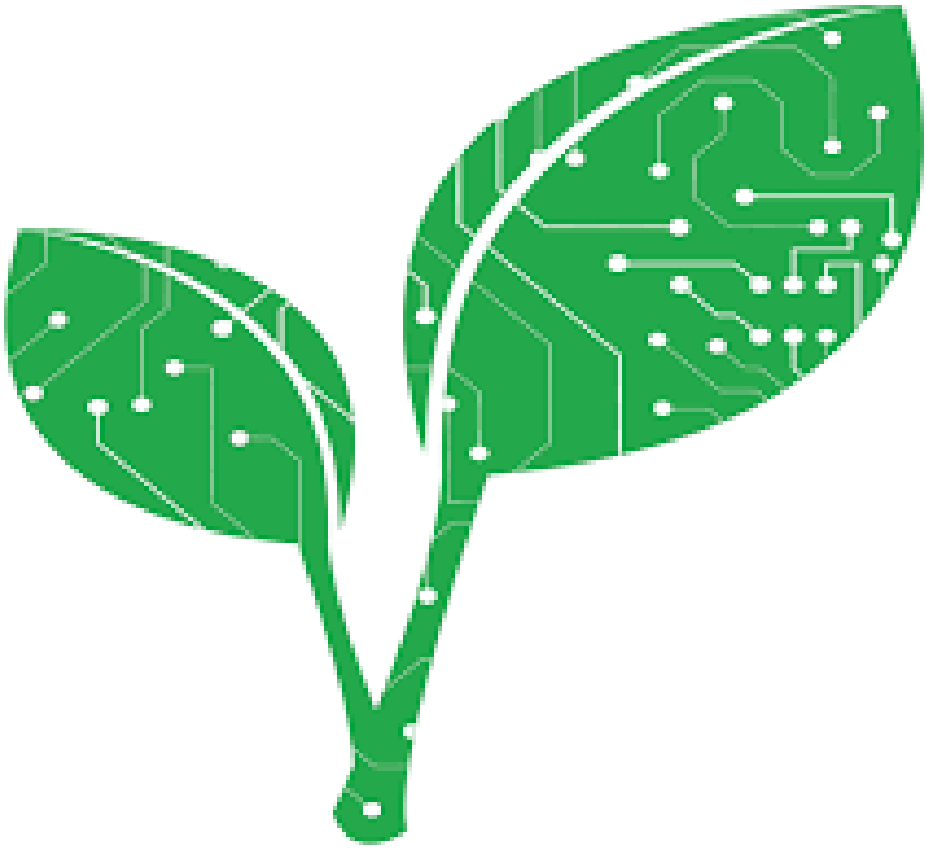
June 2020

ACCELERATING AGRITECH SOLUTIONS IN ISRAEL, CALIFORNIA, AND DEVELOPING ECONOMIES

Financial Innovations Lab®



Another project of the California-Israel Global Innovation Partnership

Jerusalem Institute for Policy Research
Milken Innovation Center

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Financial Innovations Labs

Financial Innovations Labs bring together researchers, policymakers, and business, financial, and professional practitioners to create market-based solutions to business and public policy challenges. Using real and simulated case studies, participants consider and design alternative capital structures, and apply appropriate financial technologies to them to tackle funding gaps for economic development.

The Lab was carried out under the auspices of the Israel Innovation Authority and the California Department of Food and Agriculture as part of the California-Israel Global Innovation Partnership project.

About the Milken Innovation Center

The Milken Innovation Center at the Jerusalem Institute for Policy Research focuses on developing market-based solutions to Israel's greatest challenges as it transitions from a startup nation to a global nation. Through the Fellows program, we train young professionals in creating pragmatic financing and economic policy solutions, and then deploy them as resources to government ministries, nonprofits, and other key organizations in Israel and developing economies. Our applied research and Financial Innovations Labs serve as a launching pad for transformative change, using innovative financing mechanisms, programs, and policies to bridge social, regional, economic, and technological and productivity gaps within Israel and between Israel and the world. Our goal is to accelerate economic growth, build human capital, and cement Israel's role as a pioneer in addressing global challenges in water, food, education, health, and energy with solutions.

Table of Contents

Executive Summary

The global agricultural industry, which includes agritech and other agribusiness sectors, includes not only the cultivation, harvest, storage, and transport of food, but also its distribution, processing, preparation, service, and disposal. The industry totals $8 trillion annually, according to World Bank estimates.[1] Food and food services account for 10 percent of consumer spending worldwide,[2] and a significant share, 27 percent, of global employment, if one counts subsistence farmers among the 2 billion total. The International Labor Organization reports a lower but still immense number: 866 million "officially employed" in the sector in 2018.[3] For all the economic growth reflected in these numbers, we face dire challenges, including worsening food distribution inequality and agriculture's rising share, fully 33 percent,[4] of global greenhouse gas emissions.

Yet enormous challenges present abundant opportunities, and Israel and the State of California have partnered to find solutions. With the signing of a joint Memorandum of Understanding in 2014, they are working to leverage Israel's core strengths in climate-smart agritech R&D with California's pivotal roles in the US food value chain and at the forefront of US environmental action. The results are intended to serve as models for the world.

Israeli agricultural production have declined over recent decades, from 11% percent of GDP in 1950 to about 2.4 percent of GDP in 2017.[5] Declines in agricultural exports have also fallen for the period, to about 2.1 percent of 2018's total exports.[6] These trends reflect the rise in the value of other exports, the mechanization of the agriculture sector, and open trade for agriculture imports from global markets. Yet the agritech sector remains a huge draw for investors, yielding 17 percent in total returns for the period 2004−2013, more so than either the energy or information technology sector for the same period. Israel's applied research centers, more than 900 farms, and 278-plus agritech ventures over just the period 2014−2018 have helped transform the country into a "living laboratory" of sector innovation, with projects and firms that operate globally.

Worldwide, investment in food-related and agricultural technologies is also soaring—in fact, by more than 500 percent, or from $2.6 billion to $17 billion, from 2012 to 2018, according to AgFunder, the online venture capital firm specializing in the sector.[7] This includes both "upstream" and "downstream" investments, that is, investments "upstream" into farming technologies, robotics, and agricultural biotech, for example, and investments "downstream" into post-production and consumer-oriented operations like e-grocers and online delivery. Looking at just 2018, AgFunder reports that the number of VC deals rose 11 percent, to 1,450, and mostly from the US and China.[8]

Israel's experience resonates globally. In 2015, the final goal year of the UN Millennium Development Goals, about 13 percent of the world's population—795 million people, or 1 in every 9—remained undernourished, meaning they still lacked sufficient food "for an active and healthy life."[9] McKinsey predicts that by 2050, "caloric demand will increase by 70 percent, and crop demand for human consumption and animal feed will increase by at least 100 percent." Where will it come from? McKinsey warns, "At the same time, more resource constraints will emerge: for example, 40 percent

of water demand in 2030 is unlikely to be met. Already, more than 20 percent of arable land is degraded."[10] Farmers will have to produce more with less as climate change affects local weather patterns, water scarcity, and growing conditions, and as settlement patterns shift.

In both California and Israel, agriculture consumes about 60 percent of managed water resources and is responsible, respectively, for 3.3 percent and 2.3 percent, of their total greenhouse gas emissions.[11, 12] Globally, "agriculture, forestry, and other land use" (e.g., harvesting peatlands, deforestation and afforestation, and managing grasslands and wetlands) generate about 23 percent of human greenhouse gas emissions and more than 44 percent of methane.[13]

It's hard to imagine that massive waste occurs in the midst of these numbers. Yet the UN's Food and Agriculture Organization (FAO) reports that one-third of grown food is either lost or wasted.[14] In the developed world, this is due mainly to overconsumption and spoilage; but in the developing world, most food is thrown away before it reaches market due to the mismatch between supply and demand worsened by technical problems with storage, refrigeration, and transport. In Israel, post-harvest losses are lower, estimated at about 12–20 percent of fruits and vegetables.[15]

Agriculture is still one of the most important segments of developing country economies. An estimated 475 million of the 570 million farms worldwide are smallholder farms, i.e., farms smaller than 2 hectares (or 5 acres).[16] These farms feed families who derive modest incomes from the sale of their produce each season. They would particularly benefit from technologies boosting post-harvest storage and transport, information exchange, distribution and pricing systems.

They could also benefit from access to the work done by Israel and California: how to grow food in desert climates; cultivate disease-resistant produce and grains; develop preservation techniques for long-distance delivery; increase livestock yields; and move the storage and processing production phases closer to the farmers themselves. Israel has introduced numerous innovations that increase productivity while reducing the reliance on natural resources, including accelerated seed and breeding technologies, data-based precision agriculture; water and nutrient delivery systems; post-harvest storage; and transportation logistics management systems. These technologies put real-time usage and pricing information into the hands of farmers and end users, giving them a chance to become sustainable, increase agriculture outputs and the quality of food, and improve market efficiencies.

In this context, the Milken Innovation Center convened a Financial Innovations Lab in Jerusalem in 2016 as a next step of the Israel–California partnership agenda and to assess recent developments in climate-smart agriculture. As part of the Lab, participants visited Israeli agritech companies and R&D centers that work on irrigation water technology, drones and robotics, and decision support and data management. The Lab's primary focus was on the agritech firm value chain, from the barriers at startup and early growth to the eventual application of successful models internationally. Solutions focused on three main areas:

1. **Market-ready technologies** to meet immediate and near-term needs in the sector.

2. **A financial platform**, a climate-smart bond bank, to develop funding tools for agritech firms that fill the funding gaps at various growth stages, with appropriate scale, allowable uses, terms, and conditions.
3. **Co-innovation teams** composed of California and Israeli specialists in policy, finance, investment, and business to contribute insights for investable solutions relevant to both of these markets, and to developing markets as well.

Over the three ensuing years, the Milken Innovation Center directed its work toward the California challenges cited in the Lab, and from these on to real projects to demonstrate proof of concept, with an emphasis on technology transfer to developing economies. This report looks at the results.

Postscript: In the time of Covid-19 which is covering the globe with shutdowns, quarantines, sickness, and deaths as we complete this report, the conditions of global supply chains are being shaken to their core. Food losses (ranging from 20-50 percent in the developed economies and higher in the developing economies) are soaring, transportation linkages to markets for over 25 percent of global supply that must cross international borders are stalled or closed altogether, and new approaches to inclusive production and financial collaboration among large multinational corporations and small-holder farms are more important than ever. We will see the adoption of new packaging technologies, new solutions to reduce harvest and post-harvest waste, an increasing focus on regional production, processing, and consumption, and new growing technologies to lower labor and health risks. The sudden, but long-term nature of the global pandemic and its impact on food supply, nutrition, and health bring new importance to the recommendations contained in this report – pressing us to find ways to accelerate the adoption of agritech solutions for world health and the health of the world.

Introduction

The Milken Innovation Center in Jerusalem held a Financial Innovations Lab on June 23, 2016, bringing together some 70 experts in public policy, finance, industry, and science. Public-sector representatives came from the University of California, Berkeley; the Israel Innovation Authority; the US Department of Agriculture (USDA); the California Department of Food and Agriculture (CDFA); the California Department of Water Resources; the California State Water Resources Control Board; and the Governor's Office (then occupied by Jerry Brown). With experts from the private sector, they worked to design financial tools to address the need for accelerated growth of agritech startups, and to unearth opportunities in the context of California's strategy for climate-smart agriculture.

Since then, the Milken Innovation Center has been focused on the California challenges, while expanding the discussion to include the global development context, i.e., the design of training and financial tools to leverage Israeli agritech for opportunities and solutions elsewhere. Much of the work on both training, applied research, and project development has been done in partnership with the Blum Lab for Developing Economies which is affiliated with the UC Berkeley Blum Center for Developing Economies.

The Milken Innovation Center also launched a Global Fellows program, bringing in young professionals from Africa and Latin America to learn about new agricultural technologies, and to develop specific development plans for their implementation. The Global Fellows Program has grown into an essential component of the partnership with the Blum Center, helping incubate new approaches for project and financial solutions to meet the needs of farmers, large and small. The fellows are continual reminders of the urgency and promise of our work.

This report proceeds as follows: "Issues and Perspectives" lays out the topics presented at the Lab, including global forces driving the discussion; the composition of Israel's and California's respective agritech sectors; and policy initiatives and capital formation trends that affect the agritech sector. "Barriers" discusses finance and development obstacles that exist along the entire value chain of agricultural production and agritech development. "Best Practice" presents best practice tools and programs that could be deployed to overcome these barriers and solutions to be considered to accelerate the development and deployment of agritech in the market. A concluding "Roadmap" identifies priorities for moving forward. The Appendix section offers a discussion template for a climate-smart bond bank, information on Israeli agritech firms, and how co-innovation teams might proceed.

Issues and Perspectives

Interest in agritech has been fueled by global policy and economic growth, as seen in maturing markets in developing countries; the UN's Sustainable Development Goals; and a major push for climate-smart agriculture (CSA), which aims to reduce greenhouse gas emissions by focusing on producing more with fewer resources—less water, soil, energy, and fertilizer.[17]

The UN's Food and Agriculture Organization (FAO) states that the three pillars of CSA are:

- to sustainably increase agricultural productivity and incomes
- to adapt and build resilience of people and food systems to climate change
- and to reduce and eliminate greenhouse gas emissions where possible.[18]

In California, the Office of Environmental Farming and Innovation within the state's Department of Food and Agriculture (CDFA) has also turned its attention to CSA applications and international collaborations, and to work as a scientific resource to support the "development and implementation of economically viable agricultural practices that optimize environmental and public health."[19] The State government recognizes that CSA is an important component of the UN's Sustainable Development Goals. (CSA in fact relates directly to eight of the seventeen SDGs, as shown in Figure 1. See Appendix B for a more detailed description of the SDGs and relevant technologies.)

FIGURE 1

Climate-smart agriculture and the UN Sustainable Development Goals

Source: Sustainable Development Goals Knowledge platform

SDG 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
SDG 3: Ensure healthy lives and promote well-being for all at all ages.
SDG 6: Ensure availability and sustainable management of water and sanitation for all.
SDG 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment.
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
SDG 12: Ensure sustainable consumption and production patterns.
SDG 13: Take urgent action to combat climate change and its impacts.
SDG 15: Promote sustainable use of ecosystems, sustainably manage forests, and halt biodiversity loss.

California has had its share of unpredictable water availability, extended heat waves and droughts, invasive pests, and other deleterious impacts of climate change on crop and livestock production. The

state also has grand and diverse geography, with seacoasts, mountain ranges, high and low deserts, farmland breadbaskets, river deltas, and rare redwood forests—and various microclimate pockets within those zones. This variation presents numerous opportunities to study resilience to climate change.

Since 2014, California has launched a number of CSA programs, channeled primarily through the umbrella California Climate Investments initiative; funded by the state's cap-and-trade program; and supported across state agencies and divisions like the Department of Food and Agriculture, the Department of Conservation, and the Strategic Growth Council. Programs include, among others, the Sustainable Agricultural Lands Conservation (SALC) program[20]; the Healthy Soils Program[21]; the State Water Efficiency Enhancement Program (SWEEP)[22]; and the Climate Change Research program.[23] These will be discussed in greater depth in this report.

Israel's innovative water policies led off the CSA discussion, which incorporated information and comparisons with California developed from a 2015 Lab in Jerusalem, "Financial Models for Water Sustainability,"[24] and subsequent work.[25] Israeli initiatives include demand management policy measures that seek to use non-potable water (treated effluent or natural brackish water) for irrigation wherever possible. Israel also introduced economic incentives (in both pricing and usage) to support the policies. Farmers who use treated domestic wastewater pay one-third the price they would pay to irrigate with potable water, or US $0.34/cubic meter versus US $1.00/cubic meter. If they trade part of their annual quota of potable water for treated or brackish water, they receive an extra 20 percent in volume free of charge. In addition, the government subsidizes 60 percent of farmers' costs to build the pipes that carry the treated water.

The Israeli Water Authority instituted additional policies for agricultural water usage,[26] and Lab participants agreed that they can be incorporated into California state policy.

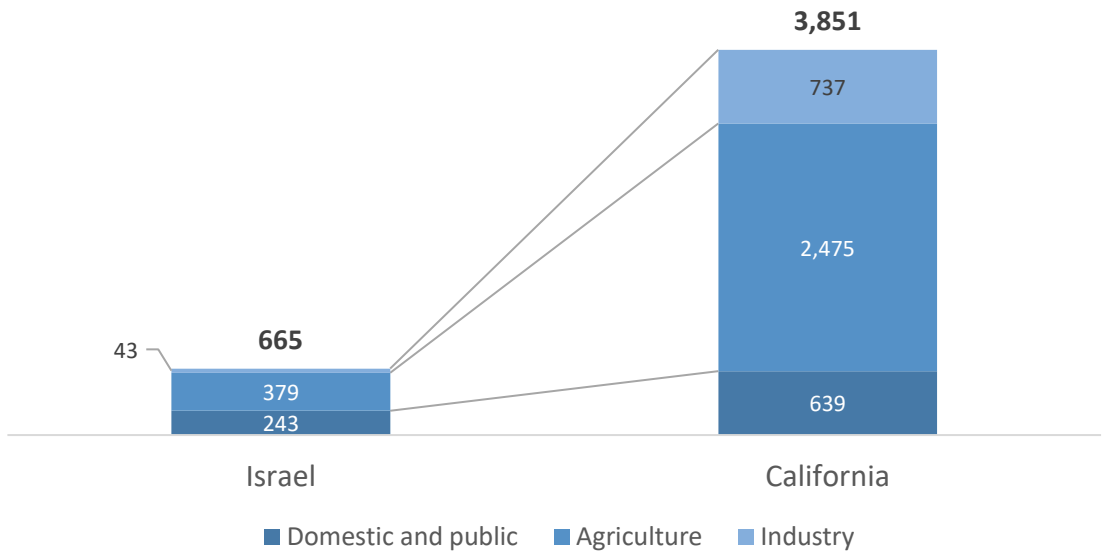
- compulsory per-customer water metering
- water supply companies to bear full the responsibility for water losses totaling more than 8 percent that occur during conveyance
- a firm cap on annual water quotas
- support for R&D, farmer education, and water conservation tactics and technologies
- higher fees, with the goal of charging the true cost of water.

Comparisons of per capita water consumption highlight the remarkable gaps between Israel and California, as well as opportunities for the latter to achieve improvements in sustainable practices. Across total households, industries, and agricultural usage, according to data of all managed water sources compiled by the Israel Water Authority and the California Water Science Center, Californians consume *six times* more water per capita per diem than do Israelis, or 3,851 liters versus 665, as shown in Figure 2. Industrial consumption (which in California includes manufacturing, mining, and power generation) is 737 liters per capita per diem, or nearly *17 times* as much as the 43 liters used in Israel. Household/public usage totals 639 liters in California, or nearly *2.5 times* that of the 243 daily liters

consumed in Israel. And agricultural consumption is a whopping 2,475 liters versus Israel's 379—nearly *six times* the consumption on a per capita per diem basis.[27]

FIGURE 2

Per capita water consumption (in liters per day)



Sources: Israel Central Bureau of Statistics, Israel Water Authority, 2012; California Water Science Center, USGS, 2010; Milken Innovation Center.

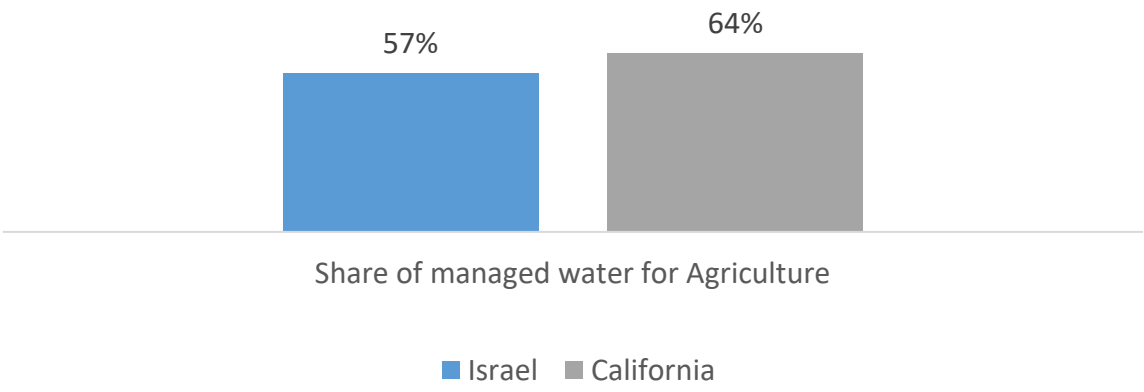
Israel has fewer sources of natural water and thus far greater need to develop technologies to recycle wastewater. Yet it now generates about 500 million cubic meters of household wastewater per year, based on a survey prepared for the Israel Water Authority.[28] Of that total, 90 percent, or some 428 million cubic meters of household wastewater, makes its way to a recycling plant. (If one counts Israel and West Bank land administered by the Palestinian Authority, the percentage drops a bit, to 86 percent).[29] That total represents nearly 23 percent of the total annual water consumption for agricultural irrigation (recall, from Figure 2, that agriculture uses 379 cubic meters per capita per diem). By comparison, California recycles just 825 million cubic meters of water per year for a variety of uses, for a rate of just over 9.5 percent of the estimated 8.7 billion cubic meters of municipal wastewater.[30]

Put another way, Israel recycles wastewater for agricultural use at a rate 25 times higher than California does. California recycles an estimated 302 million cubic meters for agricultural use—out of a total of *34 billion* cubic meters of water used in the industry. That's a mere 0.9 percent of the total agricultural water usage.[31] Bottom line? Recycled wastewater is a major source of agricultural water in Israel, but a negligible source in California.

Figure 3 compares Israeli and California agricultural water usage in 2014 as a percentage of all water collected, transported, used, treated, and recycled. Israel's percentage is 57 percent while California's is 64 percent. (This doesn't include the allocation of water that remains in natural habitats for other uses, and which accounts for about 50 percent of California's water.) In 2018, according to these same sources, water for agriculture represents, respectively, 50 percent versus 40 percent of all water usage in Israel and California. The estimate for California rises to almost 80 percent in some areas, especially the agriculture-intensive areas in the Central Valley, according to the Public Policy Institute of California.[32]

FIGURE 3

Share of agricultural water usage, Israel vs. California



Sources: Israel Central Bureau of Statistics; Israel Water Authority; California Water Science Center; Bloomberg Business (2014); Milken Innovation Center

Yet Israel's progressive water policies also take into account the potential toll on energy consumption. Water usage has a strong correlation with energy usage. Water is used in the extraction, production, and refining of fossil and plant fuels, and in the heating and cooling of power plants. Energy is used to process, store, and treat water supplies for redistribution to consumers. Thus, sustainable solutions should incorporate lower energy demand. And, again, Israel can teach California by example.

Between water and energy, just 10 percent of Israel's total electricity production goes toward water collection, conveyance, storage, desalination, and treatment, according to data from a 2013 Ministry of Energy study.[33] California's rate is double that; "water-related energy use … consumes approximately 20 percent of the state's electricity," according to state Department of Water Resources, reporting state Energy Commission findings.[34]

Global drivers

We have no choice but to change to climate-smart agricultural practices. Within another generation, by 2050, global demand for food crops—10 percent by humans, the rest by farm animals—is expected to double; and resource depletion could mean water shortages of up to 40 percent of demand.[35] The UN's Food and Agriculture Organization (FAO) reports also that "In many low-rainfall areas of the Middle East, North Africa and Central Asia, and in India and China, farmers use much of the available water resources, resulting in the serious depletion of rivers and aquifers. In some of these areas, about 80 to 90 percent of the water is used for agricultural purposes. The intensive agricultural economies of Asia use about 20 percent of their internal renewable freshwater resources, while much of Latin America and sub-Saharan Africa, in contrast, use only a very small percentage."[36]

> *In the next 50 years, farmers will have to produce as much food as they have in the last 10,000 years – combined.*
>
> Nobel Laureate Norman Borlaug, 2007

Meanwhile, a 2017 study published in the *Proceedings of the National Academy of Sciences* shows that for each 1 degree Celsius of global temperature change, global yields of wheat are cut by 6.0 percent, rice by 3.2 percent, maize by 7.4 percent, and soybean by 3.1 percent.[37] Sudden frosts, severe heat waves, and prolonged wet seasons can devastate crops and bring unprecedented swarms of pests, like those that began ravaging the crops in Ethiopia and Kenya in late 2019 and continuing in South Sudan and Somalia in 2020. As they seek to feed their people while conserving resources, developing countries are joining the market for agritech solutions.

The global population now stands at about 7.7 billion and is expected to reach 8.5 billion by 2030, and 9.7 billion by 2050, according to UN researchers who note that "the rate of population growth remains especially high in the group of 47 countries designated by the United Nations as least developed." (These include nations in sub-Saharan, Northern, and Western Africa; Central, South, and Southeast Asia; and in Oceania.)[38] This means even greater demand for food. According to the UN's FAO, "the prevalence of undernourishment—the percentage of the [global] population without regular access to adequate calories—has stagnated since 2015, and the number of people who are hungry has actually risen to 822 million from 785 million in 2015."[39]

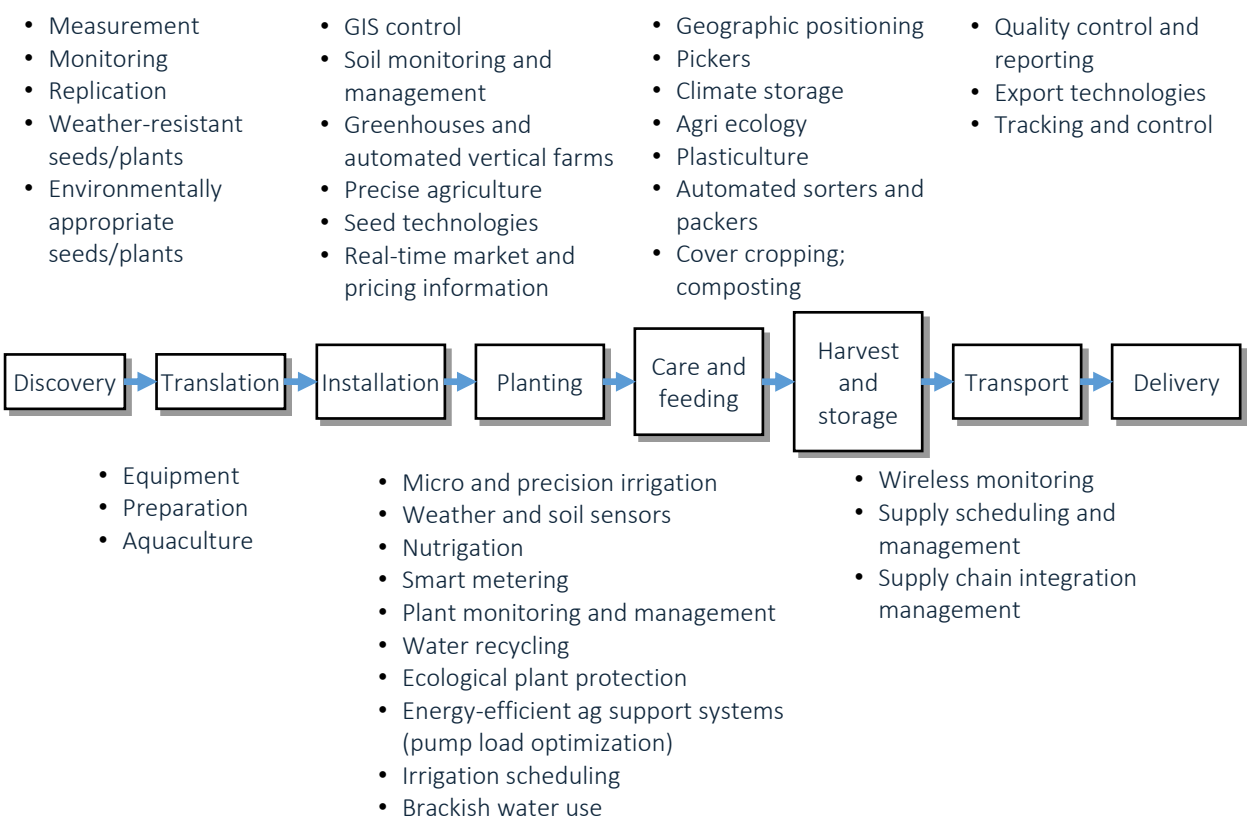
Another way to highlight economic disparity is to look at what percentage of household budgets goes toward food. Americans in 2018, for example, spent nearly 10 percent of disposable income on food, either eating in or dining out. Their food costs constitute a relatively low share of total household costs, reflective of their greater household wealth. In developing countries experiencing food insecurity and environmental degradation from climate change and poor farming practices, food costs may take up half the household income or more.[40] Thus when wheat prices double (as they have), the price of a loaf of bread may increase only from $2.00 to $2.14 in the US, but double in India. Increasing climate volatility means that price volatility is amplified in smaller and developing markets.

Lab participants agreed that specific improvements could result in higher crop yields; greater water and energy efficiency at specific stages of planting and growth; and the cultivation of varieties that

can adapt to low and poor water conditions; advanced breeding; biologicals and microbiological solutions; and harvest technologies to reduce crop lost and spoilage. The next figure depicts an overview of the agritech sector and how its various industries intersect with the agricultural production value chain.

FIGURE 4

Agritech in the agricultural production value chain



Source: Milken Innovation Center

Governments, NGOs, researchers, agritech firms, and investors must find pathways of collaboration to meet the challenge of producing more food for more people amid resource depletion and climate change. Digital solutions, crop protection, and new breeding methods will all play important roles in this process, as will support for both industrial and smallholder farms along the food value chain, from cultivation through storage and transportation, to processing.

This initial focus is on agricultural producers; other innovations, such as 3D printing, cultured meat, genetic modification, and seawater agriculture, are still in early stages but could become game changers in the next decade.

California and Israel Context

Scaling up in any industry, and agritech is no different, requires the smooth transition from development and adaptation to transfer to market. In this respect, Israel can be likened to a beta site for business startups and growth; while California is proof of concept. In both Israel and California, agriculture and agribusiness, including agritech, constitute key components of the economy. When combined with the energy and water sectors, it brings substantial production, employment, and revenue for both the public and private sectors.

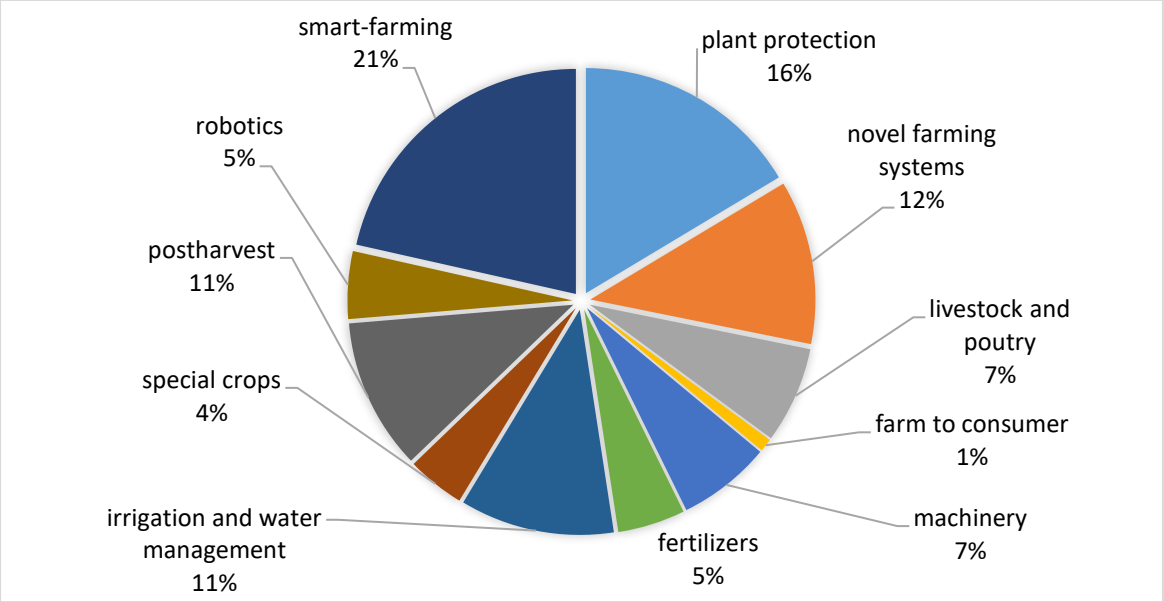
For perspective, California's 77,100 farms cover 25.3 million acres and account for $50 billion in annual income. Even though agriculture production accounts for just 2 percent of the state's GDP, in 2018, California led all other states in cash farm receipts, "accounting for over 13 percent of the nation's total agricultural value," according to the state's Department of Food and Agriculture.[41] Dairy products and milk led the group for that year, bringing in $6.37 billion, followed by grapes at $6.25 billion, and almonds at $5.47 billion.[42] Every year California farmers spend over $1.34 billion in seeds, $2.3 billion in fertilizers, and just over $2 billion in pesticides, and consume about 60−70 percent of the state's water supply.[43]

Based on 2017 estimates, Israel's agriculture sector represents 2.4 percent of GDP.[44] As of 2015, notes the Ministry of Agriculture, about 15 percent of agricultural production went for export.[45] In 2019, according to World Bank indicators, just under 1 percent of the Israeli workforce was employed in the sector.[46] This is a drop from 1.2 percent in 2014 and reflects the fact that for over a decade or more Israel has relied on foreign guest workers for farm labor.[47] About 80 percent of agricultural production is produced in cooperative communities (i.e., kibbutzim and moshavim, the latter of which comprise plots owned by individual families).[48]

According to Start-Up Nation Central's 2019 sector profile, Israel is home to 239 active startups in the agrifood-tech sector (including those firms that have been started in the last 10 years and have not been acquired). These firms are working, variously, in inputs production (26); water management (23); pathogen and pest management (50); yield and harvest management (90); preservation and supply chain management (26); and alternative food sources (24). Figure 5 furthers breaks down the entire sector by type of subsector.

FIGURE 5

Agritech firms in Israel (by share of sector, 2019)



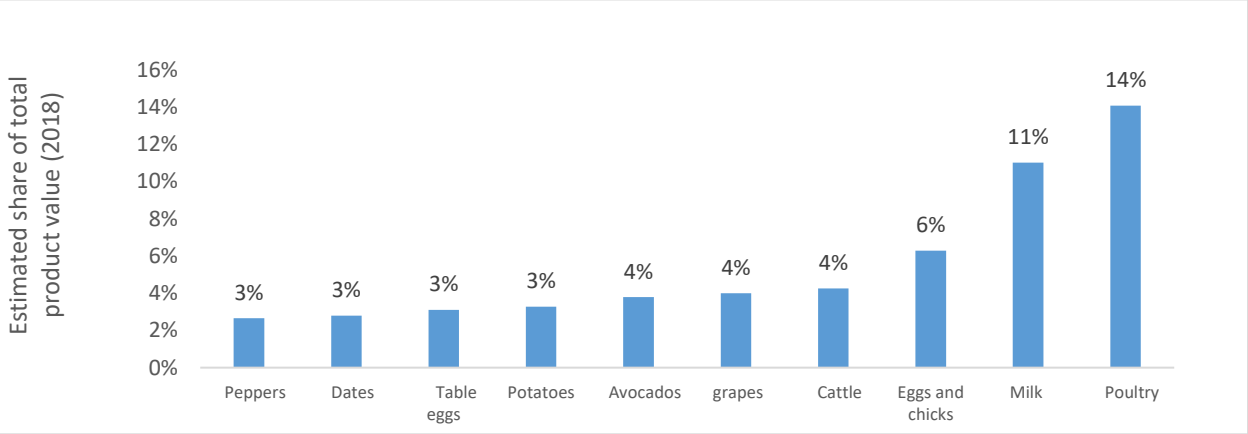
Sources: Start-Up Nation Center; Milken Innovation Center

Figures 6 and 7 look at the respective valuations of dominant commodities in Israel and California.[49] Both markets are strong in produce; in California, leaders include nuts (pistachios, walnuts, and almonds); fruit (tomatoes, grapes, and berries); and livestock (cattle and calves, milk and cream). In Israel, the lineup changes to fruits (dates, grapes, and avocadoes); livestock products (cattle, milk, poultry, chicks, and table eggs); vegetables (potatoes); and spices (peppers).

Israel has also transitioned from its role as a major exporter of oranges and other citrus fruits, for reasons that range from irrigation and land costs to foreign competition and labor issues. Instead, the country has focused on new technologies in seed selection (e.g., disease resistant and drought tolerant), storage, and transport/distribution of seeds. Not surprisingly, the value of citrus exports dropped 27 percent from 2000 through 2018, from NIS 227 million to NIS 163 million. Over the same period, vegetables exports rose from NIS 61 million to NIS 266 million, up 330 percent in nominal value.[50]

FIGURE 6

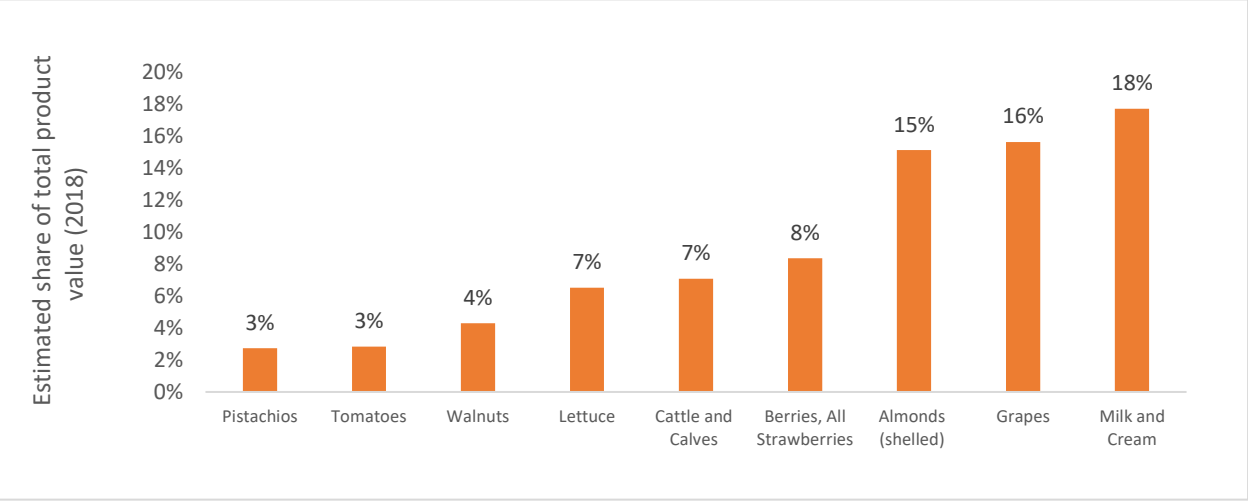
Output valuation by agricultural sectors (Israel)



Sources: National Agricultural Statistics Service (2019; Israel Central Bureau of Statistics; Milken Innovation Center.

FIGURE 7

Output valuation by agricultural sectors (California)



Sources: California Agricultural Statistics Review 2017–2018; Milken Innovation Center

The data show a comparison of *relative shares of agricultural production*, not a comparison of crop value between Israel and California.

In keeping with a number of important state policy initiatives, California must now work to scale up solutions and help farmers to access new technologies, according to the San Francisco-based Public Policy Institute of California (PPIC). At home and in developing countries, Israeli firms have already deployed several of these technologies, including:

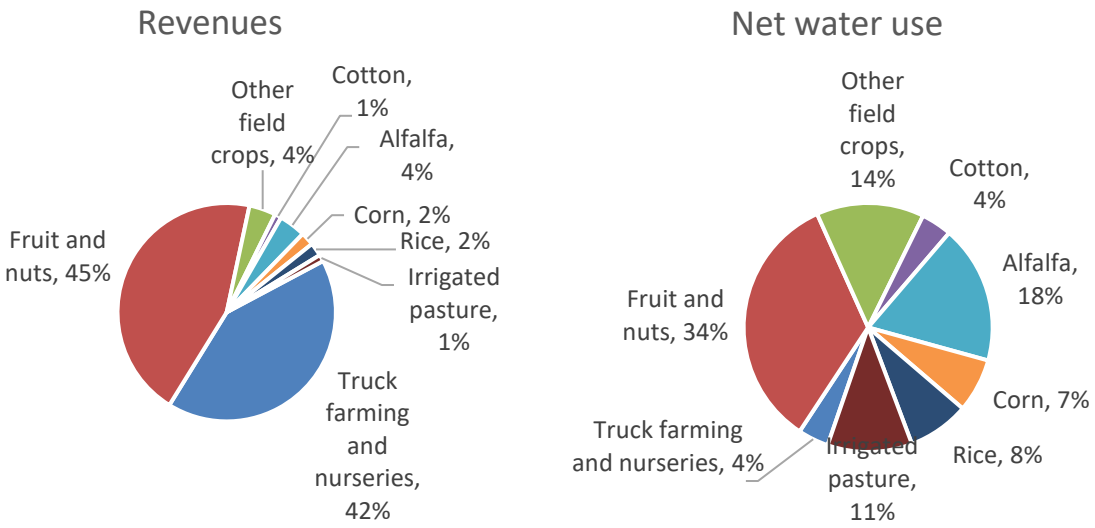
- incentives to adopt water measurement (flow and total);
- the use of moisture-sensing soil technologies,
- incentives to promote the expanded use of high-efficiency irrigation systems, and irrigation scheduling and performance monitoring systems.[51]

Because many California farms aren't connected to the water grid's management practices, the PPIC recommends that local water districts integrate deliveries on a real-time basis with water-use efficiencies, such as drip/micro irrigation methods; that they maximize the use of "agricultural water" (recycled farm water) whenever appropriate; identify opportunities for shared use for water supplies; and identify opportunities for local groundwater treatment (primarily salts) as a new or alternative water source for irrigation. Israeli firms, as noted, are ahead of the curve here. For example, researchers at Ben Gurion University's Sde Boker campus labs, in Israel's Negev region, are developing the use of drought- and/or salt-tolerant growing methods.

The Lab heard about major trends in California agriculture in recent years. For example, acreage is shifting toward higher-revenue fruits, nuts, vegetables, and nursery crops that in 2012 accounted for 47 percent of irrigated crop acreage, 38 percent of farm water use, and 86 percent of crop revenue, according to the PPIC.[52] Fruit and nut orchards must be kept watered, which means farmers are more financially vulnerable to water shortages, the center notes. At the same time, as reported in our prior Lab on California's water conditions, even though the state has seen improvements in water delivery and field irrigation efficiencies, those initiatives are not enough. Groundwater is extracted faster than it can be replenished. And in some regions, like the San Joaquin Valley, new water-saving irrigation methods have actually eliminated the runoff that had been an important contributor to groundwater replenishment. The PPIC places better groundwater management as a "top priority."[53]

FIGURE 8

California crop mix and water use



Sources: PPIC, 2015; California Department of Water Resources, 2010; National Agricultural Statistics Service, 2012

Capital formation

From a business development perspective, little can happen in agritech without the capital structures that enable firms to address the financing gaps that may hit them at various stages of development, adaptation, and deployment. Recognizing this, the Israeli government has made investments in agritech R&D through the Israel Innovation Authority (IIA, formerly the Office of the Chief Scientist, within the Ministry of the Economy) averaging about NIS 22 million annually since 2008. Since 2014, the IIA has made another NIS 6 million available annually through targeted matching and participation grants for company-specific projects.[54] Additional government-sponsored programs include the US-Israel Binational Agricultural Research Development Fund (BARD), which provides competitive research sponsorships for binational R&D projects. In terms of private investment, ten Israeli venture capital funds target agritech companies.

Agritech is also attracting global investors and multinational corporations. Worldwide in 2015, 499 agritech companies attracted investments of over $4.6 billion, according to Ernst & Young and AgFunder, with over half the total, or $2.4 billion, going to US firms.[55] This is a growing trend, especially for targeted industries like irrigation water technology, drones and robotics, decision support, and data management. As noted earlier, AgFunder's 2018 figures show that global agritech investment stands at $17 billion, and California receives about 30 percent and 63 percent, respectively, of global and US investment in the sector.[56] Most of the investment went to Silicon Valley firms focusing on system integration and solutions using remote sensoring and robotics, machine learning, and measurement technologies, where some 20 percent of all US agritech firms are based.

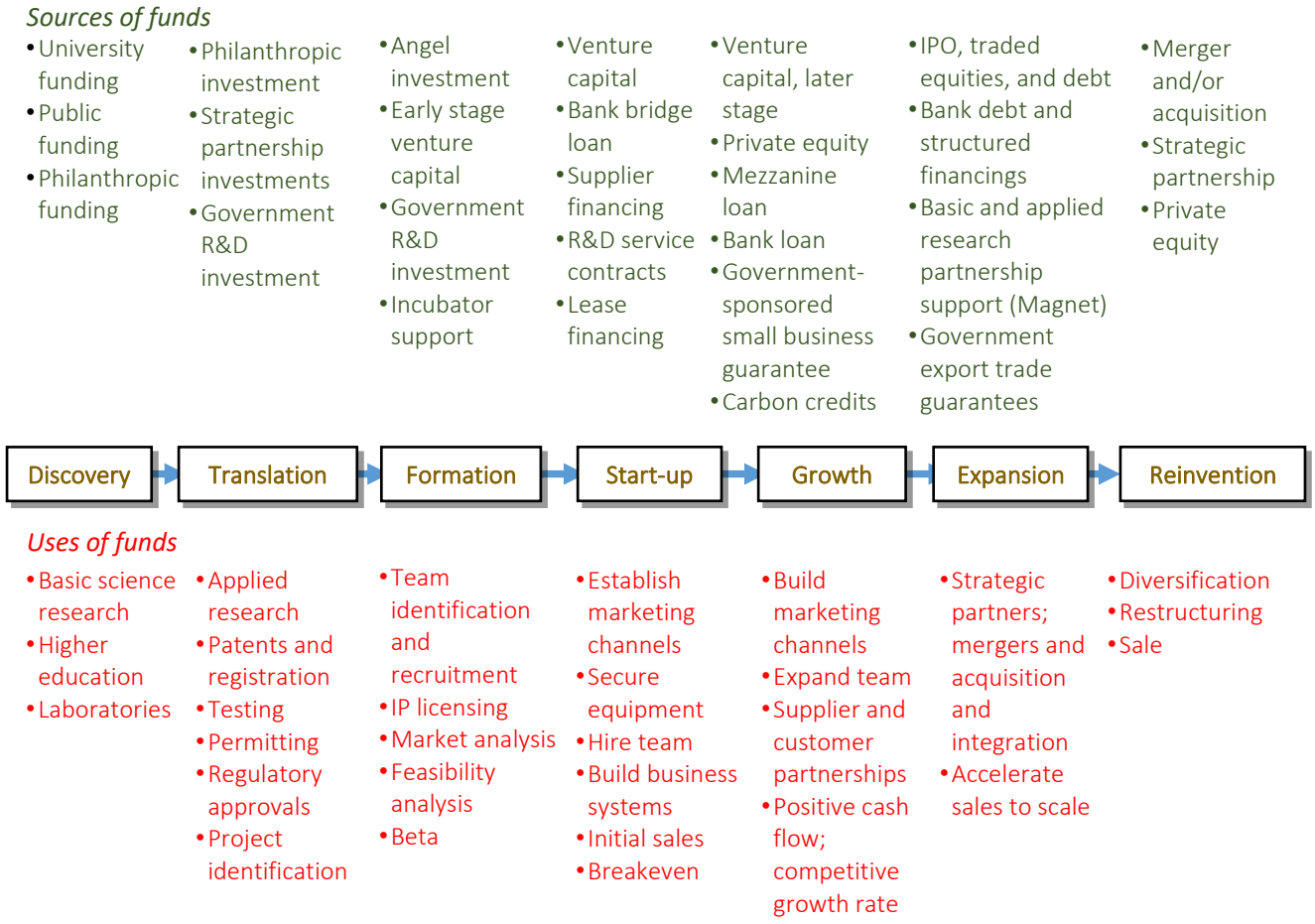
Figure 9 offers an overview of the value chain for agritech company formation. The needs of each component of the value chain—initial R&D; translation from lab to project; team formation and beta site; business startup; partnerships; expansion and scaling; and finally, reinvention with diversification and restructuring—are not unlike those in other sectors. But in some activities, agritech differs markedly. For example, they can find it difficult to obtain the funding for crucial testing of beta sites or to demonstrate their solutions.

Funding mechanisms for agritech companies are also like other sectors. It often starts with basic public support for research in the plant sciences, which is crucial to fuel the pipeline of invention. It then must be drawn from strategic partnerships and/or R&D sales to larger companies involved in the sector globally. Given the heightened global interest in agritech, these firms do tend to find it easier to obtain funding than do other sectors—but this has the downside consequence of the early sale of their invention or product at premature valuation. There are, of course, funding gaps along the value chain, whether in Israel, California, or in developing markets. These are gaps in philanthropic funding and investments; R&D service contracts and lease financing; the use of carbon credits; and accessible equity and debt project financing.

Secretary Karen Ross of the California Department of Food and Agriculture at the Financial Innovations Lab in Jerusalem

FIGURE 9

Agritech funding sources and uses, across development phases



Source: Milken Innovation Center

Policies and Programs

The Lab highlighted several global policy initiatives and many project and program models that are important in considering what could be done in both California and Israel. In 2015, the international community made three historic commitments to address the most pressing challenges of the 21st century. With the adoption in September of the 2030 UN Agenda for Sustainable Development, countries articulated their ambitions for a hunger-free, equitable, and environmentally sustainable world. A few months earlier, in July, the international community had adopted the UN's Addis Ababa Action Agenda at the Third International Conference on Financing for Development, at which they agreed on financial and non-financial means of achieving the 2030 Agenda. Finally, in December 2015, all 197 parties to the UN Framework Convention on Climate Change (UNFCCC) adopted the landmark Paris Agreement.

This landmark agreement recognizes that the goals of the 2030 Agenda, particularly the eradication of poverty, food insecurity, and malnutrition, cannot be achieved without concerted action on climate change. Farming is the very foundation for the livelihoods and food security of a large share of developing country populations, especially the poorest—making them the most vulnerable to a changing climate. The Paris Agreement also recognizes that climate *action* can become a driver for sustainable development, the impetus for investment in productive and sustainable agriculture, and solutions to deforestation, species die-offs, aquifer depletion, pest invasions, and GHG emissions.

The World Bank Group's Consultative Group on International Agricultural Research (CGIAR) develops climate-smart technologies and management methods, early warning systems, risk insurance, and other tools to support climate change adaptation and resilience. Yet despite its Climate Change Action Plans 2016–2020 and its successor plan, Action Plan on Climate Change Adaptation and Resilience covering 2025 targets, the World Bank warns that only stronger action will ensure that the goals are met. In its 2016 plan, it states, "Climate-smart agriculture profiles and investment plans will be developed by 2020 for at least 40 countries, and climate-smart agriculture programs will be delivered at scale, with a focus on hybrid seeds and carbon capture practices; high-efficiency/low-energy use irrigation programs; livestock productivity; energy solutions for agribusiness; and mainstreaming of risk management."[57] Among its projects:

- In **China** since 2014, the Modern Agriculture Development Project has supported technologies targeting more efficient irrigation and drainage methods, improved soil condition, and strengthened capacity building for both institutions and land management. The efforts have resulted in greater production of rice (up 12 percent) and maize (up 9 percent), and higher incomes for farm cooperatives.[58]

- In **Mexico** in 2016, an ongoing project in support of Sustainable Rural Development has supported 1,561 agribusinesses and "contributing to the reduction of 4.4 million tons of $C0_2$ equivalent."[59]

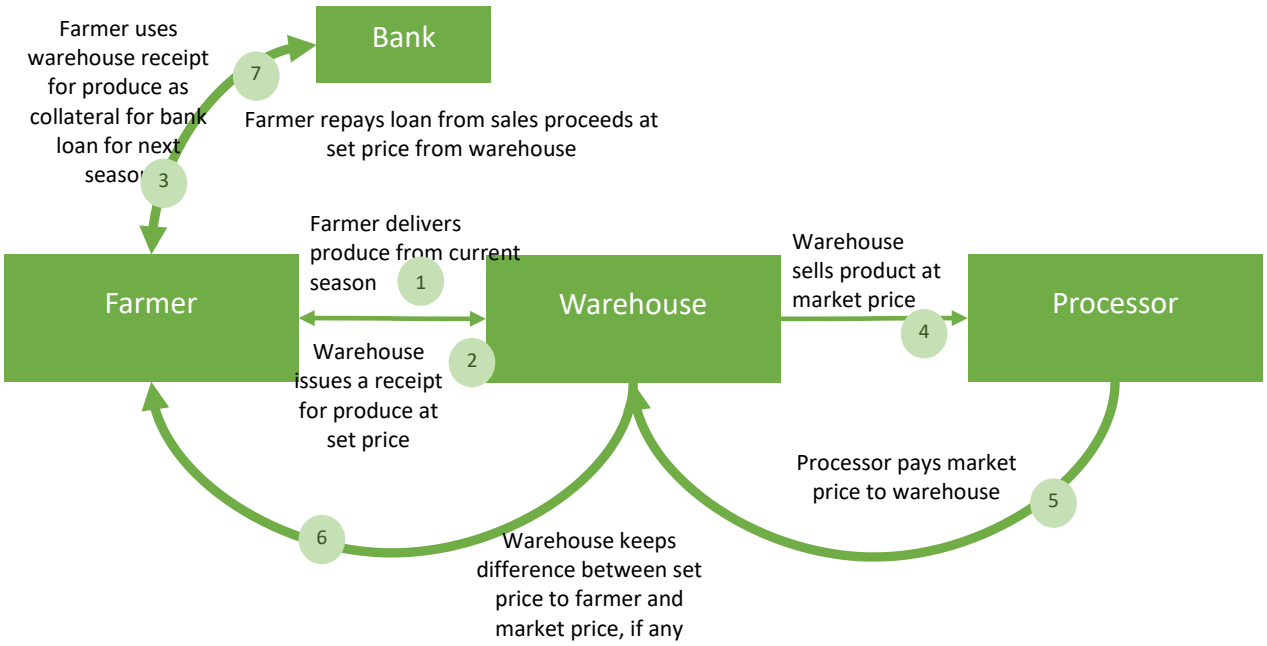
- The **West Africa** Agricultural Productivity Program (WAAP), now in the second half of its ten-year life span, targets 13 countries—Burkina Faso, Côte d'Ivoire, Nigeria, Benin,

Gambia, Guinea, Liberia, Niger, Sierra Leone, Togo, Mauritania, Cape-Verde, and Guinea Bissau—with the aim of improving climate-smart farming practices, increasing harvests of staple crops, and furthering regional cooperation. Some 9 million people and 4 million hectares of farmland have reportedly benefited directly from the long-term work, with yields of cereals up 30 percent and incomes up by 34 percent.[60]

Everyone along the agricultural production value chain, from suppliers, farmers, distributors, storage firms, and processors, requires access to finance. At the Lab, David Zilberman, a professor in the Agricultural and Resource Economics Department at UC Berkeley,[61] led participants in a discussion of the creative opportunities for financing among the different links in the value chain, including suppliers and customers financing for equipment, fertilizer, and even seeds.

The **warehouse receipt** is one such form of financing. In this case, the warehouse agrees via written receipt to pay the farmer a set price for the farmer's produce. This can help cover the farmer's costs for the season ahead and serve as collateral for a bank loan. Once the harvest is over, the warehouse pays the farmer and the farmer repays the bank. The warehouse pockets the difference, if any, between the price of the receipt and the market price for the crops.

FIGURE 10 **The warehouse receipt in value chain financing**



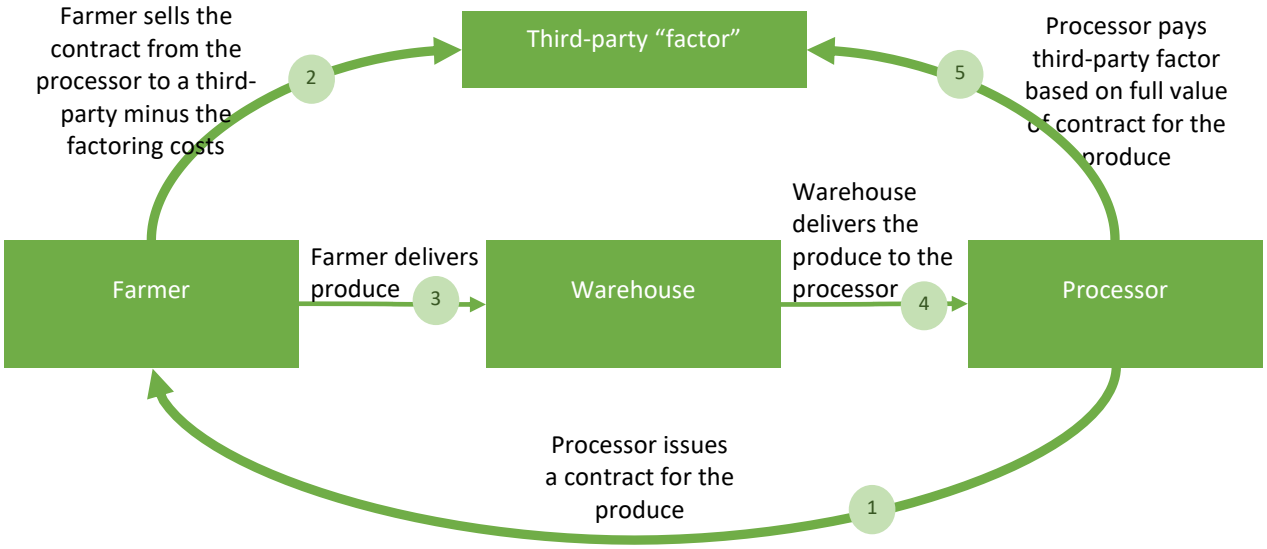
Source: Milken Innovation Center

A **repurchase agreement** (also called a repo) is another mechanism for short-term borrowing. It allows the lender to "buy" a contract for the product, say, from a storage warehouse, which promises to repurchase the contract, usually at a higher price, at a later date. A farmer might use **lease financing**

as an alternative to equipment purchase, especially if the lender won't lend for fixed assets. Here, the lease payments are made over a period of years, and there is usually a provision that allows the farmer to buy the equipment at the end of the lease. Lease financing is less risky because the lender owns the equipment and can take it back in the event of a default.

In another scenario, of **invoice factoring**, the processor, not the warehouse, agrees via receipt (contract) to pay the farmer a set price for the farmer's produce, as shown in Figure 11. The farmer then takes that contract to a third party, a factoring company, who pays cash up front for it (but deducts a "factoring" fee). When the crops are delivered, the processor then pays the third party the value of the original contract. When done at large scale with appropriate efficiency, this factoring process lowers farmers' carrying costs and improves their cash flow.

FIGURE 11 **Invoice factoring in value chain financing**



Source: Milken Innovation Center

Farmer cooperatives and credit associations also help to bridge the gaps in bank and commercial credit for small farmers; cooperatives also provide in-kind services, such as warehousing and transport, to their members. Finally, processors and wholesalers can enter long-term purchase arrangements with farmers through "chain credit" that levels out the variability of prices over longer periods. All these methods create opportunities for liquidity for the farmers, and scale and efficiency for lenders. Developing economies have incorporated these methods into models tailored to their markets. The Kenya Investment Mechanism (KIM), for example, was designed and implemented with assistance from USAID. It focuses on small- and medium-sized businesses in agriculture and clean energy; works with banks and financial institutions to mitigate risk for investors, e.g., pay-for-performance approaches; and provides capacity-building guidance for local banks and other lenders.[62]

Novel insurance programs have sprung up that offer protection against uncertain growing seasons. For example, Pula, a firm based in Nairobi, monitors an African rainfall database and uses real-time satellite data to create algorithms that allow it to price risk for micro-insurance. The cost of the insurance premium (two to three euros per farmer) is embedded in the purchase price of seeds and fertilizer for smallholder farms in Kenya, Malawi, Zambia, Nigeria, Rwanda, Tanzania, Uganda, and India.[63] In the event of no rain within the first three weeks of purchase, the seeds are replaced free of charge for a second planting in that same season. In one year alone (2017), according to its cofounder and CEO Rose Goslinga at the 2018 AGRA Conference in Kigali, Pula insured 611,000 farmers.[64] Its partners and investors include Accion Venture Lab, Omidyar Network, Mulago Foundation, Choiseul Africa Capital, and the Mercy Corps Social Venture Fund.[65] Pula works with the African Risk Capacity (ARC), an agency founded in 2012 by the African Union to serve as both an insurance pool and to provide access to its early warning technology, contingency planning, and technology transfer facilities.

California

California is exhibiting severe effects from global warming: lost snowpacks, dry aquifers, extended droughts, hotter winters, record-breaking heat waves—and an existential threat to farmers growing pistachios, almonds, cherries and walnuts. For farmers in the state's central San Joaquin Valley, warmer winters spell ruin for pistachio harvests since the trees need some five weeks of below-45-degree F temperatures and the female trees aren't receiving pollen from the male trees early enough in the season.[66] But with the help of statewide smart-climate initiatives, farmers can test new crop varieties and technologies. Some examples include:

- **Sustainable Groundwater Management**: In 2014 the California Legislature passed the Sustainable Groundwater Management Act (SGMA), a package of bills that "requires governments and water agencies of high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge … within 20 years of implementing their sustainability plans. For critically over-drafted basins, that will be 2040. For the remaining high- and medium-priority basins, 2042 is the deadline." By 2017, local governments had created 240 Groundwater Sustainability Agencies in 140 of the state's basins, and these had adopted Groundwater Sustainability Plans.[67]
- **IR-4 Program:** Some of California's specialty crops—almonds, artichokes, and broccoli—are not grown anywhere else in the country. But growers worry about invasive pests and heightened regulatory control of pesticides. In response, the state **Office of Pesticide Consultation & Analysis** (OPCA) is funding projects that offer "additional and often-lower risk tools to combat pests." Some funding helps the backlogged federal USDA IR-4 program, which looks specifically at pesticide registration cancellation and restrictions on specialty crops, as opposed to high-acreage, high-sales-volume products. The OPCA also helps fund research into new pest-control technologies and management practices.[68] Part of the national IR-4 Specialty

Crops Project, including field, laboratory, and assurance units, is based at the Environmental Toxicology Department at UC Davis.

- **Healthy Soils Program:** Since 2017 this CDFA program has awarded grants to farmers and researchers working to adopt demonstration programs and farming practices to store carbon in soil and woody plants, improve soil fertility, reduce erosion, and increase water-holding capacity.[69] In 2020, individual grant award caps rose to $100,000 (though many were well below this), up $25,000 from previous years, and the application process was simplified. In 2018, according to a CDFA press release, department "selected 194 projects totaling $8.7 million in funding across 45 counties for the Incentives Program, and 23 projects totaling $3.8 million in funding across 16 counties for the Demonstration Program."[70]
- **AgStart:** The nonprofit agricultural technology incubator grew out of the Sacramento Area Regional Technology Alliance (SARTA), and focuses on agricultural clusters that have sprung up in the state's Central Valley region and their proximity to the ag-tech clusters in Sacramento and research at UC Davis. AgStart provides mentoring, educational, and networking services for members, as well as connections with potential partners and investors. It is also a founding member of Vine, which also connects agriculture and food innovators with incubators, labs, field testing facilities, and other experts.[71]

Financing Tools

California Climate Investments are funded with proceeds from the state's cap-and-trade program, which runs to 2030. Funds collected through the program, which grew out of Assembly Bill 32, the California Global Warming Solutions Act of 2006, are channeled through the Greenhouse Gas Reduction Fund and the California Air Resources Board (CARB). Most of the annual revenue is allocated for projects promoting clean transit, sustainable agriculture, energy and water savings, and affordable housing, and in particular projects that benefit disadvantaged communities.[72] "Nearly $1.4 billion in new funding [in 2018] went to projects across all of California's 58 counties, almost double the $720 million spent in 2017," according to a March 2019 report on CARB's website, adding that "to date, $9.3 billion in cap-and-trade proceeds has been appropriated to 20 state agencies that have distributed $3.4 billion to projects that are either completed or under way across the state. These 'implemented' funds have leveraged an additional $10.8 billion from other sources."[73]

In August 2018, then Governor Jerry Brown signed into law AB 2377, which provides funding for farmers and ranchers whose applications are approved for technical assistance as they transition to climate-smart agriculture. The funding goes through three programs—the State Water Efficiency and Enhancement Program (SWEEP); the Alternative Manure Management Program (AMMP); and the Healthy Soils program—and requires that each set aside a portion of its budget for three years to establish the assistance programs.[74]

- **State Water Efficiency and Enhancement Program (SWEEP):** SWEEP did not receive funding from the 2019–2020 CDFA technical assistance grant program, but it has long supported farmers and ranchers. Since 2014, it has provided $72.2 million in cost-sharing grants to more

than 725 projects that involve soil moisture monitoring, efficient irrigation systems and system upgrades, and installation of renewable energy, such as solar panels.[75]

- **Alternative Manure Management Program (AMMP):** Launched in 2017 by the CFDA, this program helps livestock operators finance alternative and cleaner non-digester manure management practices to reduce greenhouse gas emissions. Green manure digesters use heat to process raw cow manure into the nutrients farmers put back into their fields as fertilizers. Newer digesters use anaerobic digestion processes that break down the biodegradable particles further to be captured (and burned) as methane gas. AAMP, however, is interested in alternative manure management processes that don't use anaerobic digesters, such as "pasture-based based management, solid separation, or conversion from flush to scrape in conjunction with some form of drying or composting of collected manure." Also according to its website, AMMP was expecting to receive between $19 million and $33 million from the Greenhouse Gas Reduction Fund in 2019.[76] It funds both new technologies/new practices demonstration projects, and farmer-to-farmer outreach demonstrations. To date it has awarded $63.1 million to 108 projects.[77]
- **Dairy Digester Research & Development Program (DDRDP)-** Like AMMP, the CDFA's Dairy Digester Research and Development Program is working to install digesters, but with a focus on dairy only (as opposed to chickens and hogs as well, for example) and on those that do use anaerobic processes to create methane gas, which can be sold for electricity and fuel production.[78] It was expected to receive $61 million to $75 million form the Greenhouse Gas Reduction Fund in 2019.
- Also funded under California Climate Investments and launched in 2014 is the state Department of Water Resources' **Water Energy Grant Program**, which helps fund commercial, institutional, and lower-income water efficiency programs, and programs that work to conserve both water and energy.[79] Savings from projects funded in 2014 and 2016 totaled 200 billion gallons of water and reduction of more than 300,000 metric tons of CO^2.
- On the private side, the Salinas Valley region, less than ten miles from Monterey Bay and the Pacific Ocean, is part of "Steinbeck Country," representing an area "that reaches from Silicon Valley in the north down to the Paso Robles Wine Country in the south," or about 180 miles.[80] It is home to a $9 billion agriculture industry, and 1.4 million acres of agriculture, much of it leafy greens for the most of the nation's salad bowls. The city of Salinas, about midway between north and south, is also a fast-growing agritech center (known as the Steinbeck Innovation Cluster), thanks to its proximity to Silicon Valley. Among the initiatives found there is the Steinbeck Innovation Foundation's **Steinbeck Innovation Fund**, a venture capital platform for a targeted $100 million in agritech investments. Lab participants discussed its targeted $100 million VC fund model, which encourages financial and strategic participation from the Western Growers Association in its investment strategy.
- Another agritech cluster in Silicon Valley is based on the powerful convergence of big data, machine-learning, robotics, and IOT know-how. In its second year in 2020 and hosted by the London-based Informa Plc., the **Silicon Valley AgTech Conference** attracts hundreds of

agritech entrepreneurs, farmers, and investors.[81] Over the past two years, just over 20 percent of agritech companies that received funding in the past two years originated in Silicon Valley. Venture funds and incubators, such as Los-Gatos-based SVG Ventures and SVG-Thrive, work with agritech, agrifood and high-tech entrepreneurs and startups, universities, and investors, statewide and globally.[82] An important example of this systems integration of water technologies, agritech, and information technologies is the development of vertical farming which produces turn-key, automated, and climate-smart solutions. These vertical farms, such as seed stage start-ups like OnePointOne in Santa Clara, and others in California and Israel, are experimenting with alternative revenue and service models and cutting-edge robotics and information technologies to achieve increases in production, reduced water, labor, and energy use, and more efficient post-harvest outcomes that can be scaled in important and growing global markets.[83]

Risk Mitigation

Finally, the **UC Cooperative Extension,** an outgrowth of the University of California System's Department of Agriculture and Natural Resources, is a network of UC researchers and educators who provide applied-science methods throughout the state in areas of pest management, precision farming, water management, fire control, gardening, and nutrition. Outreach extends to local agencies and organizations as well as private businesses.[84] Founded in 1914, it is "California's first incubator," aligning research with the public interest. [85]

Israel

The central government has a longstanding record of investment and support for agriculture. The Ministry of Agriculture manages a full complement of grants for farm investments, including land grants, packinghouses, greenhouses, site preparation, electricity subsidies, and, for selected crops in certain regions, operating support for farms themselves. According to the Volcani Development Organization, up to 30 percent of farmer investments were covered by these grants.[86]

Since the earliest days of the modern state, the government has played a primary role in agricultural policy. This involvement reflects both the principally arid landscape and the need to feed and grow a self-reliant nation quickly.

The largest state-supported efforts include the following, which have long and rich traditions of service:

- The **Agricultural Research Center (ARO)/Volcani Center** is responsible for almost all of the country's applied science work in agricultural engineering; plant protection; plant sciences; soil, water, and environmental sciences; postharvest and food sciences; and animal sciences. Eight regional R&D centers (sometimes called stations) are scattered along the borders of the country from the Golan in the north to the southern Arava Desert. Each has public management, professional committees, a scientific director, and a manager, and disseminates new information about crops and technologies best suited to local conditions.

- The government has a strong **Agricultural Extension Service system** (the meaning of which is slightly different from that in California) that since the mid-fifties and under the **Ministry of Agriculture** has supported farmers extending agricultural practices further into what were once arid lands. This service is particularly critical for peripheral centers to ensure and improve the profitability of their farms through the means of production available to them. Again, according to the Global Change/Volcani Center's 2019 paper, "Since the early days, extension workers operated under the Ministry of Agriculture's crop planning framework. The government was able to plan the number of extension workers around production needs." Among its benefits are specialization, collaboration and messaging, and connection to research.[87]

At the heart of all efforts—from the Ministry of Agriculture's Volcani and Extension Service to the collective farms—is the farmer. "This **[flat hierarchy] structure** and interaction enable four key elements of the agricultural innovation system," notes the Institute for Global Change: "First, it ensures that the innovation system works on the right problem. Farmers can communicate their problems directly to all parties. Second, it enables the development of an appropriate solution. Volcani researchers and regional R&D centers work together on the solution, hand in hand with extension workers and farmers. Third, the model contains a built-in adaptation function through the regional R&D centers. Spread across a small, but ecologically diverse country, the regional R&D centers adapt solutions to local conditions. Fourth, the structure and interaction lay the foundation for effective dissemination and high adoption of the new innovation."

Israel now leads the world in water recycling as a result of **agricultural demand-management policies** driven with twin objectives: irrigation with non-potable water (effluent or natural brackish water) and precision irrigation wherever possible. As detailed under "Issues and Perspectives," the government uses financial and quota incentives to help achieve its conservation goals: farmers who use treated wastewater in their fields pay one-third the price of watering with potable water; they receive annual discounts for trading a portion their potable water quotas for non-potable water; and they receive subsidies for putting in effluent piping infrastructure.

- The Institute for Global Change/Volcani Center's paper on Israeli agricultural innovation describes another important form of public-private engagement between government and farmers: **production and marketing boards**,[88] including boards for cotton, dairy, honey, olive oil, grapes and wine, eggs and poultry, and plants.
- The government supports **exposure to international collaboration**. The independent, publicly supported **Israeli Innovation Authority** is the umbrella organization for a number of programs, including **Bilateral Program for Parallel Support**, which works with R&D-funding and other innovation-funding bodies worldwide, and well as agencies and businesses, for project partnerships to advance the technology transfer and business development of Israeli firms. The program supports technology firms wanting "to develop or upgrade the

development of products, services, or manufacturing processes with an international partner" or seeking "to create strategic alliances and partnerships with companies and organizations abroad, to expand their operations, to undertake beta site and trial (pilot) projects, to gain access to innovative R&D infrastructure abroad (labs, simulators, etc.), locate additional sources of financing, break into new markets, and benefit from the access to knowledge and technology existing overseas."[89] Participating firms may be eligible for grants covering up to 50 percent of their R&D budgets. They are subject to certain conditions, i.e., they must bring added value for the Israeli economy; universities and research institutes can participate as subcontractors; they follow Israeli regulations for sharing or selling the ownership and rights to intellectual property; and they pay royalties of 3–5 percent of all sales to the government.

- The **Product Adaptation Incentive Program** assists with **technology adjustment for emerging markets in India, China, Latin America and Africa.** The program helps Israeli companies to get footholds as first movers in these important markets, helps companies with the costs (up to 50 percent in some cases) of adapting their current product or service to ae target market, meaning, adapting it for regulatory, language, climate and capacity differences. Funding may also cover the costs of setting up a pilot (beta) sites.[90]

In sum, Israel's long-established leadership in farm and food R&D, and its publicly supported models of engagement and information sharing, leave its best-resourced R&D centers well positioned to engage in new markets, especially those where water is precious, through collaboration, business development, and demonstration projects.

Financing Tools

A snapshot of some of the programs and tools for specific agricultural secludes, with funding from the Ministries of Agriculture and the Environment Protection, as well as set-aside cleanup funds, includes:

- support grants for the establishment of agricultural-waste treatment facilities and cowshed sewage
- a "support procedure," created in 2019 for the establishment of agricultural-waste treatment facilities for crops, sheep, fish, and chicken, in a total budget of NIS 2.5 million.
- a support procedure for pre-treatment wastewater facilities for NIS 4.75 million per year
- funding in the amount of NIS 26 million of six companies to establish plant waste processing plants and tree stumps for biomass (pellets) used as a "green" fuel for heating and energy production.

Again, the Innovation Authority takes a lead role in funding agricultural research and applications.

- The **Innovation Authority's Binational Funds Incentive Program** allows for the creation of a joint funding pool, set up by Israel and a foreign country, to finance mutually beneficial partnership projects. For example, the **Israel-U.S. Binational Industrial Research and**

Development (BIRD) fund, established in 1977, finances twenty-five projects across multiple sectors, including agriculture, electronics, life sciences, and renewable and alternative energy. The fund provides funding for half a project's development costs, up to US$1 million. To date, according to the Innovation Authority, "The cumulative sales of products developed through BIRD projects have exceeded $10 billion."[91] There are four more binational funds, with Canada, Singapore, Korea, and India, all working to heighten Israeli presence in the global market by means of cooperation and strategic partnerships.

- **R&D Cooperation with Multinational Corporations (MNCs)** is designed for the startup or young tech company, small to medium in size, hopeful of greater exposure by tying in with an MNC for its greater tech and sales strengths. The Innovation Authority provides a conditional grant of 20−50 percent of the development budget and receives royalties in the event of future sales from the joint venture. The MCN provides consulting and resources, and the possibility of retaining some rights to IP of the joint venture.[92]

- All government ministries have their own chief scientists, and the Ministry of Agriculture is no different. The **Office of the Chief Scientist for Agriculture** outlines the ministry's goals, sets funding targets, directs resources, and monitors commitments. Many of the projects funded by the Office of the Chief Scientist are partnerships between academia and the private sector which must invest at least 30 percent of the cost of the project. In addition, the Office includes extension services to researchers and farmers in collaboration with local and regional councils.[93]

The **Israel Innovation Authority** had representation in the Lab, as well as a strong presence in this report. The Authority in fact signed a second memorandum of understanding in 2017 for collaboration in cleantech and sustainable energy with the University of California System and the Milken Innovation Center.

The Innovation Authority's programs support different sectors and stages required as part of developing new technologies. A few programs in agritech from the Authority's **Academy of Industry** are listed here.

- **Promoting Applied Science in Academic Research:** This program aims to make Israeli business sectors more aware of the latest in college-level, university, or medical basic research (or further existing interest) with the intention that they will assist in the next steps of applied research to forge a commercial agreement after sufficient milestones have been met. The research must meet certain Innovation Authority conditions and demonstrate high added value to the larger Israeli economy; the Authority extends funding as does the partnering corporation.[94]

- **Technology transfer (MAGNETON):** This program works to match Israeli academic institutions and businesses to further technology transfer that results in commercial products. The program opens up research to outside corporate assessment of its utility, offering rare close-up evaluations. The institution must be the sole owner of the technology, and the participating firm then has a right of first refusal, as it were, to pursue rights to the commercialization of the applied research. Grant periods run up to two years, and recipients are exempt from royalty payments to the government.[95]

- **Magnet Consortiums:** These three-year programs enable Israeli companies to meet and engage in collaboration, knowledge sharing, and infrastructure technology development with other firms worldwide working in the field, and with research institutions interested in long-term R&D and eventual commercialization of the research. Funding may reach up to 66 percent of a private company's budget for the project and up to 100 percent of the budget for the research institution (meaning 80 percent as a grant, 20 percent of the industrial companies in the pool).

- **Lifting Up" program (TNUFA):** The program awards two-year grants to early-stage startups and private entrepreneurs at the proof-of-concept phase in advance of commercialization, and helps them to the point that they can demonstrate technological feasibility and business applicability. With funding of up to 85 percent of their approved budget, they can use the funds to build prototypes, go for IP protection, and pay for subcontractors, attorneys, material, and consultants.[96]

    - **Incubators Incentive Program:** Entrepreneurs at the early stages of R&D can apply for two-year conditional grants of up to 85 percent of their approved budget, or a budget cap; the incubated company funds the rest. It can also receive assistance with all the startup business needs, e.g., how to move from concept to commercialization, including business and legal guidance, administrative services, even physical space and infrastructure. It also has exposure and access to potential partners and investors.[97]

    - **Joint Programs: Innovation Authority and Ministry of Agriculture:** In 2018 the Ministry of Agriculture and the Innovation Authority announced a joint annual award of NIS 10 million to support the national innovation system and fledgling local agritech companies through the initial stages of product development. "The assistance will be awarded to developments and technologies of plant- and animal-based products, used for food or industrial raw materials, as well as products for improving and streamlining the breeding process of plants and animals," notes a statement. The grant covers up to 50 percent of approved budgets or more, depending on where in Israel the work takes place.[98] The Agriculture Ministry and Innovation Authority have launched another program using beta sites in Israel to test new plant- and animal-based agritech for sustainability, commercialization, and export potential.[99] Another initiative, the Ag-Tech Marketplace website went live in August 2019, connecting agriculture and community. It was the result of joint efforts from the Ministry of

Economy and Industry, Digital Israel, Start-Up Nation Central and the Israeli innovation Institute, and connects startups to farmers willing to offer beta sites.[100]

Risk Mitigation

Within the Ministry of Agriculture, the Training and Professional Services Unit, or **SHOHAM,** is tasked with a number of missions of national importance: to take applied research and scale it up via training of farmers; to help famers develop efficient use of labor, water, land, and capital; maintain a repository of information for use by other ministries as well as public- and private-sector entities; and help farmers meet national goals of improving sustainability and profitability in the agricultural economy. SHOHAM is staffed by experts across various agricultural fields.

SHOHAM's professional units work with vegetables, grown in open and sheltered spaces; fruit, where citrus and orchards are two separate units; flowers, which also includes the field of plant engineering and botanical gardens; the livestock subdivision, which includes dairy and meat cattle, sheep, and goats, fowl, fisheries and apiaries; a service subdivision, consisting of the field service, automation and plant protection; agro-ecology, (i.e., horticulture and organic farming fields); and the a training department and administration. It also works to market Israeli technologies and services globally.

As noted earlier, Israel's **Extension Services** emphasizes assistance to farmers along the country's periphery. Its 136 specialists serve about 15,000 farmers, or one expert for every 110 farmers.[101]

Barriers

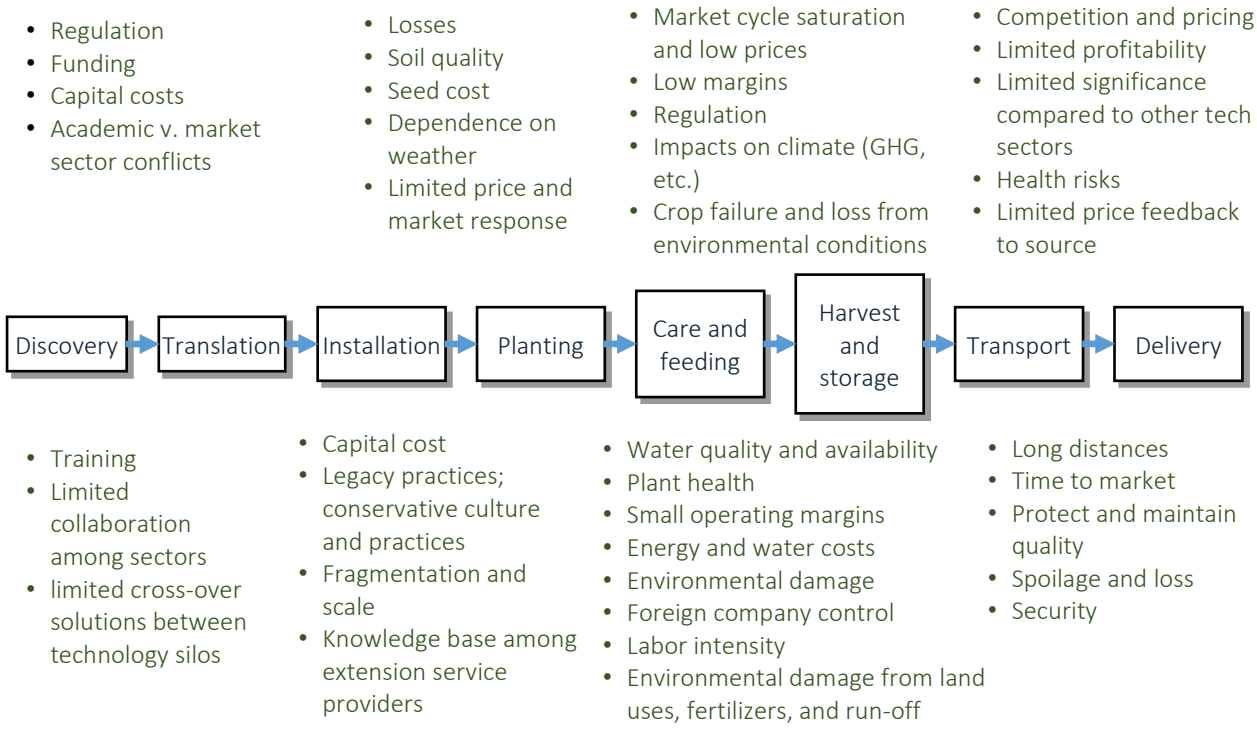
To better understand funding barriers, it is useful to recall Figure 4, which shows where the expertise of various agritech industries is applied along points in the agricultural production value chain. Here we'll do something similar. We'll look first at financial barriers along the *agricultural production value chain*, then at financial barriers along *agritech's own developmental value chain*, and then *at the intersection of these two value chains* to find funding solutions. The CEO of Evogene, an Israeli firm acting in plant genomics, points to an overarching economic challenge for firms like his: agricultural commodities are subject to frequent price fluctuations, but pricing for agritech solutions and services is expected to remain stable. We may not find direct ways to overcome these price peaks and valleys, but we can use the components of the value chains to build bridges to cross them.

Agricultural production value chain

The agricultural production value chain includes eight phases: (1) discovery; (2) translation of products and processes; (3) the installation of systems to grow; (4) the planting; (5) and care and feeding of produce; (6) harvest and storage; (7) transport; and (8) delivery of produce to the agricultural processor or end consumer. This section addresses the financial/funding and regulatory barriers during these phases, with some of the barriers spanning several phases.

FIGURE 12

Barriers in the agricultural production value chain



Source: Milken Innovation Center

Discovery and translation

During the discovery and translation stages, capital costs run high, but funding is generally limited because it may be hard to envision the connection to sales and/or return on investment. There may be institutional conflicts as well (some of them inherent) between scientific R&D and more market-oriented research. The issue of building staff with requisite expertise is often a challenge because much of today's research calls for cross-disciplinary acumen—for example, in biology, chemistry, physics, informatics, and genetics—yet silos still hamper communication between various departments and between labs. Regulatory barriers may cause delays due to health and safety concerns over the introduction of new seed varieties, fertilizers, and planting methods, and these delays increase the risks and costs.

Installation and planting

Financial barriers during the combined installation (usually of irrigation, monitoring, and management equipment) and planting stages include high seed costs; seed loss due to spillage, spoilage, or damage; and weather/climate uncertainty. The accrued legacy costs that come with sticking to "old" planting methods and outdated equipment can make it prohibitive to finally invest in new capital equipment. Additionally, the deployment of these new techniques on smallholder farms is difficult to amortize. Finally, the volatility of the futures market adds a layer of risk to any change (and its attendant cost) at planting time.

Care and Feeding/Harvesting and Storage

Farming remains a costly, labor-intensive enterprise, especially during these stages, subject as it is to the vagaries of weather; limited control of operating costs, like water and energy; and regulatory barriers. A season's investment can be decimated by a prolonged drought or extended storms. Bringing equipment, fertilizers, and pesticides into regulatory compliance can cause delays, born of safety concerns about their impacts on health and the environment. All these create financial and operating constraints. Finally, there is irony that the better the yield, the lower the return, which can lessen financial viability for the next season. Against this backdrop is the threat of catastrophic long-term regional crop failure due to climate change.

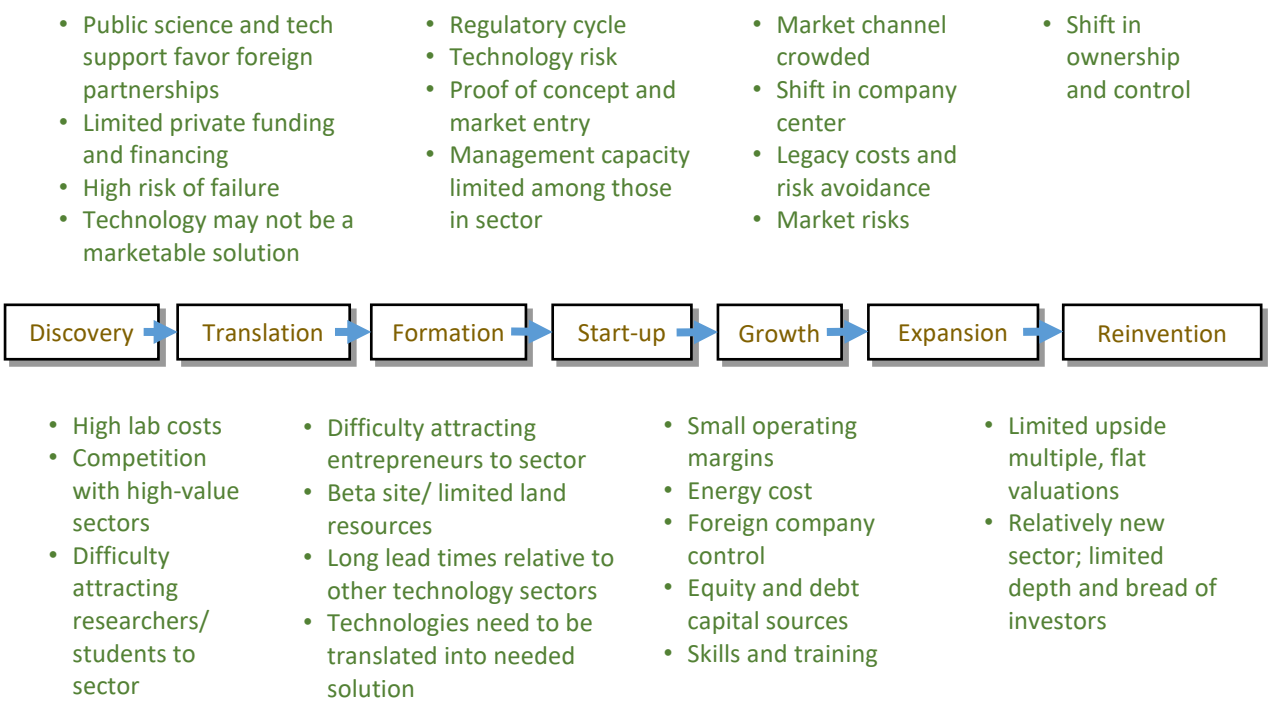
Storage, Transport and Delivery

Financial barriers during the storage, transport, and delivery phases correlate with the time to market, especially for export producers. However, there are challenges even for domestic production and consumption. Barriers include the high capital costs of security systems; forgone revenue due to product loss and spoilage during storage and transport; and the health impacts and risks associated with the product quality and potential product recalls. Lab participants identified the relative low operating margins for technologies and products in this area.

Agritech business development value chain

A value chain exists for the development of agritech companies as well, as shown in Figure 13. It consists of: (1) discovery; (2) translation; (3) formation; (4) startup; (5) growth; (6) expansion; and (7) reinvention. These stages are typical for a startup in any sector, as are most of the barriers along each stage in the value chain. But in some ways these barriers are unique to agritech.

FIGURE 13 **Barriers in the agritech development value chain**



Source: Milken Innovation Center

Discovery and translation

During these very early phases, startups face high lab costs and steep competition for both funding and qualified graduates. They may find that no market exists for their innovative discoveries. Conversely, if a strong market exists, they may (and certainly do in Israel) face pressure to join foreign partnerships, which can open the door to a complicated flow and control of intellectual property. Many projects also fail during these early stages, which also raises the perception of risk among private investors.

Formation and Start-up

As hard as it can be to find qualified research staff, it can just as tricky to hire experienced managers who understand both the product and the market. Good managers can shorten time to market and help push the startup through another barrier: adapting a technology to particular markets. Even so,

the cost of building a "proof of concept," especially one near the market participants, can be prohibitively expensive.

Growth and expansion

Like most startups, agritech firms run on very small operating margins. Their budgets are particularly sensitive to the variable costs of energy, labor, and financial fees, and the normal fluctuations in market prices facing their customers, agriculture producers and processors. They may find it hard to get a foothold in markets that are already crowded with suppliers and competitors. They must also persuade customers that the true price of legacy costs and the aversion to new technology is a lack of protection from competition. And once the firm has surmounted all these hurdles, its owners may be tempted with generous offers to sell the fruit of their labor—to a buyer who may not continue the operations or may even move the operations elsewhere, even overseas.

Reinvention

The last phase, which is really the long tail of a company's life cycle, includes continual reinvestment, innovation, adjustment, and engagement in new markets. It can mean new partnerships and/or mergers with companies in the value chain (suppliers, customers, or competitors). This phase is often characterized by changes in ownership, relocation, and control of the enterprise. Because revenue growth potential is often modest at this stage, the sector attracts few specialized investors (often industry giants) and is generally characterized by low valuations.

Development Challenges

The discussion among Lab participants focused on the following specific development questions that need to be addressed to help the agritech sector in Israel, California, and developing economies:

1. How do we increase access to information about farmers' priorities?
2. How do we access more government or private funding for the translation phase (from the lab to proof of concept)?
3. How can we gain access to, or share, marketable IP in a single location or from a single technology transfer office?
4. How can we help farmers make large capital investments in new technologies?
5. How can we align the goals of Greenhouse Gas (GHG) reduction, and water and energy conservation, when the ability to monetize the value of each is limited?
6. How can we offer effective and precise irrigation metering and monitoring when water source delivery is irregular?
7. How can we help growers reduce high labor and mechanical costs during harvest, and losses from storage and delivery to market?

Best Practices

Lab participants discussed current best practices that address these barriers and can be more broadly adapted to meet the needs of farmers, and the agritech firms that supply them.

Lab participants offered a range of solutions; these are mapped along the stages of the business development value chain, as shown in Table 1, to show how each fits into the growth of a company's capital structure as well. Each solution addresses one or more specific barriers and can be implemented at more than one stage.

TABLE 1 **Solutions by development stage**

Discovery	Translation	Formation	Start-up	Growth	Expansion
Research endowment	Challenge grants	Climate-smart venture debt	Performance financing	Warehouse invoice financing	Global investor pipeline
Testing and regulatory screening	Design grants	Farmer LP consortium	Climate-smart loan fund	Factoring	Climate-smart project financing
R&D clearinghouse	Climate-smart Incubators and accelerators	Research-backed obligations	Climate-smart tax credits	Supplier financing	Agritech business development corporation
Non-marketing reconnaissance teams	Technical assistance, extension service	InsurTech: tech efficacy insurance	Biodiversity (climate smart) credits	InsurTech,- crop loss insurance	Climate-smart bond bank
Co-innovation Teams					
	Beta site and demo farm program				
			Catalytic first-loss guarantees		
	Agritech reinvestment mechanism				
Financing research	**Financing risk mitigation**			**Financing projects and enterprises**	

Solution set 1: discovery phase support

New business development is usually an iterative, overlapping process whose actual starting point can occur at any number of stages—at the beginning, with discovery; at the middle, with the formation of essential partnerships, client meetings, and investors; and even at the end, with market demand. However, because discovery is one of the most natural starting points in the process of agritech business development, it is used here as the start point, with progression moving in a linear fashion.

Development support in the discovery stage includes an array of tools to seed a sustainable pipeline of new projects and eventual firms. It is included in the capital structure because the work in this set of solutions forms the basis for translating discovery into projects, and then projects into companies.

Among the suggested tools is a **research endowment,** and explained in Table 2, which can help ensure funding for climate-smart applied research that will lead to the creation of intellectual property that can be licensed. The endowment would be invested and generate enough income to fuel these applied research efforts and fund **testing and regulatory screening** against current standards and in simulated conditions. Early in the company formation stage, development support includes a*n* **R&D clearinghouse** to catalog best practices in a fee-supported database accessible to farmers, researchers, and entrepreneurs. Finally, **non-market, subsector reconnaissance teams**, i.e., **co-innovation partnerships** with stakeholders in different fields bring their own perspectives on new applications, opportunities, and value in new markets, including global markets. These teams can scout for niches and need, for example, in the assistance that Extension Services provides to rural farmers.

TABLE 2

Solutions Set 1: Financing discovery

What is it?	How does it work?	Why it matters?	Who pays for it?
Research endowment Supports applied research as it targets sector problems.	▪ The endowment is allocated to a fund that will support only applied research ▪ It prioritizes the research that can reach commercialization. ▪ It also prioritizes interdisciplinary research. ▪ It helps to integrate business into the research process	▪ The research targets emerging technology, product, or service challenges in the field. ▪ It also makes longer-term research projects feasible.	▪ Philanthropic and governmental matching funds. ▪ The endowment would generate investment income, which could be reinvested and yield an annuity to cover annual funding activities.
Testing and regulatory screening Verification and validation testing, including tests to ensure compliance with existing standards.	▪ The technology, product, or service is tested as close as possible to real conditions.	▪ The results will uncover "real-world" problems and barriers that may not have been anticipated.	▪ Fees for service.
R&D clearinghouse A repository of R&D ideas, results, and processes	▪ R&D projects would be cataloged into a sectoral (science, market, issue, etc.) database. ▪ Clearinghouse contributors would be tied to the technology transfer office (TTO) databases of participating organizations. ▪ The database would feature online access. ▪ Updates would be distributed via social media feeds. ▪ The clearinghouse would sponsor events at international conferences on related topics to promote database access and content.	▪ An R&D clearinghouse would reduce or eliminate silos between labs, phases of business development, and sectors. ▪ A clearinghouse would enable the rapid sharing of information.	▪ The R&D clearinghouse will be supported by allocated fees from licenses and partnerships with the participating TTOs.
Non-market subsector reconnaissance teams Teams would be defined as partnerships with schools, universities,	▪ Partnerships are established with stakeholders from different areas of expertise.	▪ Understanding challenges, problems, and opportunities in new markets will enable	▪ Scholarships funded by industrial companies, government funding, and academia.

research institutions, entrepreneurs, investors, and overseas counterparts, to encourage the learning experience and exposure to challenges, and identify unexpected and new opportunities and needs in new markets.	▪ The result is a value multiplier for learning new markets.	solutions and new best practices. ▪ Combining different areas of expertise enables the adoption of new perspectives and solutions. ▪ Partnerships will open doors to global markets for new technologies.	

Solution set 2: translation phase investment

In the translation stage, new technologies, seed types, services, etc. move from the lab to the field for beta sites and live farm demonstrations. Financial support is generally a mix of grants and long-term low-cost credit paid through the returns on investments later in the development cycle. In Israel, the Extension Service plays a strong role here. The UC Cooperative Extension system performs a similar bridge between university research, farmers, local communities, and investors.

This solution set focuses on creating investment capital to begin the startup process. Capital sources should be flexible and scalable—both are essential properties in idea discovery and company formation. **Challenge grants** and **recoverable design grants** can help entrepreneurs refine their ideas into marketable solutions. A **beta site program** that incorporates demonstration farms is essential for technology demonstrations. Another important tool is a network of agritech **incubators and accelerators** that provides support, guidance, mentorship, and investment. Ongoing **technical assistance** can again include **co-innovation teams** made up of interdisciplinary experts in technology, regulation, market, and finance, to focus on moving projects forward to a market-ready, financeable ventures. As a financial solution, an agritech reinvestment mechanism, i.e., an investment pool combining public and private—angel investors, traditional VCs—can support a robust pipeline of agritech innovations that lead to profitable exits and a direct way of reinvesting a share of those profits into this stage again. This reinvestment mechanism is described in Table 8 below.

TABLE 3 **Solution Set 2: Financing Translation**

What is it?	How does it work?	Why is it important?	Who pays for it?
Challenge grants Funding to businesses and R&D labs to develop solutions to specific problems.	▪ The market identifies a specific unmet need or challenge in need of improved technologies or processes. ▪ The need/challenge is confirmed, and the scope of the need is estimated (impact, cost, etc.).	▪ Specific funding like a challenge grant allows the R&D sector to focus on a specific challenge it might not otherwise feel it can afford to examine.	▪ The challenge grants are usually supported by a match between government and philanthropic sponsors. (Canada, Pears, etc.)

	▪ A request for proposals is issued. ▪ A challenge grant is issued to one or more of the proposers. ▪ The challenge grant winner(s) submits solutions. ▪ The solution is available for licensing to other agricultural producers or agritech companies.	▪ The challenge grant allows for the timely customization of solutions, and for their translation to the market.	
Recoverable design grants Funding for both the project and capital structures.	▪ Funding goes to a project sponsor or project leader for engineering, market work, legal work, and financial and impact analyses. ▪ If the project goes forward, the grant is repaid from the proceeds of the financing or from cash flows of the project.	▪ The design phase is the first step in the development value chain. It opens the door to projects, technologies, and financial innovations. ▪ The design phase allows the project to translate a new technology into a workable and scalable solution.	▪ Design grants are provided by a combination of project sponsors, financial sponsors, and potential investors through a development financial platform. ▪ Recovery of design grants can be used for new design projects. ▪ With a high loss rate of projects, the funding for design grants will not break even, but the successful projects along the value chain contribute to the funding base for new design grants.
Beta site program Examines the feasibility, refinement, and application of innovative technologies for customers and to promote commercialization.	▪ It enables a company to make significant progress in product readiness for commercialization, and in market penetration through the application on the experimental site. ▪ Beta sites allow for a safe harbor for testing, adjusting, and refining solutions before their introduction to the market.	▪ Beta sites bring proof of concept and of regulatory compliance, especially important for high-risk ventures.	▪ Beta site programs are supported by a matching program between government and philanthropy.
Incubator and accelerator These provide assistance, such as support infrastructure, mentoring programs by industry experts, and training needed to help	▪ They offer entrepreneurs good opportunities early on. Founders get help to quickly grow their businesses. ▪ A business that gets its start in an incubator or accelerator generally	▪ Risk is high at this stage, and most private investors are unwilling to invest their money. Here the state can assume most of the risk. This is also a	▪ Usually the public entity works with matching investments from private-sector investors (Yozma etc.) and equity funds (Berkeley SkyLab etc.)

startups improve their performance and progress.	improves its chances of attracting a top VC firm later.	crucial stage for mentoring by more experienced business and investment leaders.	
Technical Assistance Professional advisers offer support.	▪ After the design phase of the project and during the translational phase, the project will need ongoing professional guidance, including engineers, accountings, and legal advice, and operations support. ▪ This support will be provided by the project investors and managed by the project owners.	▪ The success of the project depends on timely expert advice during development implementation of the project. ▪ Technical support and assistance are key to take a project through the translation and implementation phase.	▪ Initial capital must be provided by a financial and development institutions and authorities ▪ Support can also come from a special pool of funds capitalized by the project origination and servicing fees.

Beta sites are especially crucial. Suppose startup has a solution to an issue associated with harvest, during which labor and mechanical costs run high. A beta site would test the proposed solution. Similarly, losses from post-harvest storage and delivery to market can run high. In these cases, beta sites are "real-life" labs for testing robotics, big data collection, logistics, and storage, all to mechanize harvest and optimize post-harvest value.

A good example of collaboration with active market partners can be found at the California Strawberry Commission, which funds research for post-harvest and mechanization technologies, and is developing a customized research agenda with the California Agriculture Board, Volcani, and university partnerships (in the UC system, Hebrew U., Weizmann, Technion, etc.). The University of California Division of Agriculture and Natural Resources in Davis has integrated research projects and community educational events. Its research and information centers provide important platforms for resources and information.[102]

California DFA: Two Recent initiatives on Invasive Pest Management:

(1) In August 2019, the California Department of Food and Agriculture announced the formation of a working group to study short-term solutions, hold public workshops, and develop a five-year plan for finding alternatives to chlorpyrifos, an insecticide being phased out in California. The group includes experts across fields, including universities, environmental groups, farmworker health groups, pesticide manufactures, and others.

(2) Also in August 2019, the DFA announced $1.2 million grant for proactive integrated pest management solutions on biologically integrated farming systems (BIFS). Goal: to fund on-farm demonstrations and evaluations. Funding sources: state Office of Pesticide Consultation and Analysis, and state budget allocation to "help California's farmers transition away from chlorpyrifos."

Source: News release, CDFA

Solution set 3: company and project formation investment

Once a company passes its proof of concept or beta testing, it faces still more funding hurdles before it moves toward regulatory review and market placement. This is a particularly risky development phase in both California and Israel, but only because there are few projects in the development pipeline, which makes it hard to attract investment dollars and spread risk. One solution, borrowed from biomedical research, is to create a portfolio fund with long-term debt that can bundle IP from California, Israel, and other partnered countries. It will focus on building expertise to manage project milestones and build effective market channels; and it will reinvest in more R&D after its yield-blended marketable return on investment. Imagine a structured investment model that leverages the R&D assets in water and agriculture research centers to provide a pipeline of new technologies to meet the growing food needs. Yields would be competitive with long-term bonds, offering a combination of price and risk profiles. Some of the risk could be offset by philanthropic and public investments in the form of limited guarantees.

This solution set leads to equity and equity-like investments during company or project formation phase. The investor enters participation with, and sometimes, ownership of the project. Once IP is generated, it can be combined into a **research-backed-obligation bond**, a pool of IP that can fund more product development, testing, redesign, and applications. In addition, Lab participants suggested a **farmer-led venture fund,** where the knowledge and priorities of limited partner investors (i.e., the farmers) would guide the investments, either in the form of traditional equity investments or through a **climate-smart venture debt** facility. Finally, during this period, especially in the startup phase, the solutions can include **technology efficacy insurance** to provide assurances of repayment to early adopters.

TABLE 4

Solution Set 3: Financing company formation

What is it?	How does it work?	Why is it important?	Who pays for it?
Climate-Smart Venture Debt This is debt financing from private equity or venture funds to provide a bridge funds for a startup venture until a permanent round of venture investment is closed.	▪ Private equity investors provide a short-term loan (e.g., one year) to a startup until the next financing round closes. ▪ The loan may require interest-only payments or offer a deferral and accrual of interest payments. ▪ The investors document the loan with a note, a security agreement, and a lien on the assets. ▪ The investors are usually given the opportunity to	▪ Reaching agreement among potential investors for a next VC investment round may take time. ▪ During this time, the agritech venture needs capital to meet ongoing needs. ▪ Venture debt provides a capital bridge to ensure that the agritech venture does not run out of cash.	▪ Venture debt is usually structured from the limited partnership pool at a venture capital firm. ▪ It may be provided by the lead investor or a specialist in venture debt among the prospective investors in the next investment round.

	convert the loan to equity.		
Farmer-Led Venture Capital Fund This is a VC fund led by a limited partnership of farmers	▪ A specialized venture capital limited partnership is formed. ▪ The partnership recruits a general partner with management and investment expertise in the sector. ▪ The government and/or a philanthropy invest in a catalytic first-loss pool that is a subordinated investment in the LP. ▪ Farmers and agricultural associations invest in a venture capital fund. ▪ The VC invests in farmer-led priorities, including subsectors, technologies, and solutions. ▪ Revenues from sales, mergers, and IPOs are distributed to the limited partners. ▪ A 20 percent carried interest is reinvested in R&D and deal flow origination.	▪ LP investors have a direct knowledge of the market. ▪ First-loss pool allows a blended return on investment by the market-rate investors to meet their ROI requirements. ▪ The carried interest provides important capital to seed deal flow.	▪ LP investments will come from private investors. ▪ Philanthropy and/or government will provide the subordinated LP investment. ▪ Returns on investment will come from sales, mergers, and IPOs.
Research-Backed Obligation Bond The kind of bond provides funding for the development, testing, and commercialization of a portfolio of agritech technologies	▪ A consortium of agritech technologies sources—companies, TTOs, and research institutions—forms a special purpose vehicle to house a technology pipeline. ▪ The SPV would hold, develop, test, and adjust the technologies. ▪ The SPV would also include management, marketing of the solutions, and technical assistance to ready the solutions for market. ▪ Based on the expected royalties, licenses, and exits from its portfolio, the SPV would raise a combination of long-term debt and equity investments	▪ Long lead times and high expense of commercialization require larger amounts of capital than private equity or VC investors can provide. ▪ A portfolio approach lowers the risk profile and increases the likelihood of financial success. ▪ Securitization allows for the use of low-cost, long-term debt. ▪ The risk-adjusted rate of return opens a new class of investors to agritech. ▪ The terminal events (exits, sales, IPOs, etc.) may not be competitive with	▪ Pension and insurance funds interested in long-term, risk-adjusted debt. ▪ Partial guarantee would be provided by government bodies or private/philanthropic guarantors.

	▪ Government would provide a partial guarantee to cover first losses for the long-term debt. ▪ Payments on the long-term debt would be paid from revenues to the SPV. Equity would be reinvested in the SPV until an agreed-upon milestone has been meet.	other high-tech sectors, making them less attractive without a portfolio approach. ▪ The portfolio and size allow a larger number of strategic investments. ▪ It will create new money to fuel the ecosystem from early stage to market.	
Technology Efficacy Insurance This is a special fund to cover project or technology failure	▪ Insurance payment is made to beneficiaries, including project investors, upon triggered conditions, such as technology failure or poorer-than-expected performance.	▪ Because the launch of any new technology carries risks, project owners and investors, including farmers, may be risk averse, preferring traditional methods, and missing the opportunities for lower-cost and higher-yielding solutions. ▪ Insurance shifts some of that risk to the insurance fund.	▪ Initially, the insurance fund is established with private and/or government equity. ▪ A dedicated fund is supplemented from ongoing project fees, both initial and annual payments. ▪ Insurance funds are invested, and proceeds are reinvested into the fund.

Solution set 4: startup investment

These tools work to mitigate risk through project development and implementation. Farmers are notoriously risk-averse, and with good reason: a long drought season, invasive pests, labor worries, and other operational woes can threaten crop health, yield, and operating margins. Overcoming their reluctance to give up familiar ways is one of the chief hurdles for a new technology provider. Lab participants discussed the use of guarantees; subordinated debt; tax credits, such as the California Competes Tax Credit; small-business revolving loan funds and loan guarantees; and the creation of a technology efficacy insurance, an insurance product that protects farmers who adopt a new technology against the risk of its failure.

A more complicated way to mitigate risk is to have the technology provider share the risk with the farmer. Lab participants discussed the concept of performance-based services financing; or "seller-financing-plus." This financing tools allows the seller of the new technology to share the savings in water, energy, and increased production as a method of payment—in exchange for financing the sale. It provides an incentive for the seller to offer financing to the buyer, and provides a boost (the "plus") on the payment based on performance standards.

Additional ways of mitigating risk include expanding the range of proof-of-concept and implementation programs, e.g., the crop-specific programs (CDFA specialty-crop block grants); statewide programs (e.g., SWEEP); and national programs (e.g., the NCRS Environmental Quality Incentives Program).

Because climate-smart agriculture aims for water and energy efficiency, and reduced GHG emissions, environmental or development impact bonds can be designed to leverage avoided costs, performance financing, and blended capital structures. Bond repayment can integrate a variety of impact fees, user fees, avoided costs, and environmental credits.

These solutions target a startup's capital needs during the early revenue period. Specific programs include **performance (impact) bonds** (pay-for-success contracts) whose returns to investors are based on the performance improvements, such as lower costs (of energy, water, etc.), higher direct outputs (e.g., yields, quality of yields), and indirect outputs (e.g., better nutrition, health). Other solutions include **revolving loan funds** with lower-cost and longer-term investments (in the form of debt), which may include premiums for better performance. To create an incentive for equity investment, **climate-smart tax credits** could be designed, based on the capital investment in the project and its environmental outcomes, such as lower carbon emissions and water usage. Finally, projects can offer **biodiversity and water credits** to investors. These credits, which represent use rights, can be sold to investors to raise cash for startup ventures.

TABLE 5

Solution Set 4: Financing startup investment

What is it?	How does it work?	Why is it important?	Who pays for it?
Performance (impact) Bonds These are impact bonds, either performance-based loans or equity investment in development projects.	▪ Projects are designed to create cost-saving outcomes, such as lower energy cost or lower water cost, or higher yields. ▪ Private investors buy the impact bonds based on expected performance and returns tied to the performance. ▪ The savings from these outcomes are measured. ▪ If the savings meet the specific outcome goals of the project, investors receive their principal plus a performance bonus (usually part of the savings).	▪ Impact bonds help shift the risk from the government or NGO sponsor to the private sector. ▪ With the incentive of improved performance, the private sector is willing to innovate with the service provider to improve the delivery and outcomes.	▪ The payer to the impact bond buyers is either the project sponsor (government) or a philanthropic or NGO involved in the sector. ▪ If the project does not achieve the performance outcomes, the private sector is left paying for the project.
Revolving loan fund This is secured, amortizing, participation debt for farmers, paid from the project's net operating income and performance improvements.	▪ The loans are made directly to eligible farmers. ▪ Technical assistance is provided through outreach training. ▪ The public portion of the loan is amortized and paid back from net operating income. ▪ The private portion of the loan is paid from improvements in performance (e.g., water and energy savings, increased yields). ▪ Collateral and payments are based on the assets being financed. ▪ The loan may include deferrals, lower interest costs, and longer terms for repayment. ▪ Management through a separate revolving loan fund or contract to a financial institution for underwriting and loan management.	▪ The fund leverages private investment capital into revolving loan fund. ▪ Improved performance yields a return to the farmer and to the private investors in the fund. ▪ Payments are based on performance, so it incentivizes the private investors to help fund results.	▪ The loan fund is capitalized by a combination of public (paid back through amortizing debt payments) and private investors (through performance outcomes (monetized value of water and energy savings, increases in output and quality of yields, etc.). ▪ A portion of the public investment will be used as a reserve fund for up to 20 percent of the private investors' first losses.

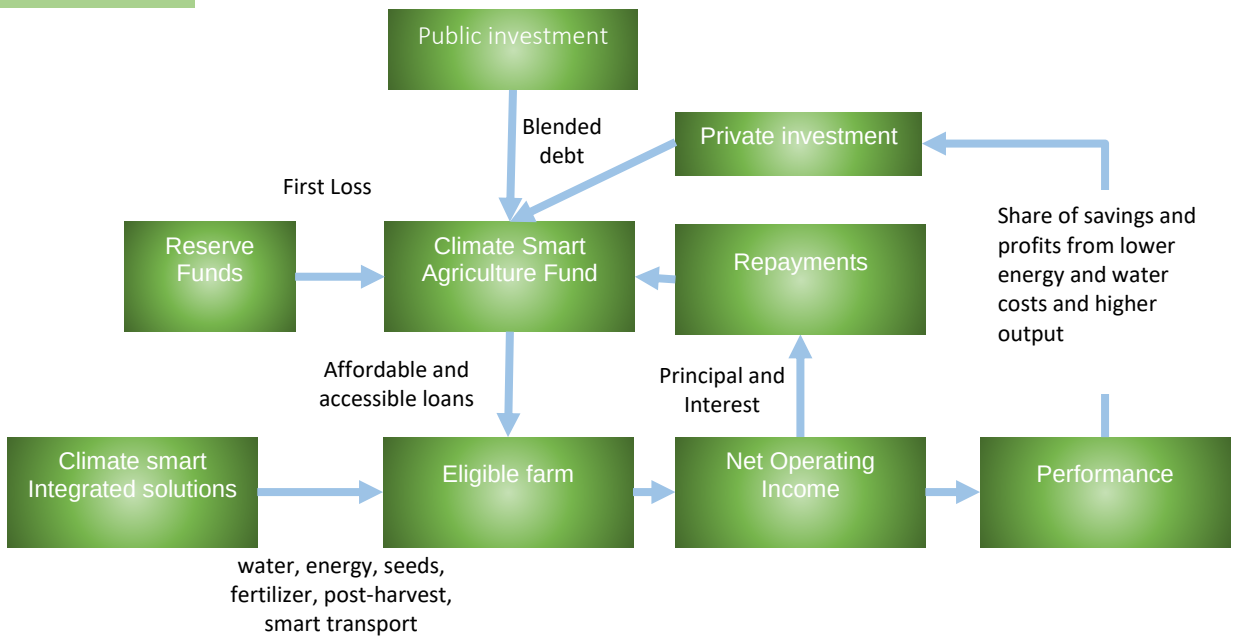
Climate-smart tax credit This is a credit against the equity investor's tax liability in an eligible project.	▪ The agriculture, regulatory, and finance agencies issue standards and identify investments, expected outcomes, and other criteria. ▪ The agritech firm structures a project investment that qualifies as a climate-smart project. ▪ A fixed percentage is applied to the eligible capital cost. This share of the total capital cost is the face value of the annual tax credit amount. ▪ The agritech company or project developer sells the discounted value of the credit to outside passive investors. ▪ This discounted credit, after structuring and selling costs, is invested in the project as equity. ▪ The passive investors claim the "face value" of the credit against their tax liability for the period of the tax credit. If the project is sold or does not achieve the expected outcomes, the tax credit is prorated.	▪ The tax credit reduces the amount of the equity needed in the capital structure. ▪ It expands the base of potential investors in eligible projects. ▪ It may increase the amount of equity available for the project by improving cash flow. ▪ It boosts the returns to the company or the project developer by reducing general tax liability.	▪ The tax credit packaging costs (referred to as "syndication costs") are paid from the proceeds from the tax credit. ▪ The government forgoes the amount of the tax credit on the buyers of the tax credits (corporate, personal income taxes) for the period of the tax credit. ▪ However, there is no direct government expenditure.
Biodiversity and water credits Farmers who engage in climate-smart agriculture earn biodiversity credits (cash and offsets).	▪ The state establishes practices and standards, including methods for monitoring and measurement. ▪ The state certifies eligible farmers for biodiversity credits. ▪ Farmers implement climate-smart activity (e.g., fertilizer usage, water methods, soil treatment, post-harvest methods, raw land preservation, etc.). ▪ The credit user (developer, land trust, cities and towns, etc.) buys credits and pays the state a price for the credit, based on demand	▪ They provide new sources of capital ▪ They preserve open and raw land, including habitats ▪ They are a market-driven method of encouraging climate smart practices.	▪ Credits are paid for by those needing development rights.

	for credits and the level of credit needed. ▪ Credits are either auctioned or traded, using an exchange platform ▪ Farmers receive payment for earned credits each year.		

One of the major failures for R&D is the lack of market information and market feedback. Here again, the case of strawberry growers in California helps illustrate the point. Strawberry growers need automated harvesting robotics and artificial intelligence to aid in their harvests. Meanwhile, the latest technologies coming onto market are focused instead on water distribution and intelligent fertilizer systems. The need to improve feedback from farmers to the researchers is key. Lab participants suggested non-sales events like farmer focus groups to improve market awareness in the R&D labs, and sponsored trade trips to learn directly about market needs. Such visits could be supported by NewTech at the Israeli Ministry of Economy; the Volcani Center, the California Department of Food and Agriculture, along with UC research institutes; and NGOs and business groups, such as the Steinbeck Business to Farm program. Another solution is to create an agritech investment vehicle funded by farmers as the limited partners to direct and prioritize funding; it could use the existing model of the Western Growers Association Center for Innovation and Technology. Yet another idea is to commission an annual "R&D challenge" to address key farm issues. This could be a fruitful collaboration between California entities (Thrive Accelerator, SARTA's AgStart) and the Israel Innovation Authority.

FIGURE 14

Climate-smart revolving loans



Source: Milken Innovation Center

Solution set 5: sustainable growth

The solutions in this set support sustainable growth and enable a vertical integration of the capital structures between producers, suppliers, and processors. Lab participants explained that the tools needed for sustainable growth often come from within the value chain itself, including **warehouse financing** and **invoice factoring** (also called invoice discounting, in which a third-party, the factor, provides financing secured by the delivery or sale of the product).[103] These solutions provide financing mechanisms that allow the farmer to make capital investments. Another direct financing source is **supplier financing**, whereby the supplier, or even a supplier finance company, provides the financing for the farmer's capital investment, seeds for example. In this case, the supplier secures financing based on the terms of the sale. Finally, because crop losses can be catastrophic, disrupting and possibly permanently upsetting the balance of financing among parties, **crop loss insurance** offers coverage to the supplier and guarantees payment in the event of an insurance claim.

TABLE 6

Solutions Set 5: Financing sustainable growth

What is it?	How does it work?	Why is it important?	Who pays for it?
Warehouse financing Warehouse receipts allow farmers to secure bank loans in advance of payments for produce sale from the warehouse.	▪ The farmer delivers produce to the warehouse, which issues a receipt for the produce at a fixed price. ▪ The farmer uses the receipt to secure a bank loan (for capital investments) for the next season. ▪ The warehouse sells the product at market prices, keeping the difference between the receipt price given to the farmer and the market price. ▪ The farmer repays the bank loan based on the net proceeds from the warehouse upon sale of the produce.	▪ Warehouse financing creates liquidity by allowing the farmer to convert delivery to the warehouse into access to credit. ▪ It allows the farmer to invest in the next season before sales in the market are completed. ▪ It creates a source of collateral by enabling the farmer to open a credit line. ▪ It creates the opportunity for the warehouse and farmers to establish partnerships in infrastructure investment.	▪ Warehouse financing is paid for by the differential price between the set price established by the warehouse and the market price.
Invoice factoring Invoice factoring allows the farmer to receive immediate payment for produce, based on a contract between an agricultural processor (the user of farm produce to manufacture food) and the farmer.	▪ A processor issues a contract for the produce to the farmer. ▪ The farmer delivers produce to the warehouse. ▪ Warehouse delivers the produce to the agricultural processor. ▪ The farmer sells the contract to a third-party, minus a discount (factor). ▪ The processor pays the third-party based on the full value of the contract.	▪ Invoice factoring increases cash liquidity in advance of delivery of the produce. ▪ The risk shifts to the third-party for payment from the agricultural processor. ▪ It minimizes the market and price risk during the production cycle. ▪ It reduces the farmer's carrying costs and improves cash flow ▪ It provides operating cash to pay for the capital improvements and prepare for the next season.	▪ The factoring discount, along with fees, are paid by the difference between the contract value from the processor and the sales price of the factored contract from the farmer.

Supplier financing A credit facility from the supplier or a third party for customers to buy goods.	▪ The customer places an order for a product from a supplier. ▪ The supplier or a third party extends credit for the purchase, allowing the customer to pay over a set term with interest. ▪ The supplier provides the goods, and the customer pays for the goods according to the terms of the sale.	▪ This improves cash flow and operations, and allows the customer to grow the business. ▪ It allows financing for an asset that may be hard to finance (disposable, hard to salvage, e.g., irrigation hose). ▪ It can be used in conjunction with other financing.	▪ It may be financed through the supplier directly or through a third-party supplier financing company
Crop insurance Insurance funds seed or plant replacement in the event of climate event, such as drought, heat, flood, or high winds.	▪ It uses big data and algorithms to identify climate risk conditions, trends, and probabilities. ▪ It establishes pricing for insurance for various target crops, based on probabilities and impacts. ▪ Seed providers pay the insurance premium as part of the cost of the seeds. ▪ In the event of a failure (recorded automatically, based on climate conditions), insurance pays for the loss to the farmer (plus a payment for new seeds) via electronic transfer. ▪ Using information about planting from the farmers enrolled in the program, extension services are directed to institute climate-smart technologies wherever appropriate.	▪ It reduces the risk to the small farmer for crop losses due to environmental conditions ▪ It provides liquidity to small farmer to plant new seeds. ▪ It integrates technical assistance based on information about planting, yields, climate conditions, and trends. ▪ It creates an electronic framework for the transfer of payments to the small farmer, including the use of electronic transaction accounts.	▪ The insurance premium is included in the cost of the seeds. ▪ The program must be large enough to amortize the payouts for losses, and cover administration, operations and technical assistance coordination (provided by others).

Lab participants also explored how to create a platform for **systems financing**, i.e., combining multiple points in the agriculture production value chain to create revenue streams that can support a range of financing needs. The credit and collateral for the financing is thus spread across an even wider asset base, yielding greater versatility, scale, and feasibility.

Solution set 6: expansion to scale

The financial mechanisms in this solution set enable new sources of capital to flow to projects and, in turn, facilitates the flow of new investable projects to these financing sources. They allow for a variety

of project types and capital needs, from debt to equity. **Climate-smart project financing** can accommodate a blend of capital sources for projects. An **agritech business development corporation** (BDC) bundles capitalized companies and projects through an IPO. The equity raised through the BDC is reinvested in more companies and projects. Similarly, projects can issue debt in the private and public capital markets through a specialized **climate-smart bond bank** that offers long-term debt to stand-alone projects or pools or projects.

The combination of these tools (and those prescribed for startup investment and sustainable growth phases) can all be capitalized through the development of a **climate-smart bond bank**, capable of raising substantial debt capital ($750 million) in the capital market with a long maturity (fifty years). See Appendix C for a template of such a facility.

TABLE 7

Solution Set 6: Financing expansion to scale

What is it?	How does it work?	Why is it important?	Who pays for it?
Climate-smart project financing This mechanism provides a legal, organizational, and financial conduit for structured financing.	▪ It creates a legal authority to issue debt on behalf of projects. ▪ It invites special purpose vehicles to carry out projects, including building facilities for water and energy. ▪ It creates a project and capital structure that is financially feasible, sustainable, and achieves smart agriculture outcomes. ▪ It creates blended capital structures, using bank syndications, bonds, and equity. ▪ It attracts investors interested in these technologies. ▪ It structures a first-loss partial guarantee from government and philanthropic investors. ▪ It issues financing for projects or pools of projects.	▪ It attracts new capital. ▪ It provides a one-stop shop for project financing with specialty and technical services about the sector.	▪ Fees for documentation and financing (including the underwriting, placement, and legal fees) are paid by projects, as part of the financings. ▪ Investors would include pension and insurance funds, philanthropic investors, and qualified investors. ▪ Guarantees would be provided by government and philanthropic investors. ▪ Banks would provide credit enhancement as needed.
Agritech business development corporation (BDC)	▪ A BDC is registered and established as a marketable security.	▪ It allows loans to business ventures that go beyond traditional banking asset class rules,	▪ Organization and implementation of the BDC comes from an investment group.

This is a regulated, closed end, publicly registered investment company traded as a security in the capital market.	▪ It issues shares to investors via a public offering. ▪ Investment from shares is loaned to eligible firms. ▪ BDCs typically focus on before-tax cash flows of $2 million or greater. ▪ Interest and principal payments on loans are returned to the BDC and loaned to new firms. ▪ Cash flow within the BDC is used to ensure liquidity.	because the loans are larger or the market is smaller. ▪ It is a new source of funds. ▪ The diversified base of investors in the BDC provides market-based cost of capital.	▪ Capital for operations and lending activity comes from the sale of stock in the capital market.
Climate-smart bond (for climate-smart bond bank, see Appendix C) This is senior debt issued in the public or private capital bond markets.	▪ A developer proposes an eligible project to a public or quasi-public bond issuer, which then packages the project either alone or with other projects. The bonds require a senior mortgage on the project being financed. ▪ The bond issuer sells the bonds publicly (e.g., to sophisticated investors) or privately (e.g., pension funds, corporate investment funds, etc.). ▪ The bonds proceeds are loaned to the project and repaid from the project's net operating income. ▪ Depending on the creditworthiness of the project, the bonds may require letters of credit, guarantees, or special insurance.	▪ Long terms for repayment; flexible repayment schedule, and fixed-rate, lower-cost interest improve the financial feasibility of the project. ▪ Project pools can be structured to improve the collateral and credit quality of the bonds. ▪ Bond issuance costs are financeable.	▪ Public and private bond markets are the sources of the funds. ▪ The projects may be guaranteed in part by public or philanthropic sources, but recourse is generally limited to the project assets. ▪ Issues can be structured to accomplish specific financial and non-financial (environmental) objectives, such as green bonds or SDG bonds, which make them attractive to specific classes of investors and new investors.

Other Cross-chain solutions

Several solutions work well for more than one stage in the business development value chain. For example, **co-innovation teams** bring together multiple disciplines during discovery, translational, and implementation stages. **Beta and demonstration farm sites** are important during both the translational and formation phases to test, refine, and demonstrate solutions in the field before the enterprise startup. The use of catalytic **first-loss guarantees**, usually provided by a government sponsor, are key to shifting the risk in the capital structure from formation through growth and

expansion. Finally, creating a platform whose **reinvestment mechanism** enables the flow of returns from investment at the growth and expansion stage on to new translation and formation/startup stages will ensure ongoing funding.

TABLE 8

Financing cross-chain solutions

What is it?	How does it work?	Why is it important?	Who pays for it?
Agritech co-innovation teams Create multidisciplinary teams from California and Israel to focus on translating technologies into market-ready, climate-smart solutions.	▪ Identify policy, financial, tech, and business stakeholders for subsector teams. ▪ Organize teams to focus on setting an agenda, sharing information, raising investment capital, and building solution sets.	▪ Overcome R&D silos ▪ Create synergies among researchers and collaboration among stakeholders. ▪ Create stronger investment partnerships, and be ready to participate in larger-scale projects.	▪ Create a stakeholder, agenda-setting membership in co-innovation teams to build ongoing support. ▪ Initial support comes from impact philanthropy and government support. ▪ Participation fees from new investment in co-innovation strategies.
First-loss guarantee This is a pledge to cover part of the debt on a project, transferring a share of the risk from the lender to the guarantor.	▪ A guarantee is a contract to pay the lender a designated amount (all or a portion) of the debt in the event of either a delinquency or default. ▪ The guarantor makes the payment, which may be a first-loss payment up to a certain amount, or a pro rata payment based on the guarantee's coverage of the loan. ▪ The borrower must repay the guarantor for the advance of the guarantee. ▪ The borrower assigns rights of the assets to the guarantor to cover a portion of the loss. ▪ The guarantees are a limited obligation, capped at the agreed-upon guarantee amount, and are non-recourse to the guarantee providers (e.g., philanthropy, government).	▪ Guarantees may lower the risk of the loan, saving between 50 and 200 basis points on the debt and improving the financial feasibility of the project. ▪ Guarantees may make a loan possible.	▪ The fee is paid by the borrower on the basis of 0.5–1.25 percent of the outstanding principal. ▪ The guarantee funds are provided by a combination of philanthropic investments, standby social investments, and government funds.

Beta and demonstration farm sites Demonstration and experimentation farms test technologies in new target markets under the specific local conditions.	▪ They use dedicated sites or use of local agricultural plots belonging to local farmers. ▪ They test technology adapted to new markets under real experiment in these markets	▪ They help gain understanding of the characteristics of the new markets.	▪ Investments through public and philanthropic challenge grant programs
Agritech reinvestment mechanism This financial pool combines innovation grants, angel seed investments, and VC to create a blended, shared return to support early-stage deal flow.	▪ It combines innovation grants, angel equity investments, and VC investments into an investment pool. ▪ Investments are made from the pool according to criteria for each type of capital (e.g., technical support, proof of concept, initial revenue, etc.) ▪ The deal flow established by each investment is advanced within the pool (not exclusively). ▪ Sales, IPO, and other terminal events return capital to the pool, shared on a formula basis	▪ It creates deal flow along the project development value chain. ▪ It creates returns on investment to each stage of investment. ▪ It protects again full dilution among early-stage investors.	▪ Investments for each investment stage come from normal sources (government, philanthropy, angels, and limited partners). ▪ Operating costs are generated from cash flow. ▪ Returns on investment are generated from exits and sales.

Roadmap

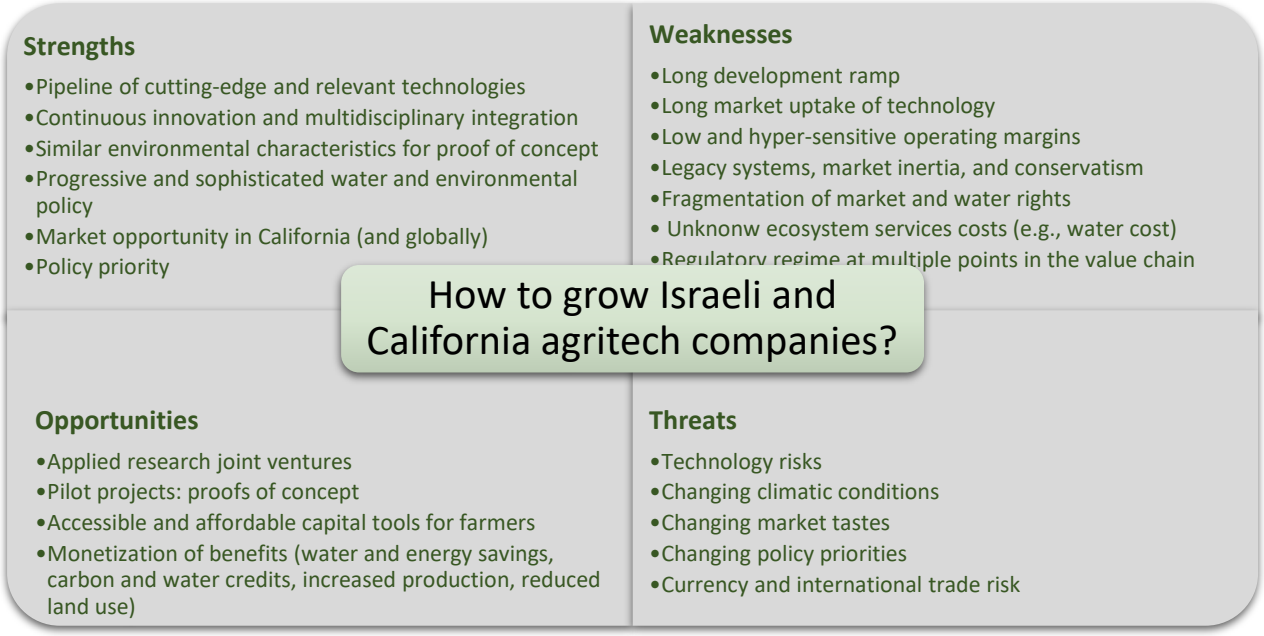
The path ahead for California and Israel agritech is marked by the increasing demands born of global warming, resource scarcity, waves of migration, and the need to produce more food more efficiently. The Lab approach is to find market-ready solutions and accelerate their implementation by aligning financial and regulatory policy with agritech programming.

Israel's recognized success in agritech innovation has come down to a number of factors in which the government plays a major role: leadership, supportive policies and agendas; enforcement and follow-through; and proper planning at various levels.[104]

The Lab found areas of overlap and several additional takeaways from Israel's smart practices:

1. Encourage applied research to meet market needs.
2. Translate technologies into market-ready solutions, leveraging the pull of the market to increase the speed to market.
3. Bundle technologies to create whole, sustainable solutions which is being done in important examples in both Israel and California.
4. Go beyond enterprise and project financing, and build platforms to support systems financing, incorporating alternative ownership and service models to create more efficient financing and better returns for project participants.
5. Leverage the value chain to build performance-financing mechanisms.

FIGURE 15 **Strategic analysis of US/Israeli agritech sectors**



Source: Milken innovation Center; Financial Innovations Labs

We propose three tracks to take full advantage of the opportunities:

1. **Market-ready technologies** to meet current and looming market needs.
2. **A financial platform** to help fill the funding gaps for agritech firms at various points in growth, with appropriate scale, allowable uses, terms and conditions; again, see the model template in Appendix D.
3. **Co-innovation teams** that to target possible breakthroughs for California agriculture; again, see examples of co-innovation teams in Appendix E.

The following table brings forward the development challenges raised earlier and matches possible solutions (tools) to some of the key development challenges.

TABLE 9 **Challenges and tools for agritech startups**

Development challenge	Selected solutions
How do we increase access to information about farmers' priorities?	• Meet with farmer focus groups to gain feedback and insights for the R&D lab.
	• Create agritech investment vehicles, with famers as limited partners to direct and prioritize funding.
	• Commission annual agritech "R&D challenge" on a key technology-related farm issue.
How do we access more government or private funding for the translation phase (from the lab to proof of concept)?	• Create a portfolio fund with long-term debt that will bundle IP; focus on translation, proof of concept, and initial sales; allow a firm to build expertise to manage milestones and market channels; reinvest in R&D; and yield blended marketable ROI.
How can we gain access to, or share, marketable IP in a single location or from a single technology transfer office?	
How can we help farmers make large capital investments in new technologies?	• Offer guarantees, loans with attractive terms, tax credits.
	• Offer technical efficacy insurance. • Offer performance-based services financing; seller financing-plus.
	• Strengthen the program connection to the University of California Cooperative Extension.
	• Development global development finance tools to build beta site projects.
How can we align the goals of GHG reduction, and water and energy conservation, when the ability to monetize the value of each is limited?	• Create environmental impact bonds (EIBs) to leverage avoided costs, performance financing, and a mix of project financings by activity, price, and maturity.
	• Build a water credit market based on the carbon credit market.
How can we offer effective and precise irrigation metering and monitoring when water source delivery is irregular?	• Build project financing to support water service infrastructure on demand; price water to reflect the cost of delivery.
How can we help growers reduce high labor and mechanical costs during harvest, and losses from storage and delivery to market?	• Customize research program in robotics, big data, logistics, and storage to mechanize harvest and optimize post-harvest value.

We also propose to design specific California/Israeli public and private partnerships, including designing project and capital structures that serve as the basis for an action plan. The development of these projects will include considerations of feasibility, sustainability, scalability, market pull, and leverage. The path forward will create projects that respond to the barriers and opportunities, and deploy the right technology for the right need. Table 10 begins to trace this path for California with Israeli companies and their technologies.

TABLE 10

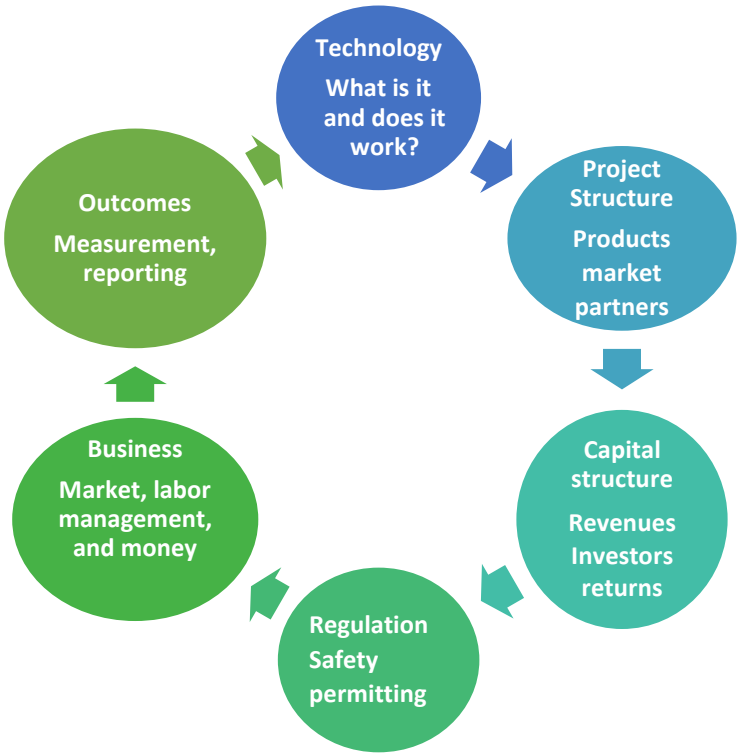
Company challenges and potential solutions/partnerships

What are the top problems for California agriculture?	What are their consequences?	How can they be addressed with the technologies and funding solutions?	What Israeli companies will be good fits?*
Groundwater contamination and depletion	Water quality decline for agricultural uses	Water treatment reclamation and purification of contaminated groundwater	Amiad Ayala Water & Ecology NUFiltration
	Decrease in the availability of freshwater for agriculture	Water management to maximize efficiency in the use of irrigation water	Rivulis Eurodrip Netafim Sensoil Innovations CropX AgroSolar Irrigation Systems
	Increase in effluent or natural brackish water	Seed improvement, cultivating seed varieties that can adapt to irrigation with treated water	Seed-X Evogene Equinom
Arable land available for food production is decreasing.	Contaminated soil and erosion as a result of increased pesticide/ fertilizer use and irrigation	Smart input (water/ fertilizer/ pesticides) sensing /monitoring technologies	Groundwork BioAg Polyam Trellis Beewise SupPlant
	There is a need to feed the world growing population with limited and decreasing land resources	Improved seeds with higher yield; more resilient plants	Seed-X Evogene Equinom
		Smart crop protection (pathogens, pests and weeds)	Agrint FieldIn Nobactra Groundwork BioAg Polyam
Changing consumer dietary habits: greater demand for protein substitutes and healthier foods	Increase in quantities of protein substitutes from plant sources	Improved seeds with higher yield; vegetable protein substitutes (legumes etc.)	Seed-X Evogene Equinom
		Smart crop protection (pathogens, pests and weeds); higher yields	Agrint FieldIn Nobactra Groundwork BioAg Polyam
		Smart input (water/ fertilizer/ pesticides) sensing /monitoring technologies; higher yields	Groundwork BioAg Polyam Trellis Beewise SupPlant

The elements of a basic action plan for Agritech projects and their progression into self-sustainability are depicted in Figure 16.

FIGURE 16

Agritech project development map



Source: Milken Innovation Center; Financial Innovations Lab

Conclusion

As we look into the decades ahead, the question is not how we will feed ourselves, but whether we *can* feed ourselves. This is the challenge facing every country on the planet.

California is a good testing ground, as it holds some of the most difficult challenges in agriculture, including aquifer depletion, long droughts, and changing climate patterns. Israel, meanwhile, has a long and successful record of surmounting many of these challenges, and can offer its technologies for "proof of concept" and adaptation in California, and then scale-up elsewhere around the world. The promise of this relationship is articulated in the 2014 Memorandum of Understanding between the State of California and Israel. With this Lab report, we offer a systematic and comprehensive pathway forward to solve these challenges as partners.

Appendices

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B. United Nation's SDGs and objectives related to climate smart agriculture

TABLE 11 Summation of SDGs and relevant agritech technologies

	Selected sectors	Seeds	Fertilizers	Pesticides	Smart water usage	Harvest management	Smart water treatment	Post -harvest management
SDG 2	End hunger; achieve food security and improved nutrition; promote sustainable agriculture.	■	■	■	■	■		
SDG 3	Ensure healthy lives and promote well-being.	■	■	■			■	
SDG 6	Ensure availability and sustainable management of water and sanitation.	■	■	■				
SDG 8	Promote sustained, inclusive, and sustainable economic growth, full and productive employment.	■	■	■	■	■		
SDG 9	Build resilient infrastructure; promote inclusive and sustainable industrialization; foster innovation.	■	■	■	■	■		
SDG 12	Ensure sustainable consumption and production patterns.	■	■	■				■
SDG 13	Take urgent action to combat climate change and its impacts.				Indirect benefit from these technologies			
SDG 15	Protect, restore, and promote sustainable use of terrestrial ecosystems; sustainably manage forests; combat desertification; halt and reverse land degradation; halt biodiversity loss.					■		■

Source: Blum Lab for Developing Economies

C. Selected Agritech Companies

TABLE 12

Selected Israeli agritech firms, sorted by agricultural value chain/technology sectors

Agricultural value chain stage	Agritech sector	Firm name	Description of company
Discovery and translation	**Seeds**	Kaiima Bio-Agritech	Kaiima Bio-Agritech is a plant genetics and breeding technology company that partners with seed companies and research institutes to develop solutions specifically suited to sustainable agriculture. Kaiima has developed a non-GMO platform called EP, which in conjunction with advanced breeding programs boosts the inherent productivity and resource-usage efficiency of high-impact food and energy crops.
		Seedwiz	Seedwiz is a GIS and AI system that allows farmers to select seed varieties and supports the direct trading of seeds between farmers and seed companies.
		Equinom	Equinom is a seed breeding company that uses DNA sequencing and proprietary algorithms to make the breeding process more efficient. The company has used this technology to produce varieties of legumes, sesame, and quinoa.
		Seed-X	Seed-X develops machine vision technology with customized deep learning algorithms for seed breeding and production cycles. Seed-X offers breeders the ability to detect genetic traits from the phenotypic appearance of a seed, including resistance to viruses, male infertility, and fruit and grain color, size, and quality.
		Rootility	Rootility develops and implements root-focused plant-breeding methods designed to increase crop yields and overall agronomic performance while preserving crop quality. The system functions without genetic modification and is applicable to a broad range of crops including tomatoes, sunflowers, peppers, melons, and corn.
		Evogene	Evogene is a biotechnology company developing products for life sciences markets using a computational predictive biology platform that incorporates deep scientific understanding and advanced computational technologies.
	Fertilizers	VGI	VGI produces organic fertilizers from natural components that support healthy, natural plant growth. Its products reduce carbon dioxide emissions in agricultural production and help break the cycle of excess chemical use in agriculture.
	Pesticides	Groundwork BioAg	Groundwork BioAg produces natural mycorrhizal inoculants for commercial agriculture. Products can improve soil nutrient uptake in many plant species and help increase crop yields for crops such as corn, soybeans, tomatoes, and onions, especially under stressed conditions.

		Polyam	Polyam (Pollination Services Yad-Mordechai) mass-produces bumblebee colonies for pollinating agricultural crops, as well as other beneficial insects for the biological control of greenhouse crop pests.
		TarriTech	TarriTech has developed an essential oil delivery system designed to prevent the decay of fresh vegetables, fruits, and herbs. The company's system is tailored to specific crops and designed to integrate into existing packinghouse processes. The solution has been implemented on a pilot scale with strawberries, peaches, nectarines, and persimmons.
		Nano-CapSolution	Nano-CapSolution specializes in nano-encapsulation for green pest solutions in the crop protection field. Its ecologically sound solutions are as effective as chemical pesticides, and one spraying can protect crops for an entire season. The solution is based on an innovative nano-capsular platform that enables the coating of active biochemical, such as pheromones or essential oils on a molecular scale with environmentally friendly carriers.
		Nobactra	Nobactra develops environmentally friendly formulations for the control of bacterial and fungal diseases in agriculture. The solutions have shown high efficacy rates in the control of several diseases in plants and poultry. Its solutions are composed of antagonistic bacteria and a powder formulation of essential oils.
Installation and planting	**Water solutions**	Sensoil Innovations	SenSoil Innovations provides real-time images and efficient solutions to detect water percolation and contaminant migration in the subsurface. The technology can be used to protect groundwater resources from pollution hazards, optimize subsurface remediation, manage heap-leach mining, control agricultural input down-leaching, manage landfill waste, and provide early warning of earthen dam instability.
		Amiad	Amiad Water Systems develops and produces automatic, self-cleaning water treatment and filtration solutions. The company provides green solutions for the industrial, municipal, irrigation, oil and gas, and ballast water markets.
		Rivulis Eurodrip	Rivulis Eurodrip offers a full line of irrigation devices, including drip lines, drip tapes, filters, hoses and tubing, sprinklers, sprays, and valves. Its products are designed for the above-ground and subsurface application of water and nutrients directly to the root zone of every plant, resulting in greater yields using equal or lower amounts of water and nutrients compared to other water-distribution systems.
		AgroSolar Irrigation Systems	AgroSolar is developing a solar irrigation system for use in areas not connected to the electrical grid. Its initial target market includes small-scale farmers cultivating one to two hectares in India and other developing countries. AgroSolar's solution is a piston-based solar-powered water-pumping system. The technology can be combined with drip irrigation or other micro irrigation systems to allow grid-independent pumping, irrigation, and fertilization for improved yields.

		Netafim	Netafim delivers tailor-made irrigation and fertigation solutions to millions of farmers, enabling growers to maximize food production with the lowest environmental impact. Specializing in end-to-end solutions from the water source to the root zone, Netafim delivers irrigation and greenhouse projects supported by engineering, project management, and financing services. Netafim is also working on digital farming, integrating real-time monitoring, analysis, and automated control into one system.
		CropX	CropX is an agriculture analytics company that has developed an adaptive irrigation service that automatically optimizes irrigation, thereby delivering an increase in crop yield, as well as water and energy savings for farms. The company generates irrigation maps and automatically applies the right amount of water to different parts of the same field.
		Ayala Water & Ecology	Ayala Water & Ecology is the developer of the Natural Biological System (NBS), a sustainable natural technology for treating sewage and waste streams, rehabilitating affected water bodies, and rebalancing watersheds. Each system is created from modular treatment compartments embedded in the natural topography to minimize energy requirements. Inside the treatment compartments is a combination of biotic and abiotic components, plants, as well as aggregates selected for their physical and chemical properties and varying internal hydraulic layouts.
		NUFiltration	NUFiltration designs, manufactures, and distributes water and wastewater treatment systems based on its patented NUF technology. The technology enables the reuse of medical filtration devices in the field of water treatment. NUFiltration systems are used in greenhouses and hydroponics to recycle drain water by removing all pathogens, viruses, colloidal matter, and other microbiological pollutants while leaving salt and micronutrient levels unchanged.
Care and feeding/ harvest and storage	**Data and computation**	InPlant Technologies	InPlant Technologies is the developer of a platform delivery technology designed to increase the mobility of active agrochemical ingredients (AIs) in plants to increase their activity and reduce the required dosage, resulting in higher yields and lower environmental impact, and ultimately releasing the agrochemicals within the plant cells. In addition, the technology can provide the following benefits in different permutations, depending on the specific agrochemical ingredient used: lower costs with fewer applications; improved efficacy; less carryover to the following season; reduced use of toxic additives; and the potential for new synergetic AI combinations in a single product.
		SMART Fertilizer Management	SMART Fertilizer Management develops a software system designed to achieve higher yields by optimizing fertilization mixes. The company's nutrient formulation and fertilizer optimization software determine the optimal combination of fertilizers, along with their application rates, blends, and proper application methods. The solution aims to help

			farmers maximize their crop yields and quality, resulting in reduced costs and increased profits.
		eggXYt	eggXYt is developing a CRISPR-based proprietary technology that detects the sex of chick embryos immediately after the eggs are laid and before they enter the 21-day incubation period. The sex-identification process prevents chicks from hatching unnecessarily; keeps the eggs within the food industry; and addresses the common ethical, environmental, and economic problems of egg and poultry production.
		FieldIn	Fieldin is a data software company that helps fruit and nut growers improve the quality, efficiency, and safety of their pest management applications. The company collects and analyzes an array of geospatial, chemical, biological, meteorological, and other data to enable growers to reduce pesticide use, benchmark and optimize performance, and minimize spray mistakes.
		Trellis	Trellis provides artificial intelligence to remove the risk from and optimize global food supply chains. The company's Food System Intelligence Platform allows key agricultural players, from growers to food manufacturers, to accurately forecast crop production, supply chain fluctuations, and market trends, which can result in lower costs, improved quality, and reduction in food loss, all in an ever-scaling environment. Trellis helps producers maximize supply chain efficiency, profitability, and quality, with a big environmental benefit.
		CultiVu	CultiVu aims to improve small-farm productivity by connecting farmers with local agricultural advisors. Using the company's free platform, farmers can receive relevant, insightful, reliable instructions and knowledge from local advisers to improve productivity and reduce costs and risks.
		Beewise	Beewise offers autonomous beehives that function without human intervention, utilizing robotics and powered by artificial intelligence. The company's solution automates practically all beekeeping activities in order to increase yield, reduce colony loss, and eliminate the use of chemical pesticides.
	Machinery and robotics	AgriDrones Solutions	AgriDrones Solutions develops autonomous spraying drones for the agricultural sector. Its drones can provide extensive coverage in all types of terrain and weather conditions, and perform multispectral imaging and mapping, enabling the identification of a variety of problems, regardless of the operator location. The drones can fly to precise points in order to perform their required tasks.
	Sensing	Croptimal	Croptimal performs accurate real-time testing of plant tissue, soil, and water in the field. The solution, which is offered as a service to farmers and agronomists, can reduce the time to analysis from 10 days to between 10 and 60 minutes, using a compact mobile laboratory that automatically prepares samples and analyzes component material elements. Croptimal technology utilizes multispectral spectroscopy and solution electrical measurement units for a full range of material analysis of nutrients and contaminants.

		Agrint	Agrint has developed a sensing technology for the early detection of infestation threats in trees. The company's IoTree technology is based on sensors that provide early detection of pest activity, regardless of the size of the tree or larvae. With Agrint's solution, each tree is outfitted with a durable, energy-efficient sensor that can detect the activity of red palm weevil larvae. The sensor is highly sensitive to the slightest movement of the larvae, even in their early stages of development, and sophisticated enough to filter out other noises that could lead to false alarms. The sensors continuously measure and transmit the infestation status of every tree, with all of the gathered data stored on the Agrint platform, creating a constantly evolving trend analysis of the pests' behavioral patterns.
		Phytech	Phytech provides a patented phytomonitoring technology that enables growers to obtain and share a constant, real-time stream of data regarding their crops needs. This process aids growers in making daily crop management decisions for increasing yields and optimizing quality.
		yieldsApp	yieldsApp has developed a decision-support platform for optimizing pesticide use in agriculture. The company's system helps growers make decisions regarding pesticide use, application rates, timing, and efficiency. The company's solution integrates real-time data from satellite imagery, weather conditions, crowd-sourced information, data from sensors, and agronomy know-how to provide farmers with concise and simple recommendations.
		SupPlant	SupPlant offers an online platform and smartphone application designed to collect real-time sensor data from farms and provide continuous feedback to farmers. SupPlant uses wirelessly transmitted data from sensors in the field that monitor the weather and soil, as well as from specialized plant sensors that measure stem diameter, leaf temperature, fruit size, and more. With these sensors, SupPlant can monitor plants to identify changes in growth rate, detect stress situations resulting from lack of irrigation, and compute actual and potential evapotranspiration (ET) to determine how much to irrigate.
Transportation and Delivery	**Postharvest**	Amaizz Advanced Agriculture	Amaizz is an agritech company dedicated to developing products designed to minimize losses caused by spoilage and degradation throughout the handling, storage, and processing stages of agricultural commodities.
		Save Foods	Save Foods has developed a line of eco-friendly sanitizing solutions for fresh produce. Its products provide effectiveness against human pathogens such as salmonella, E. coli, and listeria, as well as plant pathogens, and help to extend the shelf life of produce.
	Insurance firms	OKO	OKO uses satellite and mobile technology to bring affordable and simple crop insurance to smallholder farmers. OKO creates index partnerships with weather data suppliers and uses them to create parametric insurance products underwritten by a locally licensed insurance company. In addition to insurance, farmers can benefit from weather alerts, farming tips, and access to affordable micro-credit. OKO bundles together services, including a weather-based index insurance product, tools for

			distribution and customer education, and an automated policy management platform.
	Sales and delivery firms	Avenews-GT	Avenews-GT has developed a web platform, powered by blockchain technology that integrates services for the commercial trade of agricultural produce. The platform enables farmers and industrial buyers to transact directly with each other locally and worldwide, simplify transaction processes, and increase supply-chain transparency The platform integrates both agribusinesses and financial institutions into one digital ecosystem for agricultural trade. Avenews-GT enables agribusinesses to digitally manage their trade operations; reduce errors; and get enhanced visibility, collaboration, and intelligence for their business.
		Farmster	Farmster is a digital produce marketplace that does not require farmers to have Internet access. Its AI-driven SMS chatbot allows farmers to publish information about their upcoming harvests without the need to buy a smartphone, download an app, or use any data. Buyers are able to search for their produce using the Farmster app and then connect over the phone. Farmster helps farmers market their produce while creating a network effect between farmers and buyers.
		Tender	Tender Market is developing a trading platform for fruits and vegetables, with the goal of making trading between farmers and retailers more efficient.

Source: Milken Innovation Center; data and descriptions from Start-Up Nation Central and CrunchBase.

D. Climate-Smart Bond Bank: Illustrative Guidelines

Purpose

The purpose of the climate-smart bond bank is to provide financing to accelerate the growth for projects and firms in the agritech value chain. The climate-smart bond bank will be capitalized through initial equity from government and the issuance of long-term revenue bonds in the capital market secured by investment and lending activity of the fund.

Eligible Applicants

Specific applicants in these priority areas include:

- R&D centers
- Government
- Universities
- Private firms
- Social enterprises

Eligible Activities

Eligible project activities include:

- Research and development
- Beta testing
- Proof of concept installations
- Business start-up and growth

Eligible Uses of funds

- Land
- Buildings
- Equipment
- Working capital

Eligible financial activities

- Senior or partnership debt
- Subordinated debt
- Bridge financing
- Venture debt
- Project and performance financing
- Warehouse and factoring financing
- Refinancing existing debt is not permitted

Eligible sectors

Priority sectors include

- water and energy
- vertical agriculture
- plant science
- fintech
- post-harvest tech

Terms and Conditions

Amount

- Up to $500,000 per project or 80 percent of the total project cost, whichever is less.
- Up to 20 percent of the project funding may be used for planning and organization of the projects.

Maturity

- Up to 12 years to repay the loan, depending on the depreciable life of the assets and the tenor of the matching loan(s).
- Up to 2-year deferral of principal repayment

Interest

- From 3 percent to 7 percent, depending on the project type, stage of development, and sector.

Fees

- 1.0 percent origination fee on amount of loan
- 0.25 percent servicing fee on the outstanding principal

Subordination

- Shared 1st lien with other public lenders
- Able to subordinate to senior bank lender on repayment

Collateral

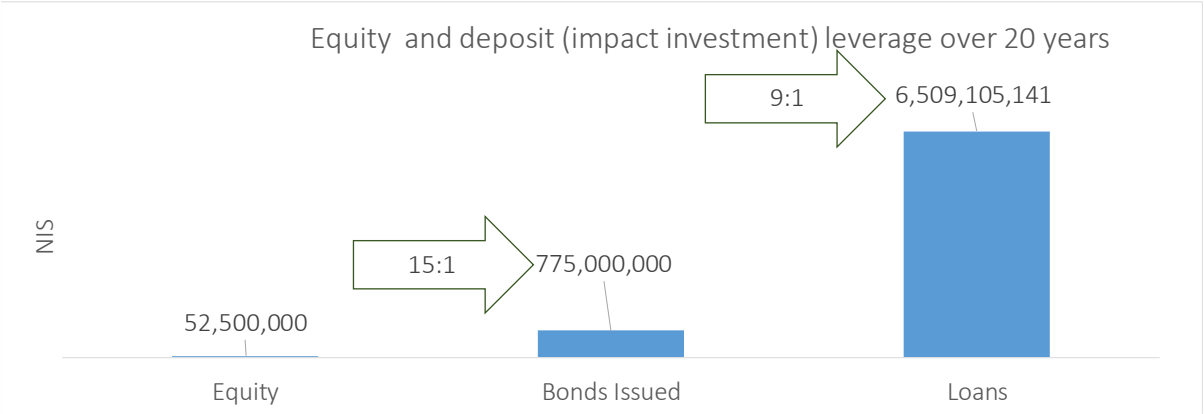
- Pledge of the assets being financing
- Corporate and/or personal guarantees may be required

Climate Smart Bond Bank: Illustrative Proforma Results

Using $52.5 million in equity leveraging (15:1) the issuance of $750 million in climate-smart bonds over three years, it is expected to capitalize a portfolio of over $2.45 billion in 10 years and almost $6.5 billion in loan activities (9:1) over 20 years. This multiple is possible with the issuance of long-term bonds (50-year maturities) at a fixed rate of 3.5 percent, and the relending of the balance of payments to new loans. These activities will generate a sustainable level of lending activities, sufficient liquidity, and a high leverage multiple. Additionally, the bond bank becomes self-supporting based on the repayment of the portfolio and the low cost of investment capital to begin the bond bank.

Climate Smart Bonds

	Water tech	Plant tech	Fintech	Post-harvest	All activities
How much will be loaned over 20 years?	1,952,731,542	1,952,731,542	520,728,411	2,082,913,645	6,509,105,141
What is the average amount loaned each year?	78,109,262	78,109,262	20,829,136	83,316,546	260,364,206
What is the average number of loans each year?	293	407	130	625	1,455
What is the average size of each loan?	266,604	191,955	159,963	133,302	178,929



To illustrate the flow of funds in the climate-smart bond bank, the following figure shows the proforma projection and how the bond bank will be capitalized, pay for expenses, account for losses, issue loans, and make repayments to the bond buyers for the initial 10 years of the program operations.

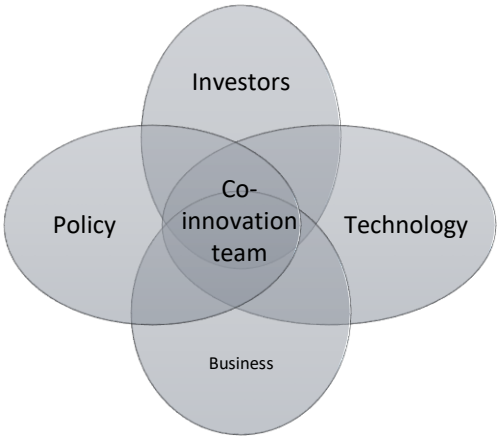
Table 13

Climate Smart Bond Bank – Operating and Lending Projection (estimates)

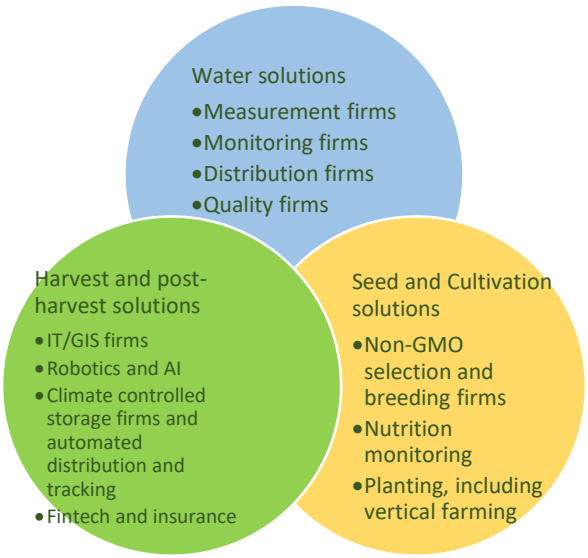
Climate Smart Bond Program - Operating and Lending Projection											
Forward Looking Estimates											
		Year	Year	Year	Year	Year	Year	Year	Year	Year	Year
.		1	2	3	4	5	6	7	8	9	10
CAPITAL SOURCES											
Equity Investment in start-up and lending (cash)	(000)	15,000	17,500	10,000	-	-	-	-	-	-	-
Strategic Impact Investments	(000)	150,000	250,000	350,000	-	-	-	-	-	-	-
Total Capital Sources	(000)	**165,000**	**267,500**	**360,000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
OPERATING BUDGET											
Total revenues	(000)	21,923	32,195	43,325	47,677	62,547	73,001	58,338	54,327	53,575	54,561
Total expenses	(000)	(4,800)	(5,549)	(12,206)	(22,691)	(20,673)	(14,224)	(9,975)	(9,009)	(10,570)	(12,885)
Net operating Income	(000)	**14,848**	**24,022**	**28,144**	**24,986**	**41,874**	**58,778**	**48,363**	**45,318**	**43,004**	**41,675**
Debt payments and other adjustments to Net Operating Income	(000)	(4,875)	(12,960)	(24,224)	(24,008)	(23,785)	(23,554)	(23,316)	(23,070)	(22,817)	(22,555)
Operating and Program reserve contributions	(000)	(7,880)	(8,557)	(2,377)	-	(12,077)	(2,939)	(2,418)	(2,266)	(2,150)	(2,084)
Portfolio loan losses	(000)	(309)	(666)	(1,301)	(2,549)	(3,516)	(3,699)	(3,594)	(3,592)	(3,683)	(3,724)
Retained Earnings from Operations	(000)	**1,784**	**1,839**	**242**	**(1,571)**	**2,496**	**28,585**	**19,035**	**16,390**	**14,354**	**13,313**
CAPACITY AND LENDING ACTIVITY											
Retained Earnings from Operations	(000)	1,784	1,839	242	(1,571)	2,496	28,585	19,035	16,390	14,354	13,313
Additional equity for lending	(000)	-	5,000	-	-	-	-	-	-	-	-
New debt proceeds from Impact Investors and depositors	(000)	150,000	250,000	350,000	-	-	-	-	-	-	-
Available funds from prior period	(000)	-	77,392	270,461	464,983	192,205	31,039	27,242	82,046	150,133	191,259
Plus principal payments from portfolio	(000)	22,842	50,618	95,047	189,483	256,887	259,417	242,829	239,692	246,236	250,999
Less: principal repayments to impact investors and depositors	(000)	(1,235)	(3,417)	(6,651)	(6,867)	(7,090)	(7,321)	(7,559)	(7,804)	(8,058)	(8,320)
Total capital available for lending at beginning of year	(000)	**173,392**	**381,432**	**709,100**	**646,029**	**444,497**	**311,720**	**281,547**	**330,323**	**402,665**	**447,250**
Total new loans	(000)	(96,000)	(110,971)	(244,116)	(453,824)	(413,458)	(284,478)	(199,501)	(180,190)	(211,407)	(257,706)
Funds available to lend at end of the year	(000)	**77,392**	**270,461**	**464,983**	**192,205**	**31,039**	**27,242**	**82,046**	**150,133**	**191,259**	**189,545**
	(000)										
Total cumulative lending	(000)	96,000	206,971	451,087	904,911	1,318,369	1,602,847	1,802,349	1,982,538	2,193,945	2,451,651
Total outstanding portfolio	(000)	73,158	133,511	282,580	546,921	703,492	728,554	685,227	625,724	590,895	597,602
Annual number of new loans		569	655	1,433	2,651	2,404	1,646	1,148	1,032	1,205	1,461
Cumulative number of loans		569	1,224	2,657	5,309	7,712	9,358	10,506	11,538	12,743	14,204
Cumulative reserve	(000)	**7,880**	**16,437**	**18,814**	**18,814**	**30,891**	**33,830**	**36,248**	**38,514**	**40,664**	**42,748**

E. Co-innovation teams and work process

Co-innovation teams are composed of specialists from multiple disciplines and sectors brought together to focus on problems in those sectors. A team approach is not unusual, especially in science, where research labs across the Globe collaborate. What is missing, and what is proposed in the co-innovation teams, is the addition of finance and investment, policy, and business specialists who can contribute insights and practices to create investable solutions relevant to Israel, California, and the developing markets.



The targets for co-innovation teams in climate smart agriculture include the following priority areas, based on discussions in the Lab:



The co-innovation teams pursue the following key activities:

- Identify specific obstacle to sustainable water, climate smart agriculture, and efficient renewable energy
- Identify and gather relevant policy leaders, investors, businesses, and scientists
- Coordinate agenda for projects and programs to address obstacles; identify what is new and assign priorities
- Convene working groups to collaborate across priority innovation workstreams, secure joint funding and support for program and projects
- Implement innovation projects and programs

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