Sub-theme: 13.1 Skills, knowledge and experience required for building effective partnerships between universities, business, government and the community

Feed the Gap – Optimizing Returns on Investments in Innovation for the Commons

Tom Turpen[a, b,*], Jim Dukowitz[b] and Dan Hanson[b]
[a]Citrus Research and Development Foundation, Inc., 700 Experiment Station Road, Lake Alfred, FL 33850, USA and [b]Technology Innovation Group, Inc., 7006 Firewheel Hollow, Austin, TX 78750, USA

*Corresponding author. Tel: +1-863-956-5894; e-mail: tom.turpen@innovationmatters.com

Author information:
Tom Turpen, Ph.D., is a Principal with Technology Innovation Group (TIG) and currently serves as Program Manager for the Citrus Research and Development Foundation (CRDF). He assisted the Florida Citrus Production Research Advisory Council, the Department of Citrus, the Department of Agricultural and Consumer Services and Florida Citrus Mutual with the launch and start-up of the CRDF. TIG provides: management of the annual cycles of calls for research proposals, reviews and funding approvals; oversight of subsequent contracts and research progress; continuous advisory services with respect to technology commercialization. Dr. Turpen served on the Liaison Committee of the National Research Council on Strategic Planning for the Florida Citrus Industry: Citrus Greening Disease and is currently a member of the USDA National Citrus Science and Technology Coordinating Group. Dr. Turpen has over 25 years of healthcare and agricultural biotechnology experience in startup and Fortune 500 companies as a researcher and senior executive.

Jim Dukowitz, Ph.D., is a Principal with Technology Innovation Group and has developed and implemented programs with governments, NGOs, universities, and companies around the world in the areas of innovation, entrepreneurship, Intellectual Property management and commercialization. This includes training and educational programs, assessments, organizational design and structuring, mentoring and assuming leadership positions in individual companies. Dr. Dukowitz supported the launch and start-up of the CRDF by developing templates and roadmaps

to guide the commercialization of its most promising research. Dr. Dukowkitz has over 35 years of experience in global technology management, including over 20 years in senior executive positions at Texas Instruments, where he served as President of Texas Instruments Asia and Texas Instruments China, as well as several Corporate Staff Vice Presidencies in the areas of strategic planning, business development, communications and international marketing.

Dan Hanson is a Founder and Principal with Technology Innovation Group and specializes in the creation of sustainable public-private partnerships that promote innovation and high value economic development. Mr. Hanson has worked as a participant advisor to government, NGO, and business clients around the world at many levels, from crafting national science and technology policy to developing regional economic engines and launching new technology growth ventures. Mr. Hanson led the team that developed the business plan for the CRDF. This Foundation is the nexus of scientific research and commercialization for productivity improvements in the citrus industry. It combines industry funding, government enforcement, and an NGO structure and governance. Mr. Hanson has a 30-year career in business, government, and volunteer work on the board of directors of strategic NGOs.

Key words: agriculture, technology transfer, research investment

INTRODUCTION

It is generally recognized that there is significant value to be realized by improving the performance of research, development and commercialization systems that translate ideas, inventions and discoveries into useful products and services. There also exists an almost infinite supply of ideas, inventions and discoveries ready to be applied to specific challenges if only the capital, people, and research needs are defined and optimally connected. Yet the reality is that these connections have proven difficult, particularly when multiple organizations and multiple stakeholders with diverse and often competing interests are involved.

Accordingly, the “Triple Helix” is a useful heuristic to model how university-industry-government relations might function more closely together toward common goals (1). This is a rich biological analogy because while the canonical double helical structure of DNA is well known, the triple helix form of DNA also does exist in living cells where unique functions are ascribed to the structure (2). What can be learned from concrete examples of “Triple Helix” case studies wherein the structure of these relationships determines success and failure?

This paper will present a case study that describes conditions surrounding the emergence of a successful, highly functional Triple Helix, delivering value to multiple stakeholders with a very well connected and purposeful alignment to industry level and societal needs. The case study deals with the actions of the Florida citrus industry to fight a disease called Citrus Greening that has threatened the survival of the entire industry and has interesting implications for several reasons:

First, this case provides insights into the challenges of innovation management within the agricultural system, which is the nexus of the three most critical resource and environmental issues facing the future of the planet: food, water and energy. Effective production and delivery of nutritional calories is a complex interlocked system that depends critically not only on raw material inputs and germplasm but also on a number of additional scientific, economic, regulatory and political considerations that must be understood and addressed together. For that reason, a systems level perspective is essential to integrate creative ideas, technologies, and risk capital, enabling innovation to occur in a timely and cost-effective manner. Success requires optimizing the roles and performance of the academic, industrial and institutional participants. The health of the entire food production and delivery system depends on continued innovation to open new markets, reduce costs, and mitigate risk.

Second, citrus is a specialty crop, which provides its own special set of challenges. Seed companies, for example, can profitably integrate their research and development around value added traits marketed to growers. However for many so-called specialty crops there are no natural sponsors to bridge the gap with the required capital and expertise. The industrial organization of most specialty crops typically does not lead to vertical integration. Instead, there exists a wide range of industry participants, including growers, university researchers, government research labs, regulatory agencies, and a vast array of companies that develop and sell everything from clones to farm equipment to pesticides. Each stakeholder has its own interests, risk profile and expectations for return.

Therefore, to fully understand any agricultural system it is first necessary to ask:

- Who are the stakeholders, what are their interests and expectations, and where are they aligned or working at cross-purposes?
- Is a reasonable fraction of crop value being spent in R&D and commercialization to provide a pipeline of solutions? What is this optimal rate of collective investment?
- Are processes and mechanisms in place to provide significantly higher returns?
- Are there mechanisms at an industry level to rapidly and effectively address the industry's most pressing problems and opportunities?

STATE-OF-THE-ART

Citrus is a nutritionally dense and desirable specialty crop. Citrus production accounts for one-fourth of Florida's agricultural income, and most of the orange crop is processed and marketed as orange juice. A vascular bacterial disease named Citrus Greening currently limits citrus production globally and is transmitted by the feeding behavior of an invasive sucking insect pest. Citrus Greening is a formidable disease challenge because the symptoms are initially latent and then lethal to trees, the bacteria cannot be cultured, the insect vector is difficult to sustainably control and there is no known genetic resistance in citrus cultivars or relatives. By 2010 just a few years after its introduction, Citrus Greening disease spread to all 34 citrus producing counties in Florida and presented a serious threat to the iconic industry with annual revenue of approximately $1B in "on-tree" value and $9B in economic impact on the economy of the state.

METHODOLOGY

Recognizing that urgent action was needed, the Florida citrus industry engaged outside expertise to devise a strategy for employing scientific, financial and other resources to devise solutions and move them quickly into the citrus groves. A science-based strategic plan was developed and implemented, led by a grass roots organization of Florida citrus growers, the global research community, various government agencies and the National Research Council of the National Academies. Working with the diverse range of stakeholders, the outside experts drafted the original business plan and suggested product development road maps and action plans. The initial assessment, business and strategic planning documents (3) provided essential guidance for operational success bringing resources together in an effective manner.

ORGANIZATIONAL APPROACH

- The outside experts provided leadership in thinking through new organizational designs and informational initiatives. These initiatives were launched concurrently to create vehicles for sponsor access to innovators and the ultimate developers of new solutions.

- The outside experts also worked with stakeholders to develop an in-depth business plan, which was circulated, debated, and agreed to by key stakeholders. This plan recommended creation of a new organizational entity to manage the research and commercialisation activities.

- With acceptance of the plan, a start-up non-profit organization was launched in 2009, the Citrus Research and Development Foundation (CRDF). The CRDF was carefully structured to maintain involvement and alignment of key stakeholders. For example, the CRDF volunteer governing board of citrus professionals and paid staff now manage the interface between production priorities and researchers.

- A statewide referendum of Florida citrus growers overwhelmingly affirmed the creation of the CRDF in 2009 and dedicated a self-imposed assessment on boxes of fruit sold toward citrus research investments.

- Building on a successful grower advisory council, approximately $15M is raised and invested annually since the 2008 fiscal year with a mission to advance citrus disease research and product development activities that ensure the survival of the citrus industry.

- Coordinated meetings and communication with state and federal regulatory agencies allow necessary reviews to proceed in a parallel, rather than serial, manner.

- Growers and agricultural advisors are organized into Citrus Health Management Areas (CHMAs) to more effectively communicate and coordinate area-wide disease management practices.

RESEARCH MANAGEMENT APPROACH

- Using a set of innovative tools and methodologies, research and technology objectives are targeted with a range of near, intermediate and long-term outcomes that create a portfolio of valuable technology options over time. Projects are solicited and evaluated on merit and impact criteria only.

- The primary criteria for the selection of research proposals are scientific quality and likelihood of practical application. Rigorous outside technical review and industry dialogue with a Research Management Committee of the board promote clarity on the use of technologies, priority market needs and constraints and development milestones.

- The Foundation excludes no one from submitting research ideas for consideration and uses a pre-proposal process to select applicants for invitations to submit full research proposals with a relatively high success rate of funding. The pre-proposal is a single page outline that lays out what is to be accomplished, the research team and their expertise, the time line and

likely use of the results and a draft budget. This process provides an efficient focus for both researchers and sponsor on the value of the research investment.

- The Foundation engages innovators through the web (www.citrusrdf.org), through traditional academic request-for-proposal distributions, through advertisements and through targeted incentive prize campaigns.

PARTNERSHIPS

In addition to the world-class research centers located in Florida with the University of Florida and United States Department of Agriculture, additional research partners include other non-profit organizations, biotechnology companies, top research institutions and universities located in seven other US states as well as in Brazil, China, Spain and France. CRDF research contracts a) promote transparency and accountability with respect to detailed objectives, timelines, and the use of funds and b) clarify appropriate roles, responsibilities, and rights with respect to commercialization and intellectual property issues.

The Foundation offers two types of partnerships to accelerate rapid market access to technology: a royalty-sharing arrangement or a non-exclusive license/option that both anticipate continued industry involvement and support as needed. Web-based information tools promote the exchange of technical data and general information between the research and grower communities and the public. Brief progress reports are posted every calendar quarter for over 100 individual projects. The research portfolio is visualized with a customized tool (InnoMap™) that communicates development of solutions by stage of maturation (Phase I, II, III) and by target (host, pathogen, vector, the environment and their interactions).

COMMERCIALIZATION

The Commercial Product Development Committee of the Foundation Board is focused on traversing the remaining steps to bring new products to the groves because once new solutions are found, the penultimate questions remain: Who pays for the development and registration of new products? Who speaks for the use of new technology? The answers to these general technology transfer questions are only found in practice through case-by-case determinations and specific product development roadmaps. This Committee seeks to reduce the risks of successful new product introductions in order to attract commercialization development partners. Such risks include technical, intellectual property, regulatory, manufacturing and ultimately market acceptance factors. The Foundation will invest directly in this type of development work as

needed, with contracts designed to help close the gap to market launch of new products and practices. A free-market commercialization approach is not the only way to bring products to public use but it is proven to work quickly and efficiently when private capital is available.

FINDINGS AND INTERPRETATION

This crisis and the response created unprecedented co-operation between government, public and private entities across many geographic, institutional and industry boundaries. In just a few years the dramatic spread of the disease and rapid decline of infected groves has been slowed and stabilized while the pipeline of improved mid- and long-range solutions continues to expand. One main factor in this success was controlling the insect vector of disease (the Asian Citrus Psyllid) with improved methods. These methods were based on a basic understanding of the biology of the organism and the application of the knowledge to coordinated area-wide practices within CHMAs. The traditional preferred method of disease control, to scout for and remove infected trees as a source of inoculum, while providing stringent psyllid control and replanting with clean stock is practicable in large areas with low disease incidence. Where the disease pressure is high, some growers prolong the harvest of marketable fruit with enhanced nutrition. New molecules to control psyllid transmission of disease and control the bacterial pathogen have been discovered and are in development. In the long term, genetic resistance will provide a most environmentally acceptable and cost-effective solution. It is critical to stabilize production in the short term while delivering more profitable solutions in the long term because the industry must maintain a volume of production to sustain the processing segment of the juice industry.

This infectious disease crisis created an opportunity to align the interests of a segmented industry once the CRDF was formed to help restructure relationships between and within university-industry-government sectors to address the Citrus Greening threat. In addition to the formation of CHMAs, a key organizational recommendation of the NRC study was to empower one organization to have responsibility over research and development efforts. However, effecting this change and implementing this recommendation was and remains a challenge. Industries become segmented for economic reasons. Specialization improves profits for participants such as growers, harvesters, packers, and processors. However, growers carry most of the production risk of disease, the weather and the like, whereas, a large processor carries the capital and labor-intensive commitment to operate the plants. They are capable of bearing this risk over wide ranging time horizons. Achieving success with a new organization means understanding and sometimes balancing the same opposing forces and economic tensions that created segments. It is best to make these tensions explicit and subordinate to a greater goal of stabilizing profitable

production in the face of a severe threat. In this way most participants can understand that some form of co-operation and competition can coexist.

If the structure for stakeholders to participate is an advisory committee there can be a tendency to represent the appointing organization rather than the mission of the committee, and frustrations can build if the recommendations of the advisory body can not be implemented because of any number of legacy constraints in collaborating institutions. The corporate structure of the non-profit Foundation centers the ownership and responsibility for solving the problem. The type of corporation implemented in Florida is a “Direct Support Organization,” which is a special non-profit, independently governed but mutually supportive and compatible with the mission of one of the top traditional land-grant Universities in the country, the University of Florida (UF), and the Institute of Food and Agricultural Sciences. The relationship is essentially that of a Professional Employment Organization where numerous employment functions like human resources and payroll can be outsourced to UF in an efficient manner. The Board of Directors is composed of two members nominated by UF, one member from the Florida State Department of Agriculture and Consumer Services, and ten members nominated from industry. All meetings and proceedings are conducted in a manner compliant with stringent Florida “Sunshine” laws on public notice and access. These volunteer Board members have the fiduciary responsibility to manage the research investment for the benefit of the commons. This is the higher challenge: stable employment and food supply, educational and technical training opportunities, and economic development.

Using the Foundation Board as a forum for public participation and to achieve a balance of industry and researcher consensus is a key to success to date but it is also a continuing challenge. Here are some of the most significant tensions to be managed:

Large vs small scale: There are some 8,000 growers with all manner of individual production concerns and operations. The Foundation must serve them all. The CHMAs and traditional extension system of the land grant University system are crucial to setting the scale of operations and communication to their needs.

Marketing vs research: Florida has a robust and valuable brand recognition that is also supported by a fruit tax assessment. Collaboration and communication with the Department of Citrus is essential to arrive at a balance of marketing and research interests. This is challenging because marketing returns can be more easily measured in the short term, whereas research investments are long term and can be viewed as more speculative.

Grower vs grower: Not every grower will agree with the research priorities. The Foundation board and its committees are essential to hearing concerns and achieving consensus.

Researcher vs researcher: There is not enough funding to sponsor every valid research program proposed. The Foundation maintains a rigorous review process to make best efforts at selecting projects that are of high scientific quality and likely to yield practical applications with a dual track of grower and technical expertise and review. However, wherever there is sponsorship there will be efforts to undermine the merit process with an expectation of personal entitlement from a small minority.

Segment vs segment: Infectious disease in some way threatens the entire industry and cannot easily be separated from any other problem. However, there are certainly other research topics that warrant additional investment. Today the Foundation provides a forum to analyze and set research priorities more broadly and to assist as an industry advocate for enhanced support of those research areas by other state or federal programs. Moreover, the mission of the Foundation anticipates the research and commercialization of technologies that enhance the productivity of the citrus industry across all segments, with the goal being the continuation of a viable citrus industry in Florida.

Leadership: The “Architect in Chief”

The success of the Florida citrus case was highly dependent on having a trusted point person, or “Architect in Chief” to drive the overall process of strengthening linkages in support of the CRDF mission. To do this requires a view of the entire landscape from scientific, business, intellectual property and regulatory perspectives. It requires a deep understanding of the various stakeholders, their concerns and their interests on their own terms to conceptualize the problems and visualize organizational and programmatic change in creative ways.

CONCLUSIONS

It is important to learn from prior problem-solving success with complex agricultural systems in today’s global markets because the societal impact of limited agricultural resources will only become more acute as the use of plant biomass is further developed for non-food applications. The alternative uses under development include biofuels and pharmaceuticals, high value feed-stocks and the low-cost manufacturing and delivery of beneficial health care products such as subunit vaccines. Furthermore, there is increasing evidence the global agricultural system has become further strained by global environmental change (4).

Indeed, we do live in the Anthropocene (5) and there is no going back to another epoch. The only way forward is with our evolved intelligence and collective foresight. It is an enormous challenge to optimize the interactions in university-industry-government relations but is the only way to connect innovation effectively to societal needs. A search on Google Trends for the terms "unintended consequences" shows a steady rise in frequency of usage in the "News reference volume." This is encouraging news because it shows growing societal awareness. We now recognize when we screw up and it makes the news. But, it would be better to see a rise in "consequences intended." We need more accurate predictions, plans with precision, and better execution. It is time for the Triple Helix to function well. For Florida citrus cultivation, the formation of a new non-profit organization, the Citrus Research and Development Foundation, was the key to successful adaptation to a severe production threat. Many individuals within this complex system function well together once they are focused on a clear, common, and worthy goal.

POLICY IMPLICATIONS AND DIRECTIONS FOR FURTHER RESEARCH

In the real world many complex systems evolve to states where function is constrained by structure. In the cell, a function of triple helix DNA is to promote recombination as a transient intermediate. The major implication from this work is that societal relationships will need to be restructured to function well for the creation and diffusion of innovations. One method of revealing dysfunction is to follow the use of funds toward outcomes that are relevant to the intended beneficiaries. In this case, the fundamental change was to transition the focal point of the program investment from a grower advisory committee to a grower led non-profit Foundation. The corporate structure of the Foundation provides improved operational capacity with greater clarity and transparency in its mission, governance and use of funds. It is more broadly inclusive of the needs of the industry and consumers. It provides a constructive alignment of government and University resources toward common goals. The non-profit solution warrants further case study investigation as a solution to stabilizing the Triple Helix under similar conditions.

REFERENCES

1) Etzkowitz, H., Leydesdorff, L., 2000. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. Research Policy 29, 109-123.
2) Jain, A., Wang, G., Vasquez., 2008. DNA Triple Helices: biological consequences and therapeutic potential. Biochimie 90 (8), 1117-1130.

3) National Research Council. 2010. Strategic Planning for the Florida Citrus Industry: Addressing Citrus Greening Disease. Washington, DC: The National Academies Press.
4) Gillis, J., The New York Times. June 4th, 2011. A Warming Planet Struggles to Feed Itself.
5) The Economist. 2011. A man-made world. May 28th-June 3rd pp. 81-83.