Workshop Report

Genome Canada ABC Integration Workshop

January 28-29, 2010
Banff, Canada

VALGEN is a Genome Canada project managed by Genome Prairie.

Executive Summary

In April 2009 twelve successful projects were announced as a result of the Genome Canada competition on Applied Genomics in Bioproducts and Crops (ABC) with Genome Canada and project partners investing $112 million. Eleven of the twelve research projects funded through the ABC competition are science and technology projects with integrated social science research activities focussed on one or more of the ethical, economic, environmental, legal and social (GE^3LS) aspects of the proposed scientific study and intended technology development. The twelfth project funded in the ABC competition is a stand-alone GE^3LS project entitled *Value Addition Through Genomics and GE^3LS* (VALGEN). VALGEN is a multi-part program of information-sharing, research collaboration and mutual support to link research projects, researchers and end-users of GE^3LS research.

The scientific and GE^3LS leaders of the twelve ABC projects were invited by VALGEN to a workshop in Banff, Alberta on January 28-9, 2010. The stated goals of the workshop were to 1) bring the ABC community together for the first time, 2) share cross-project information, 3) identify opportunities for, and barriers to, ABC genomics research, 4) share best practices regarding GE^3LS integration, and 5) structure relationships between VALGEN and the science and technology projects.

Participants were introduced to the research goals and overall structure of the VALGEN project. During a round-table discussion, science and GE^3LS representatives were invited to share a summary of their project and how the science and GE^3LS activities interrelate with each other within the project. The results of a desk study of the original project proposals (scientific and GE^3LS activities) was presented to help the participants gain an understanding of the overall research landscape and identify potential areas of collaboration between projects. A Social Network Analysis (SNA) of the ABC community helped participants visualize connections between the members of the project teams. Project representatives participated in three interactive polls regarding GE^3LS integration, social networking, and communications and branding of the ABC projects. The results of a first round of a Delphi seeking opinions concerning barriers to ABC research was presented and discussed.

Several discrete lines of research and potential collaborations with iGE^3LS projects were identified, particularly with respect to intellectual property and technology transfer, and governance and regulation. The participants identified communication between a wide variety of stakeholders (government, industry, non-government organizations, and technology end-users) as a key action leading to resolution of barriers to ABC research and development. Several workshop participants expressed an interest in the ABC community responding to certain GE^3LS issues as a unified group under the direction and co-ordination of VALGEN. The results of the workshop will facilitate the development of effective communication processes between researchers, increase overall understanding of the role of the integrated GE^3LS activities within the projects, and to develop a communications and branding strategy for the overall ABC community. The result will be a critical component to the prioritization of research, communication, and networking activities over the life of the VALGEN project.

ACKNOWLEGEMENTS

Value Addition through Genomics and GE^{3}LS (VALGEN) gratefully acknowledges the participants of the workshop and presenters Lisa Jategaonkar, Alexandra Mogyoros, Cami Ryan, and Stuart Smyth are also thanked for their contributions to the workshop and report.

We would also like to thank our project funding partners Genome Canada, Genome Prairie, Genome Alberta, Genome BC, Genome Quebec, the Government of Saskatchewan, Western Economic Diversification, the Canola Council of Canada, the University of Saskatchewan, the University of Ottawa, the University of Western Ontario, the Scottish Centre for Research in Intellectual Property and Technologies (SCRIPT, The University of Edinburgh), the Delft University of Technology, the Kluyver Center for Genomics of Industrial Fermentation, and SRC Holdings Ltd.

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1. The Workshop Context

In April 2008 Genome Canada launched the competition on Applied Genomics on Research in Bioproducts or Crops (ABC). The competition themes were the results of a 2007 position paper process initiated by Genome Canada in which sixty letters of intent yielded eleven position papers proposals. The two successful position papers, one on bioproducts, the other on crop genomics, were amalgamated into one competition given the individual strengths of the papers and the potential synergies between them. Genome Canada received fifty eight letters of intent for the ABC competition, and twenty seven full proposals were invited. Twelve successful projects were announced on April 20, 2009, with Genome Canada and the project partners investing $112 million.

Eleven of the twelve research projects funded through the ABC competition are science and technology projects with integrated social science research activities. Science projects tend to track the original two themes. Under the bioproducts theme projects employ genomic and proteomic approaches to understand and manipulate the underlying biological processes exploited in the production of economically viable and environmentally sustainable bioproducts. Three areas were targeted: feedstock optimization, microorganisms for sustainable processing technologies, and value added-bioproducts. Research projects under the crops theme employ genomic and proteomic approaches to foster an improved understanding of systems that govern plant growth, development and performance. Funded projects cultivate a comprehensive understanding of the genetic and physiological factors that contribute to the underlying biological processes of Canadian crops. Three areas were targeted: basic plant genomics, application of plant genomics, and agriculture and food production sustainability.

Each of the eleven scientific research projects is required to consider the ethical, economic, environmental, legal and social (GE^3LS) aspects of the proposed scientific study and intended technology development. Successful GE^3LS integration (iGE^3LS) viewed from the perspective of the ABC proposal phase requires the GE^3LS and science scholars to anticipate GE^3LS issues. As they arise within a funded project, GE^3LS issues are circumscribed by the scope of the science project. They are, nevertheless, original sources of research questions for GE^3LS scholars rather than a set of services provided by GE^3LS scholars to the science project. For science and iGE^3LS research agendas to be integrated, GE^3LS scholars cannot simply work in parallel to the activities of scientists, and the reverse is true. Science and iGE^3LS researchers can collaboratively co-evolve priorities for science and GE^3LS research and undertake joint activities. The extent to which this happens, and the manner in which it happens, are not prescribed and do not follow a template.

The twelfth project funded in the ABC competition is a stand-alone GE^3LS project entitled *Value Addition Through Genomics and GE^3LS* (VALGEN). VALGEN responds to deep governance challenges for bioproducts and crops by assembling a team of researchers to study how Canada can benefit from applying genomic research to agriculture. Using current research methods in the social sciences, humanities and legal scholarship, VALGEN researchers examine three contexts from which barriers to innovation in agricultural biotechnology research and

development arise: intellectual property management and technology transfer, regulation and governance, and democratic engagement.

- *Intellectual property and technology transfer* research concerns the use of legal tools like patents, copyright and trade secrets in combination with public policy, industrial structure and business strategy, and the effect on commercialization and use of new technologies and products.
- *Regulation and governance* research addresses increasingly complex systems of domestic and international regulation meshing, with varying outcomes, with private supply chains, and the identification of regulatory bottlenecks and blindspots.
- *Democratic engagement* research focuses on the need to engage the public early and often about the direction of scientific research and technological development, and to identify meaningful ways for Canadians to participate in decisions about how we choose to use new agricultural technologies and products.

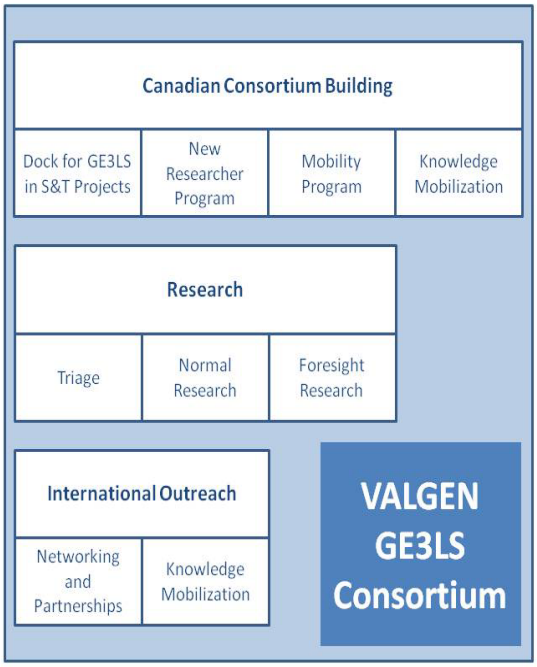

Figure 1: VALGEN activities portfolio

VALGEN adds value to the eleven GE³LS projects integrated in the ABC science-based projects through a number of mechanisms – formal networking, identification of overlaps, gaps and potential for synergies in the collective research activities of integrated GE³LS, communications, coordination of partnerships, and new researcher mobility programs. VALGEN furthers the reach of ABC project by spanning disciplines, institutions and other pre-existing networks and collaborations to foster national and international collaboration and partnerships. Mobilizing knowledge in creative and effective ways is a chief priority – VALGEN is a multi-part program of information-sharing, research collaboration and mutual support to link research projects, researchers and end-users of GE³LS research. The iGE³LS projects can relate to VALGEN in

several ways, from absorption of information as a silent partner to information sharing among all alliance partners, trouble-shooting, networking opportunities, and research partnerships, all of which can be continuing strategic partnerships or short term collaborations.

In keeping with the primary objectives of the VALGEN project the project team organized a meeting of the twelve Genome Canada ABC project leaders. The workshop was design to facilitate discussion and encourage feedback regarding VALGEN's role and objectives.

2. The Goals of the Workshop

The Genome Canada ABC Integration Workshop in Banff in January 2010 was the first opportunity for the leads of the science and GE^{3}LS projects to meet as a group and discuss issues of mutual interest. The goals of the workshop were to:

- Bring the ABC community together for the first time
- Share cross-project information
- Identify opportunities for, and barriers to, ABC genomics research
- Share best practices regarding GE^{3}LS integration
- Structure relationships between VALGEN and S&T projects

3. Participants

All eleven of the ABC science based projects were invited to send their lead scientist and their GE^{3}LS lead. Twenty-five scholars representing the science and iGE^{3}LS aspects of ten of the eleven science projects attended and participated. The co-principal investigators of VALGEN and two other Science Management Executive Committee members were also present. Three VALGEN administrative and research staff assisted with developing the program and facilitated parts of the event.

The following individuals participated in the event in Banff on January 28-9.

Tom Bureau
Tania Bubela
David Castle
Keith Culver
Jeremy DeBeer
Kari Doerksen
Elizabeth Edwards
Edna Einsiedel
Peter Facchini
Richard Gold
Anil Hira
Lisa Jategaonkar
Nolan Kane
David Levin
Terry McIntyre
Alexandra Mogyoros
Anwar Naseem
Mark Perry
Peter Phillips
Jeremy Rayner
Gordon Rowland
Cami Ryan
Brad Saville
Stuart Smyth
Adrian Tsang
Hank Venema
Gerrit Voordouw
Gregor Wolbring

The agenda is in appendix A.1. All the sessions proceeded under the Chatham House Rule.[1]

Table 1: Summary of the applied genomics on research in bioproducts or crops (ABC) projects

Project title	Budget	Science lead(s)	GE^{3}LS lead(s)
Bridging Comparative, Population and Functional Genomics to Identify and Experimentally Validate Novel Regulatory Regions and Genes for Crop Improvement (VEGI)	$4.66 M	Thomas Bureau	Anwar Naseem
Genozymes for Bioproducts and Bioprocesses Development	$17.42 M	Adrian Tsang	David Secko
BEEM: Bioproducts and Enzymes from Environmental Metagenomes	$10.99 M	Elizabeth Edwards and David Major	Douglas Reeve
Genomics in Agricultural Pest Management (GAP-M)	$6.39 M	Miodrag Grbic	Mark Perry
Microbial Genomics for Biofuels and Co-products from Biorefining Processes	$10.57 M	David Levin & Richard Sparling	Stuart Smyth
Total Utilization Flax GENomics (TUFGEN)	$11.79 M	Gordon Rowland and Sylvie Cloutier	Stuart Smyth
Synthetic Biosystems for the Production of High-Value Plant Metabolites	$13.60 M	Peter Facchini and Vincent Martin	Edna Einsiedel
Metagenomics for Greener Production and Extraction of Hydrocarbon Energy	$11.26 M	Gerrit Voordouw	Gregor Wolbring
Grape and Wine Genomics	$3.44 M	Steven Lund & Hennie van Vuuren	Michael Howlett and David Laycock
Genomics of Sunflower	$10.48 M	Loren Rieseberg	Emily Marden
Genomics-Enhanced Forecasting Tools to Secure Canada`s Near-Term Lignocellulosic Feedstock Supply for Bioenergy using the Mountain Pine Beetle-Pinus spp. System	$7.80 M	Jorg Bohlmann and Janice Cooke	Tim Williamson, Grant Hauer, Brian Aukema, Barry Cooke

[1] "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed". http://www.chathamhouse.org.uk/about/chathamhouserule/

4. Inputs to the Workshop

VALGEN's research program calls for a study of the ABC projects with respect to the science and technology focus as well as the iGE^{3}LS plans. This study is comprised of the following elements:

- A desk study of the 11 project proposals with respect to the science and iGE^{3}LS
- The development of a method of triage to identify gaps and overlaps
- A Delphi study to investigate the barriers and opportunities related to research, development and commercialization of ABC research
- A social network mapping exercise of the ABC world and development
- A series of interactive polls (three at the Banff event) about specific networking opportunities in the ABC area

The collective results of the studies will establish a baseline of information and assist VALGEN in setting research priorities. The results of the studies were presented to the participants of the workshop to increase awareness of the types of research happening within the ABC community, stimulate discussion regarding challenges and opportunities with respect to ABC research, and to assist the participants in the identification of potential areas of complimentarily with respect to their research program.

If requested, researchers at the workshop were provided, in advance, with a copy of the VALGEN project proposal to reciprocate sharing of information.

A complete copy of the presentations is available at www.valgen.ca.

4.1 Desk analysis of the ABC science

With the aim of understanding the current research and development (R&D) landscape of the GC ABC Competition, the scientific leads of each of the eleven approved projects were contacted to request a copy of their proposal as was submitted to Genome Canada in the autumn of 2008. Ten of the eleven scientific proposals were received and reviewed to compare and contrast: (a) project scope; (b) species targets; (c) the 'omics approaches; and (d) expected outputs.

a. Project Scope

In its proposal guidelines, Genome Canada had defined two themes for the ABC competition—bioproducts and crop genomics—and further divided each of the themes into three issues that the projects were encouraged to address.

The bioproducts theme included the following issues:

- *Feedstock Optimization* – to optimize feedstock for various climatic regions or for industrial applications,
- *Microorganisms for Sustainable Processing Technologies* – to optimize enzymes and microorganisms for use in the Bioproducts sector,
- *Value Added-Bioproducts* – to transform low value biomass into high value bioproducts or increase the range of bioproducts available.

The crops theme included:

- *Basic Plant Genomics* - research to expand our knowledge of plant genomics
- *Application of Plant Genomics* - to improve health or food security.
- *Agriculture and Food Production Sustainability* – to reduce the environmental footprint of the agricultural sector, for example through reduced pesticide or fertilizer use.

Each of the ABC project proposals addressed more than one of these six issues (Table 2). The two themes and most of these six subtopics were evenly represented in the ten projects. The exception was feedstock optimization; only one project intends to look at this issue. Although the two themes areas are quite closely related, offering potential for overlapping research areas, most projects address issues only under the crops theme or under the bioproducts theme. Only two projects address a topic that involves both themes.

Table 2: Scope of research projects in the Genome Canada ABC competition.

Theme	Issue	Number of projects addressing issue
Bioproducts	Feedstock Optimization	1
	Microorganisms for Sustainable Processing Technologies	4
	Value-Added Bioproducts	3
Crops	Basic Plant Genomics	4
	Application of Plant Genomics	3
	Agriculture and Food Production Sustainability	3

b. Species

Overall seven different projects intend to examine one or more plant species (Table 3). Three of these projects are looking at a plant in combination with yeast, animal and/or fungus. While there is a wide range of different plant targets, there are also some obvious areas of complementarity. For example more than one project is looking at *Vitis* spp. and Brassicacea. One project had listed over 90 potential targets and as a result will potentially be examining other closely related plants. Three projects target bacteria, and one looks at fungi. Moreover, all of the projects that examine microorganisms intend to examine them from a population perspective, instead of targeting a specific species, which creates potential for synergies in their methods and results.

Table 3: Species targets in the ABC projects.

Plants	Yeast	Animal	Fungus	Bacteria	Number of projects that target
X					4
X	X				1
X		X			1
X		X	X		1
			X		1
				X	3

Note: This table includes the 11th project as the targeted species could be determined from the scientific summary available on Genome Canada's web-site.

c. Research approaches

Over the last decade genomics methodologies have evolved from sequencing an organism to including a variety of "*omics"* approaches such as proteomics, transcriptomics and metabolomics. This diversity of high throughput data-gathering methodologies is well represented in the ABC projects. Table 4 shows that although almost all projects have some genomics (pure sequencing) included in their project proposal, there is a diversity of "*omics*"approaches being used. Genomics, functional genomics, transcriptomics, proteomics and metabolomics are all approaches being used by multiple projects. There is also considerable diversity within these approaches. For example, of the nine projects employing genomics approaches, one project is looking solely at the non-coding regions, some are doing genomics studies of populations, others are doing comparative mapping and one project is focused on genomics of specific tissues.

Table 4: "*Omics"* approaches employed by the different ABC research projects.

	Genomics	Functional Genomics	Transcriptomics	Proteomics	Metabolomics
Number of projects employing this approach	9	5	3	2	2

d. Research outputs

The project proposals outline research activities and their expected outputs, which though heterogeneous in scope, species or methodology, can be grouped into broader output categories. In some cases the expect outputs are "*basic*" in that they generate knowledge that could be of use to the broader scientific community and transferred through academic publications. These include sample collection, phenotypic characterization (physiological characterization without genotypic characterization), the "omics" (e.g. genomics and transcriptomics), bioinformatics, mapping and functional genomics. Other outputs are categorized as "*applied*" in that they can be protected by patents or other property protection systems and transferred through the commercial marketplace. Applied outputs may be used by the scientific community or by industry or other end-users. Categories include gene characterization, database development, scientific tool development, industrial tool development, models for industry, new cultures, new bioproducts, novel microbes and novel plants.

While every ABC project proposal describes the intent to develop both basic and applied research outputs (Table 5), some projects tend to have more basic outputs, while others tend to have more applied outputs.

Table 5: Expected outputs from the ABC projects.

Nature of output	Output	Number of projects intending to deliver this output
Basic	Sample collection	6
	Phenotypic characterization	3
	'omics	11
	Bioinformatics	4
	Mapping	4
	Functional genomics	3
Applied	Gene characterization	6
	Database	4
	Scientific tool development	5
	Tool for industry	2
	Models for industry	2
	New cultures	3
	New bioproducts	2
	Novel microbes	2
	Novel plants	2

Once the declared outputs of the ten science projects were coded, it was possible to plot the number of applied research outputs to basic research outputs for each project. The majority of

projects tend to be more basic in nature (Figure 2). Each marker represents a project, which is positioned according to the number of basic outputs and the number of applied outputs that the project intends to produce.

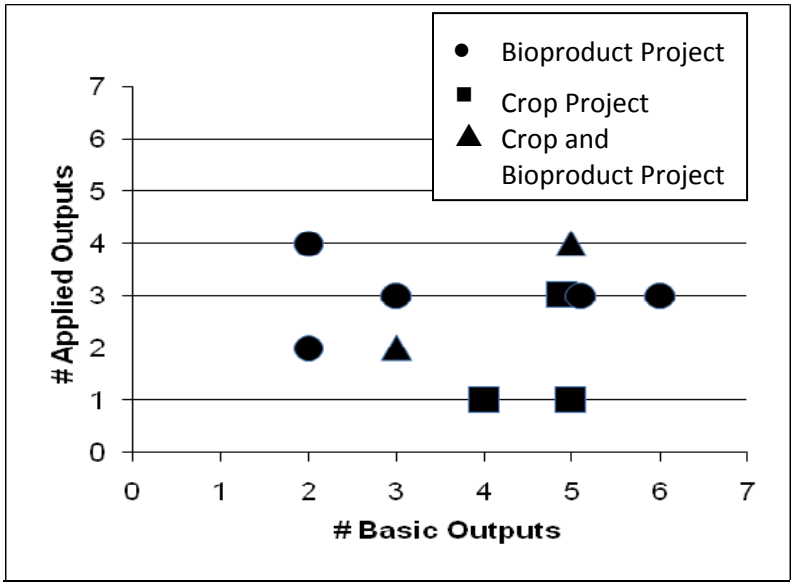

Figure 2: Research outputs by project.

We also compared the intended outputs of each project against the budget for the projects. Those projects with higher funding seem to have more applied outputs (Figure 2). Crop projects tend to be more basic than the bioproducts research, with the two projects that look at both bioproducts and crops to be in the middle (Figure 3).

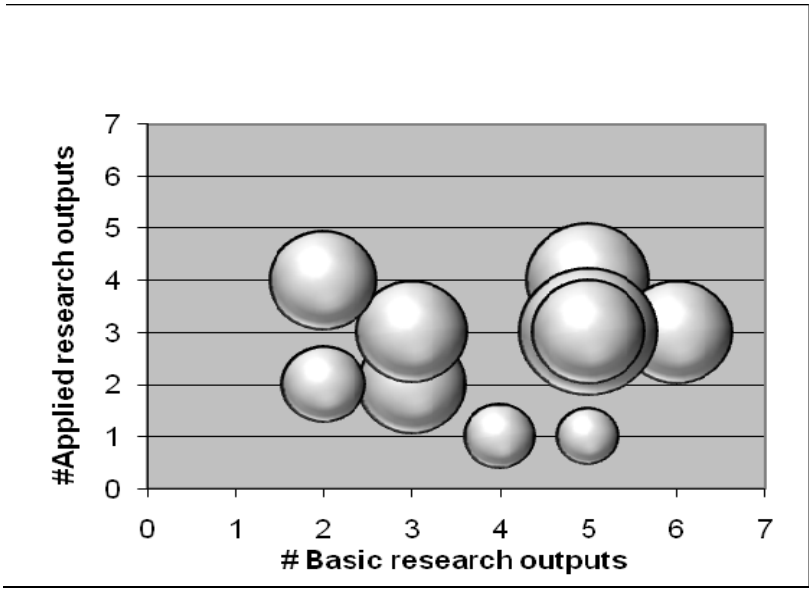

Figure 3: Relative size indicates the total project value approved by GC.

Overall the landscape of the ten ABC projects reviewed here reflects a considerable amount of diversity in their scope, species targets, approaches, and outputs. In several of these areas there are potential synergies among projects. Multiple projects aim to address the same scope issue from different perspectives, use similar approaches, and/or aim to develop basic and applied outputs of a similar nature. The heterogeneity of intended outputs and the broad scope reflected in the ten projects gives rise to a wide spectrum of potential GE^{3}LS research topics. At the same time, the commonalities among the projects assist in prioritizing GE^{3}LS issues of common interest to the success of the ABC projects.

4.2 Desk analysis of ABC iGE^{3}LS

The scan of the integrated GE³LS (iGE³LS) projects within Genome Canada'a ABC competition included 10 of the 11 science and technology projects and the one stand-alone GE³LS project. To undertake this scan, each project was contacted and asked to provide their full project proposal that was submitted to the Genome Canada competition in the fall of 2008. The scan focused on the research objectives, the methodologies that would be utilized and the expected deliverables.

To provide a sense of structure to the iGE³LS scan, the 11 projects reviewed were grouped based upon research objectives. The various iGE³LS efforts generally are seeking objectives in six areas: intellectual property; regulatory and governance; democratic engagement; economics of science; environmental; and ethics.

Table 6: Targeted GE^{3}LS topics.

Category	Number of Projects	Themes
Intellectual Property	8	Landscape assessments and assessing alternative IP strategies
Regulation and Governance	7	Focus on gaining insights into how the existing Canadian regulatory system will be applied to the products resulting from the research
Democratic Engagement	4	Population surveys so that there is increased understanding of consumer's attitude toward their research products
Economics of Science	2	Economic value of specific genetic traits and the returns to research
Environmental Dimensions	3	Life cycle analysis is the major research initiative
Ethical Dimensions	1	Food versus fuel debate

The eight projects undertaking aspects relating to IP research tend to be focusing their efforts on landscape assessments and investigations of alternative IP strategies. Several projects identified that patents would, or could, act as barriers to the research and to ensure the successful commercialization of research an assessment of the existing patent regime would be required. There is some possibility that the task of conducting patent database searches might be a opportunity for cross-project collaboration. Investigations of alternative IP strategies are also an integral part of this aspect of research as scientists are seeking new ways of protecting their knowledge that might increase their ability to share technology.

Seven projects have objectives involving regulatory and governance analysis, mainly focused on gaining insights into how the existing Canadian regulatory system will be applied to the products resulting from the research. With numerous research activities focused on biofuel research and development, there is an identified substantial knowledge gap in how regulators will perceive the products that will eventually result from the research. Reviews of existing regulations that could be applicable will be part of the research, but it may also be necessary to open a dialogue process with the federal regulatory agencies so that insights and information can be shared and exchanged. Most research proposals express hopes that this process will be of benefit to both researchers and regulators.

Four projects have included aspects of democratic engagement, which largely involves undertaking population surveys to gauge citizen and potential consumer attitudes towards the research products. In addition to the surveys, public discussion or dialogue events are proposed as a way of providing important science information to an interested segment of the population and then receiving their views.

Two projects have focused the iGE^{3}LS effort on assessing the economic value of specific genetic traits and the returns to research. More specifically, this research involves undertaking impact analyses on the novel traits that are identified by the scientific researchers to determine which of the traits might have the highest economic value. The broader aspect of this is to contribute to the literature that examines returns to agricultural research.

Three projects propose to apply and undertake life cycle analysis of the products and technologies targeted in their ABC science project. Climate change mitigation is an important component of the biofuel projects and a detailed examination of the biomass contribution to climate change is planned in these projects. The goal is to provide insights as to the carbon footprint from biofuels, which is largely lacking in the current literature.

Finally, one project has an ethics component that examines the food versus fuel debate. This project will undertake a survey that includes questions of an ethical nature regarding the development of biofuel technologies and the transfer of these technologies to developing nations.

The methodological approaches being applied vary by project and category. Nevertheless, there is some clustering of methodological approach. Six projects are undertaking patent landscape assessments, three are doing public surveys, three are undertaking life cycle analysis, three are doing regulatory impact evaluations, five have identified quantitative data analysis, two will build and use empirical models and four intend to pursue bibliometric or literature scans. These overlaps offer some potential for projects to learn from and contribute to the development of new models, methods and metrics for iGE^{3}LS research.

While the outputs of these project are, by and large, directed towards academic publication, some of the projects explicitly target to produce public presentations and other 'translated' knowledge.

4.3 The ABC world: a social network analysis

In dealing with the complexities of geographically and institutionally dispersed actors, it is valuable to understand how a network of actors is connected through use of social network analysis. Social network analysis (SNA) is based on mathematical and graph theory and provides both maps and quantitative measures for intra-network connectedness.[2] SNA has quite an extensive history that runs the disciplinary gamut from mapping genomics pathways, to epidemiology to detecting terrorism cells.

SNA was used to examine the baseline nodes or actors in the ABC World, and to identify patterns of exchange and integration amongst ABC actors and projects. The ABC world consists of more than 150 actors (scientists /GE^{3}LS scholars) who signed the original proposals with Genome Canada and are planning to work on one or more of 12 projects.

[2] Intra-network connectedness refers to 'density' and individual actor level measures consist of a family of 70+ centrality measures. Centrality is the level to which a node or actor is connected to other nodes in the network. Quite simply, more connections equates to a higher centrality measure.

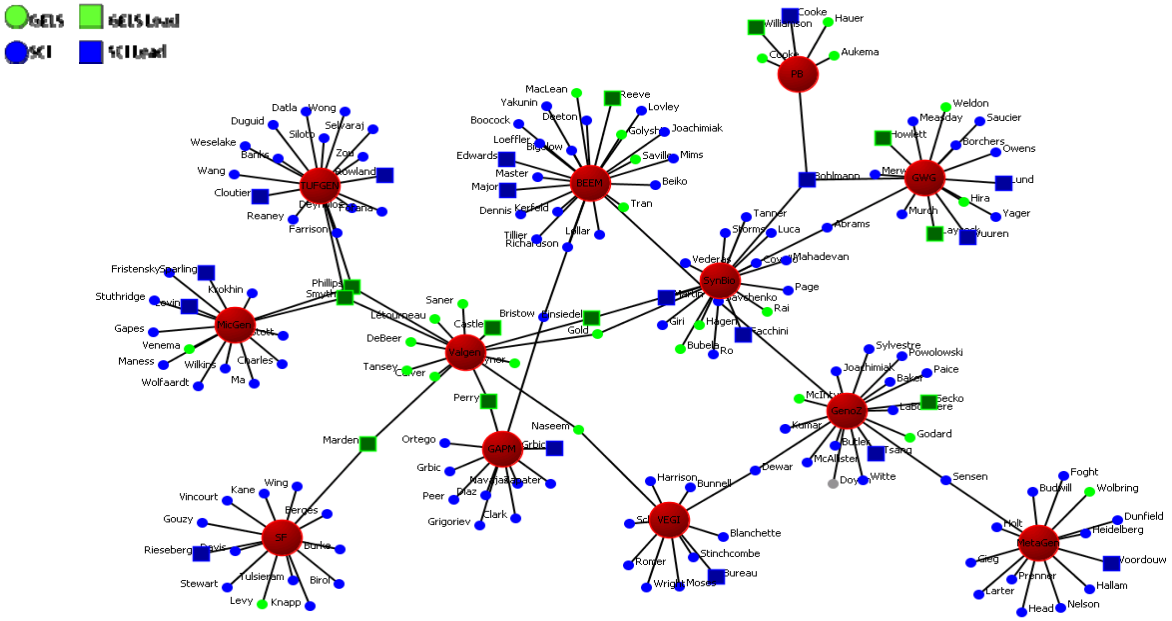

Figure 4: The ABC world

We employed co-publication analysis to explore the pre-existing collaborative activity in the ABC science world. Data for this was accessed through ISI Thomson World of Science. After generating a primary node or actor list of ABC science and GE^{3}LS leads, a search was conducted and then we ran an algorithm[3] on the resulting data to test and explore co-publication activity. Data was parsed into two time intervals: 2000-2004 and 2005-2009 in order to see how networks evolved over time. Results were filtered by limiting output to only articles and excluded any authors with less than two publications.

Table 7. Comparison of network level measures (2000-2004 vs 2005-2009)

Parameter	2000 – 2004	2005 - 2009	Trend
# nodes	227	467	↑
# ABC Actors (science)	19	24	↑
# ABC Actors (GE3LS)	9	12	↑
Density	0.028	0.048	↑
Fragmentation	0.712	0.367	↓
Component Count	13	13	Same
Degree Centralization	0.061	0.138	↑
Betweenness Centralization	0.156	0.236	↑

In the first time interval, GE^{3}LS actors and scientific leads were largely working independently of each other and, to a great extent, integration between them is not evident. In the latter

[3] CoAuth.exe software developed by L. Leydesdorff - http://users.fmg.uva.nl/lleydesdorff/software.htm

interval, integration between science and non-science scholars begins to emerge—there are, in fact, a collection of ABC actors representing several projects clustering together. This integration is largely independent of individual project development trajectories.

Overall, based upon SNA calculations and these observations, the ABC network appears to be:

- evolving over time, with the growth of the network illustrated through the addition of primary (ABC Science and ABC GE^{3}LS) and more secondary (non ABC) actors (↑nodes);
- there is evidence of more visible clustering of ABC actors in the latter interval indicating the dispersion and intensification of collaborative activity over time (↓fragmentation; ↑density; ↑ centralization); and
- GE^{3}LS actors are beginning to integrate with science in the 2005-2009 time interval (↑centralization).

Taking the SNA data from the 2005-2009 latter interval, the actors and their positions in the research world were examined more intensively. Figure 5 shows the results. The horizontal axis shows the personal centrality of ABC investigators and the vertical axis shows their related project centrality in the ABC world.

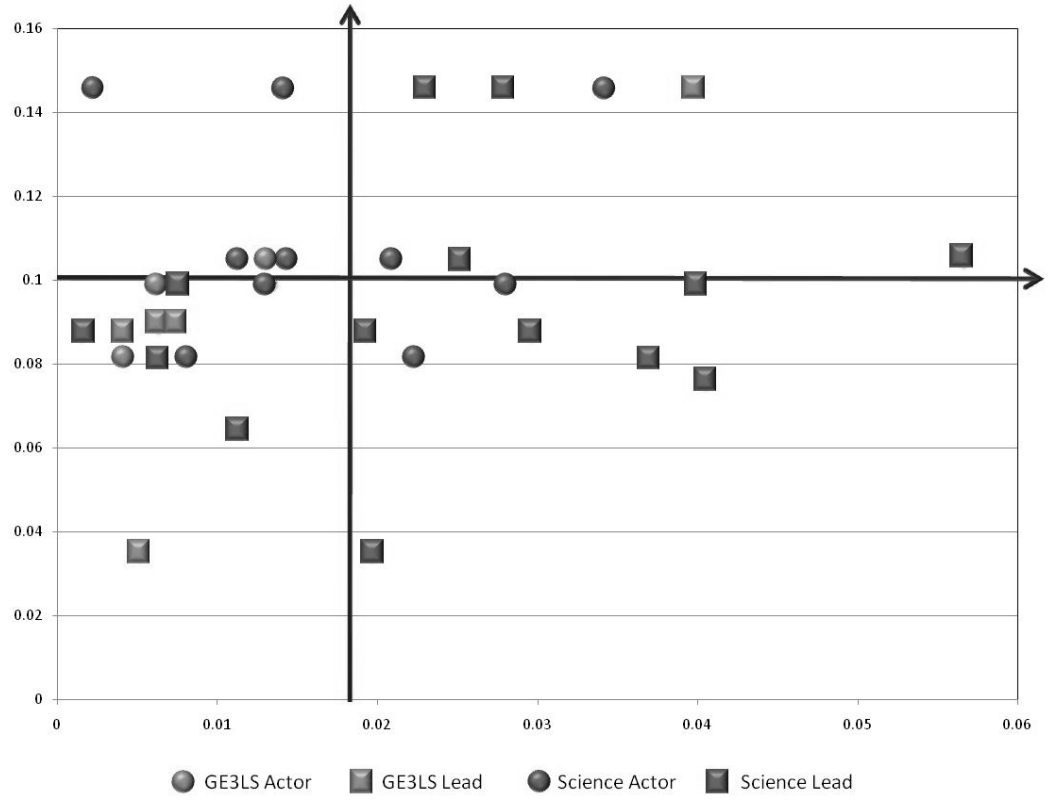

Figure 5: Actors in the ABC world according to centrality measures

Two points arise in this part of the analysis:

1. Science is spread widely across the upper quadrants, suggesting that scientific actors have a background of greater personal collaboration and traditionally engage in more networked research.

2. The social scientists in the ABC world are predominantly in the lower quadrant, suggesting they have historically had lower levels of collaboration and networked research.

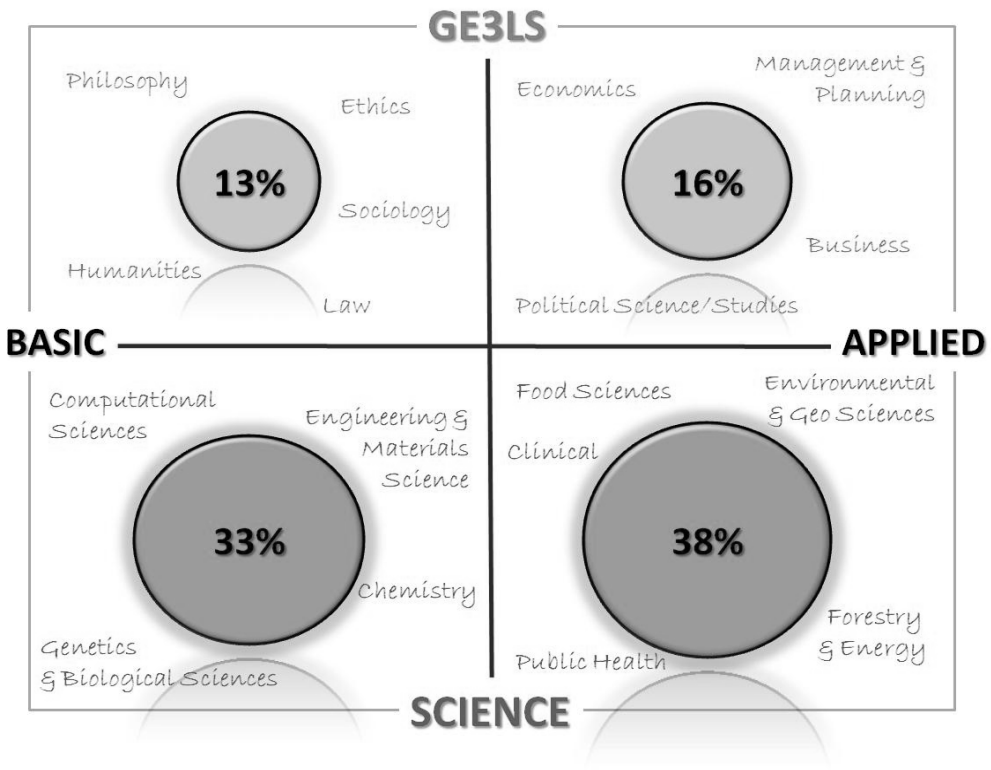

Figure 6: Publication distribution by subject (2005-2009)

The second observation prompted further analysis of the nature of collaborations. We isolated GE^{3}LS scholarly data for further examination. For this, we used ISI Thomson filtering tool to parse all of the publications by the GE³LS scholars from 2000-2009 into subject categories. According to the results, GE^{3}LS actors are not only actively publishing in their respective non-science fields (29%) but they are also demonstrating a significant amount of publishing activity in science fields as well (71%).

A closer investigation of the GE³LS network and its connections requires a more qualitative-based analysis. Actor CVs were analysed in order to identify and weight linkages amongst GE³LS actors to provide a representation of relationships amongst GE³LS actors. Based on this analysis, it is apparent that there are some really solid relationships amongst GE³LS actors in the 12 ABC projects. We particularly noted that while a variety of GE³LS scholars are centrally placed, VALGEN actors are disproportionally highly centrally positioned within the GE³LS network.

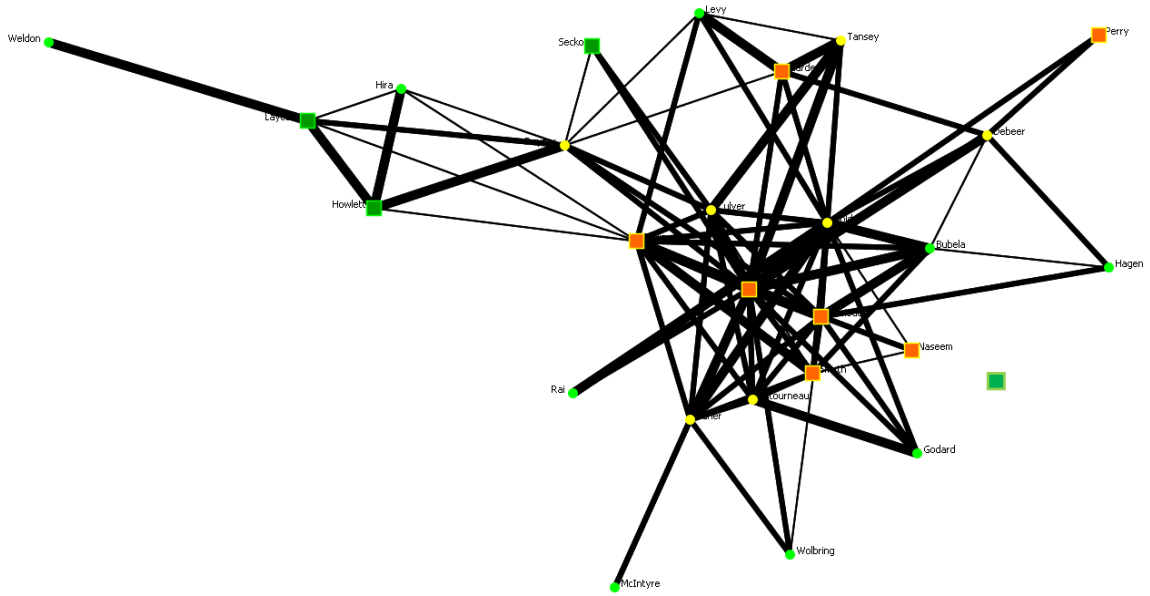

Figure 7: The ABC GE³LS community

Another way to look at the ABC world is in the context of the institutions in which people work. One obvious question is what role does their institutional context, in this case the ABC project environment, play in network integration. One way to test this is to "knock-out" the VALGEN project, just as one might consider knocking out a gene to find its effect. Once removed, the ABC World – once a fully connected network – breaks up into four subsets including one isolated project.

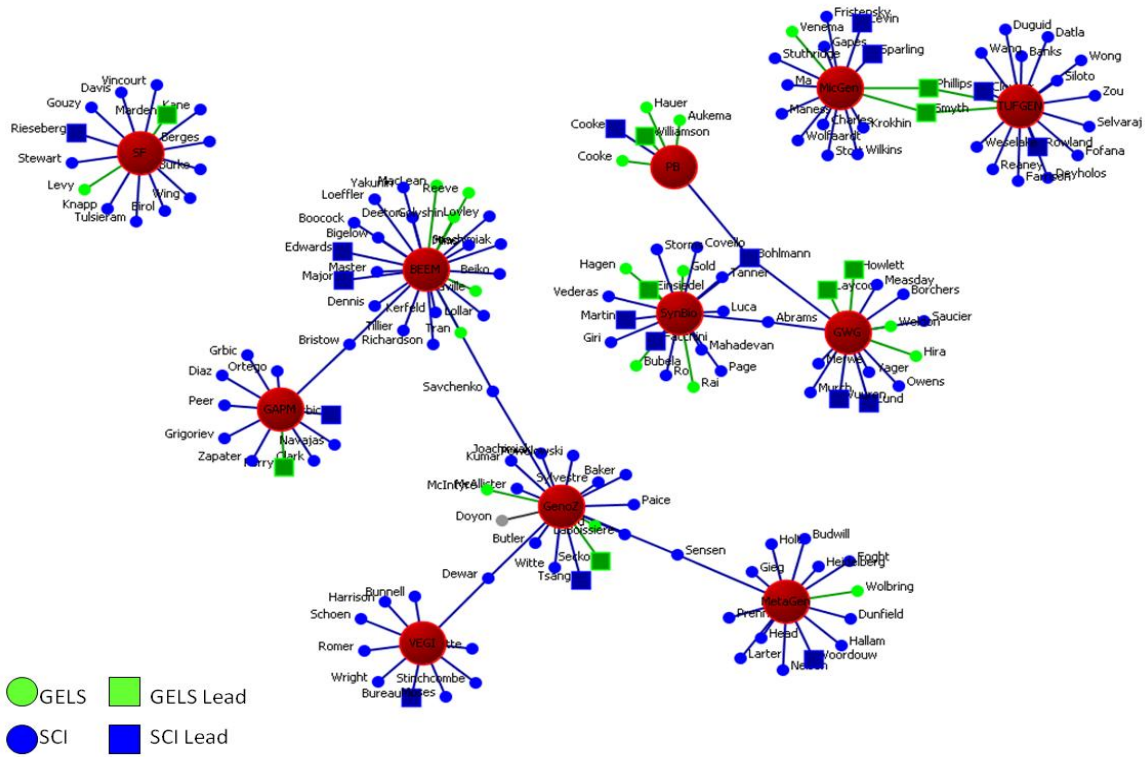

Figure 8: The ABC community without VALGEN

Genome Canada has invested in a theme area, ABC, in order to position Canada as a globally recognized leader in ABC research and commercialization. Centrally located in the ABC world, VALGEN has the potential to play an important role for positioning and co-branding ABC as a world class research network.

4.4 Interactive polling

On the first day of the VALGEN workshop, members of the conference were asked to participate in three interactive polling sessions. Questions were presented on a PowerPoint presentation, and participants were given the opportunity to vote on several questions regarding social media/networking, GE^{3}LS integration, and communication and branding.

a. Goals of the polls

The goals of the polls were two-fold. First, the polls provided VALGEN with immediate feedback and opinions from the ABC community on social media/networking activity and behaviours, status of GE^{3}LS integration, and opinions regarding VALGEN-mediated communication and branding strategies. Second, the polls acted as a conversation stimulus for participants both during the breaks, and breakout discussions. This resulting information serves as a valuable tool

for guiding the implementation of VALGEN practices and programs over the next four years with respect to Activity 1.

b. Overview of methodology

The participant group was composed of the science and GE^{3}LS leads from Genome Canada supported ABC projects. When participants registered on the first day of the event, Thursday February 28th, they were given an individual TurningPoint Clicker, a handheld wireless polling device, and a consent form to read and sign.

The polls were conducted on the first day of the VALGEN workshop. The polls were assembled using Turning Technologies polling platform which has two linked components. Participants see a PowerPoint slide presentation with the polling questions. The data is collected wirelessly using a USB-key receiver that collected the responses on a laptop. In order to vote, participants were asked to select their answer choice from their individually assigned response remotes.

The participants voted from their seats in the conference room. While the TurningPoint receiver was able to identify what each participant voted, the responses were kept anonymous to all the other participants. The results later underwent a preliminary statistical analysis, and selected results were shared with the participants during the second day of the workshop, Friday February 29th.

c. Ethics approval

The polls were evaluated and approved by the University of Saskatchewan Research and Behavioural Ethics Board: # 09-256 dated Dec. 24, 2009.

4.5 The Delphi survey: An overview

An essential part of VALGEN's platform is to understand and respond to the deep governance challenges and opportunities of applied genomics for bioproducts and crops by focusing on the core issues of intellectual property management, regulation and governance and democratic engagement. To better anticipate potential areas of research activity, a Delphi exercise was implemented. This strategic intelligence tool is an innovative way to gather information, regarding ideas and issues as they pertain to GE^{3}LS research and GE^{3}LS integration in the ABC sector, which would not be available via a more conventional form of research. Conducting a Disaggregate Policy Delphi survey is one of VALGEN's first steps towards identifying potential challenges and opportunities over the next four years.

a. Goals of the Delphi survey

An extensive literature review of the Delphi methodology resulted in the decision to conduct a Disaggregate Policy Delphi (DPD). This Delphi model is uniquely suited to the needs of VALGEN,

as its focus is to bring forward as many different well-reasoned options and alternatives as possible in order to "saturate" the idea pool. In contrast to the more conventional Delphi survey, the DPD is not intended to generate a consensus or be a mechanism for decision-making. Rather, the goal of the DPD is to ensure all possible options are available for consideration, which may then serve as an input for a variety of strategic intelligence policy tools such as scenario planning, concept mapping, and discussions surrounding policy.
The initial questionnaire was constructed to be as open-ended as possible. This was done so as to not guide the participants to any particular answer, and to also not restrict or limit any possible answer. The survey also had a benchmarking quality to it, as we were equally interested in the responses as we were in the abstentions. The more specific goals of this DPD survey were to:

- gain an understanding of how GE^{3}LS research is perceived by the ABC genomics research community;
- identify barriers and obstacles to GE^{3}LS research;
- learn about the factors that impact successful GE^{3}LS research and integration; and
- identify drivers of change that will impact GE^{3}LS issues and how GE^{3}LS research is done.

b. Overview of methodology

The Delphi survey is a validated research tool used in soliciting the judgment and opinion of a group of individuals on a particular issue, topic, or question. The Delphi is a structured form of communication between a group of individuals, which is used in place of a face-to-face meeting when such a meeting is not logically feasible or desirable. As power hierarchies and social dynamics may result in certain individuals dominating the conversation, and others repressing their thoughts, the Delphi de-identifies all responses that are shared with the participants to neutralise all answers and ensure they all have equal value.

As the purpose of the survey was to elicit views about GE^{3}LS research in the context of the Genome Canada competition in Applied Genomics in Bioproducts and Crops (ABC), the participant pool was chosen accordingly. The initial round was sent to 139 GE^{3}LS and science signatories on the 12 ABC project. Seventy-six (57%) responded to the survey.

All participants received an email with an individualized link to an electronic copy of the survey. The Delphi was conducted using the online survey tool Survey Monkey (www.surveymonkey.com). Participants were given two weeks to complete this survey, and over this time they were free to go back and make changes to their responses, even after they had submitted it.

The results were collected and underwent a primary round of coding, which is the basis for the statistical results presented below. As the DPD is an iterative process, after a more extensive analysis, the results will be circulated to all participants who completed the first round for them to review prior to completing the next Delphi survey. While participants will have the opportunity to view actual responses to the survey (in addition to the coded results), all

responses will be de-identified to protect the privacy of our participants. The next round will build on the responses from the first round, and will seek to further unpack and develop arguments around the ideas that have begun to be generated in the first round. This process of collecting, analyzing, and circulating responses will continue in each round of the DPD.

The Delphi was evaluated and approved by the University of Saskatchewan Research and Behavioural Ethics Board: # 09-256 dated Jan. 12, 2010.

c. Analysis of Delphi results (*n=76*)

When asked about the main barriers to R&D in the ABC sector, funding was identified to be the primary barrier (see Table 8). This is not a surprising result, as money is generally, to some extent, considered a ubiquitous problem as scientific research tends to generate high costs. An interesting point is that "public perception" was also identified as a major barrier, as was regulation, governance and policy. Another point of interest is the range in answers in response to this question. Being a Disaggregate Policy Delphi, there is value not only knowing what the greatest number of people perceived to be the largest barrier, but to note all responses and the variety between them. What is not presented by these statistics is the relationship between the responses. For example, is public perception a barrier because the lack of public acceptance of this research results in a lack of funding? Or does the lack of funding result in neglect of research areas that are important to building public trust, such as long-term effects of consuming GMOs? As the Delphi progresses, answers to these and other questions will be sought in greater depth.

Table 8: What do you think are the main barriers to research and development in applied genomics in bioproducts and crops (please cite up to three barriers)?

Answer Options	Response Percent
Funding	24%
Public Perceptions	22%
Regulation/Governance/Policy	18%
Industrial structure	8%
Scientific barriers	8%
Highly Qualified People	7%
Intellectual Property Rights	7%
Economics	3%
Environment	2%
Ethics	1%

Another topic explored by the first round of the Delphi was the major GE^{3}LS issues related to the ABC sector (see Table 9). The respondents identified regulation, scientific barriers and public acceptance as the three most pressing challenges to ABC research.

Table 9: What are currently the most important GE^{3}LS issues related to applied genomics in bioproducts and crops (ABC)? Please provide reasons for your answers.

Answer Options	Response Percent
Regulation/Governance/Policy	22%
Economics/Industrial Structure	20%
Public Perceptions	19%
Intellectual Property Rights	16%
Environment	12%
Scientific barriers	7%
Ethics	3%

When asked how to resolve those barriers, funding did not come up as a barrier to resolving the major GE^{3}LS issues, as it did with the scientific side of ABC research. This suggests that while there is a need for research funding, money itself is not an adequate solution to resolving the issues. This result may also reflect the fact that ABC scientific research itself tends to be very high cost, whereas this may not be the case in GE^{3}LS research. This point will be pursued in the next Delphi round.

Table 10: What are the most important barriers to resolving the most pressings GE^{3}LS issues described in the previous question? Please provide the reasons for your answer.

Answer Options	Response Percent
Regulation/Governance/Policy	29%
Public Perceptions	24%
Intellectual Property Rights	16%
Economics	9%
Industrial Structure	9%
Money	5%
Environment	5%
Ethics	3%

Finally, respondents reported that communication is the most significant factor in ensuring successful GE^{3}LS integration—48% of respondents cited communications as the key indicator of success in the Delphi. Several respondents asserted that to have successful communication between science and GE^{3}LS there needed to be a common understanding of each other's "languages." This implies that merely being on the same project does not entail integration.

5. The Outputs

5.1 A Summary of the Discussion

A significant amount of time during the workshop was dedicated to discussion about the barriers to ABC research and innovation. Key issues of intellectual property management and technology transfer, regulation and governance, and democratic engagement emerged from the discussion. The requirement for communication with multiple actors across all three theme areas was a frequent topic of discussion.

Intellectual property and technology transfer were the main topic of discussion. Workshop participants were interested in investigations of alternative IP strategies, especially where some discoveries may only be partially or not at all protected by patents. Concerns were raised that if discoveries are not patented, companies will lose motivation to invest in new technologies due to reduced return on investment or another country will benefit from Canadian investment. It was suggested that revenue generation is not the only metric of success. Other metrics include improved quality of life, innovation, or knowledge generation. Metrics of success and the type of discoveries will guide the appropriate IP strategies. There is clearly a need for some sort of guidance document/methodology to assist in choosing the appropriate IP strategy on a case-by-case basis. Technology transfer issues were also a major topic of discussion. Concerns were raised that there is little incentive for businesses to be the innovators during the initial stages of their business model. One participant suggested that there is an absence of market pull for genomics-based technologies, especially in Canada. The general consensus was that new business models which promote innovation and commercialization should be evaluated.

Regulation was also a main topic of discussion. Although most participants were aware of the need for regulation, it was portrayed as a barrier to innovation. Two specific concerns were the lack of knowledge and trust amongst regulators and researchers and the current process of policy creation and translation to regulation. One participant suggested building of trust with regulators using governance models which include consultation and communication. Another suggested co-ordination of policy making procedures to include diverse actors. All agreed that regulatory community involvement in research and commercialization is advantageous, and that a complete overhaul of the current regulatory system may not be necessary. One technical issue, the assessment of novelty and its use as a regulatory trigger under §2.1 of the *Assessment Criteria for Determining Environmental Safety of Plants With Novel Traits* generated significant debate about how new products might most efficaciously and efficiently be introduced. [4]

Democratic engagement was also discussed. Concerns were raised that engagement is not often performed with marginalized populations. Moreover, engagement processes need to be

[4] Canadian Food Inspection Agency. 2004. Assessment Criteria for Determining Environmental Safety of Plants With Novel Traits. Directive 94-08 (Dir 94-08). Available at: http://www.inspection.gc.ca/english/plaveg/bio/dir/dir9408e.shtml.

expanded to more effectively engage regulators, policy makers, and judiciary. Also, some concerns were raised regarding non-government organizations (NGOs)—while understanding the perspectives and beliefs of NGOs and the public may be a reasonable first step to moving forward, it does not necessarily always move towards a common understanding. While discussing the issues surrounding IP and TT, regulation, and democratic engagement, communication became a common and universal theme. Participants identified the need for better communication with and between many actors, including patent lawyers, technology transfer offices, regulators, policy makers, the judiciary, NGO's, the public, and the end-users of the technology. The attendees suggested that VALGEN could lead the communication and branding efforts on behalf of the ABC scientists and GE^{3}LS researchers.

5.2 Polls Results

a. Poll #1: Social Media

The results of poll #1 indicate that both GE^{3}LS and science researchers use social media--Facebook is the most commonly utilized social media tool. When asked which social media tools would be most preferable for VALGEN to use, the most popular results were Wiki and Listserve. There is also an interest expressed in blogging, which – for the time being – may be best fulfilled through VALGEN's continued production and circulation of policy briefs. A "lack of time" and the fact that many of these tools are "not widely used by … peers" were identified as the primary barriers to use of social media by both GE^{3}LS and science researchers. These were the only two barriers cited by the science researchers (as seen in Figure 12). The discussion suggested VALGEN could get value by implementing 'quick and dirty' tools such as Really Simple Syndication (RSS) feed, Twitter, and establishment of a listserve—tools that offer the user access to new information at a low cost in terms of time.

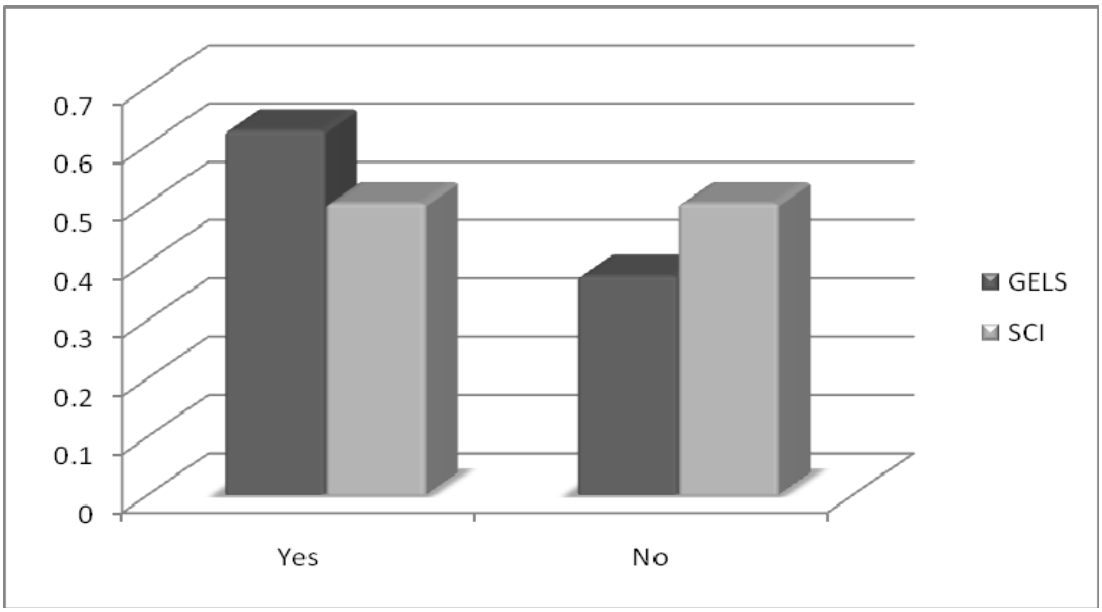

Figure 9: Do you use social media?

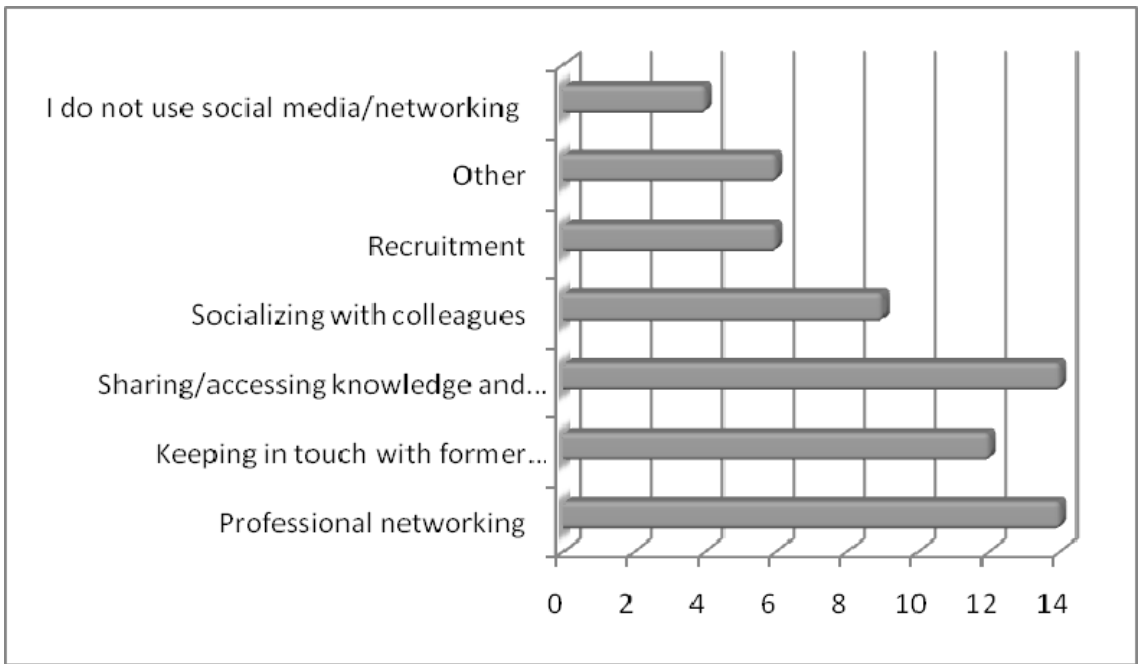

Figure 10: For what purpose do you engage in social media/networking?

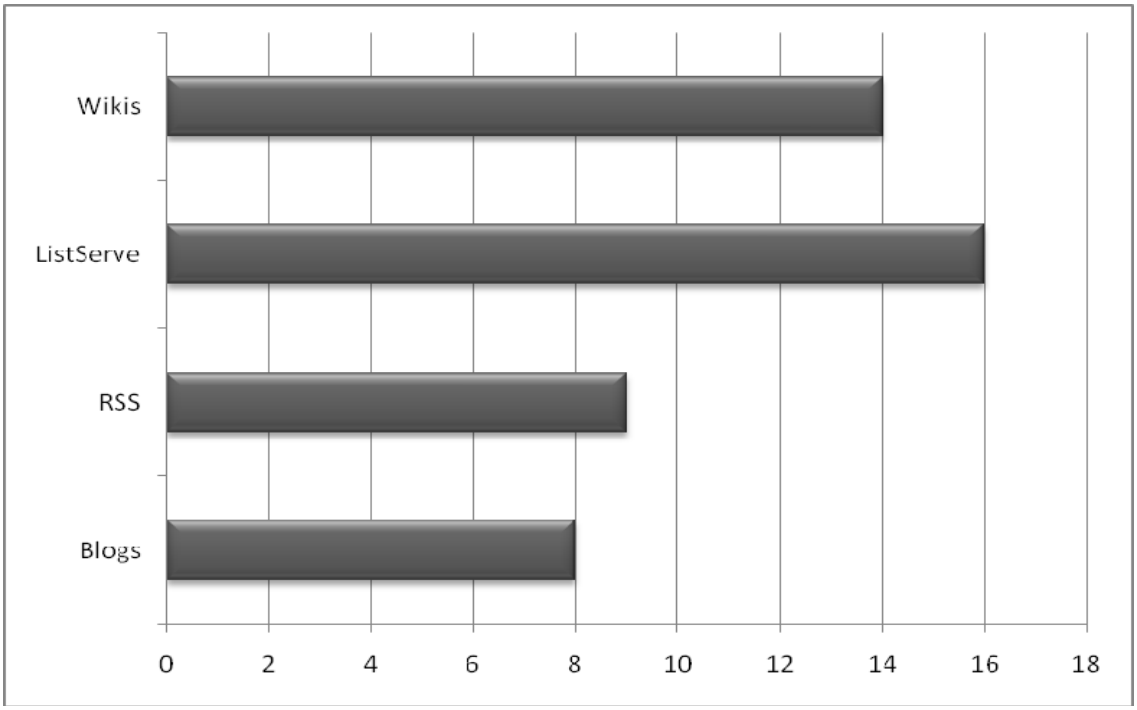

Figure 11: If VALGEN provided an online social networking tool for GE^{3}LS research, what would you most like to see? (#)

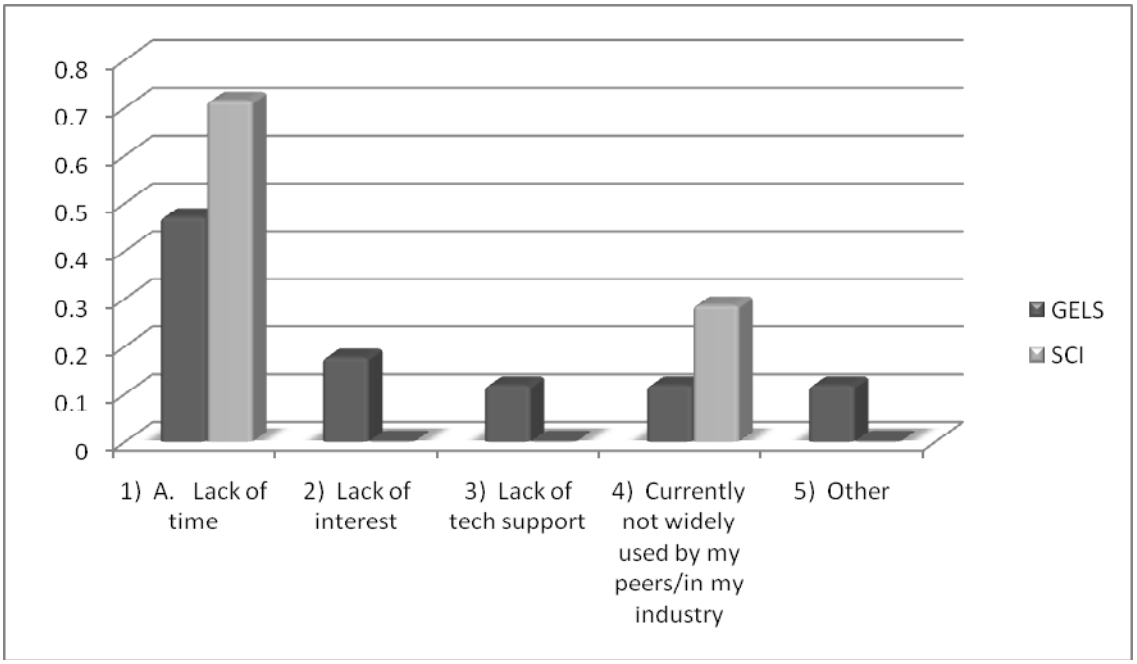

Figure 12: What do you see as barriers to the use of social media tools (%)

b. Poll #2: Integration

When queried about awareness of GE^{3}LS prior to the ABC competition, 55% science researchers and 20% of GE^{3}LS researchers responded 'no'. This suggests that the term GE^{3}LS, and possibly the nature of GE^{3}LS research, may not be known to researchers outside the Genome Canada community. Interestingly 35% of both science and GE^{3}LS researchers had worked with their counterparts prior to the ABC Competition.

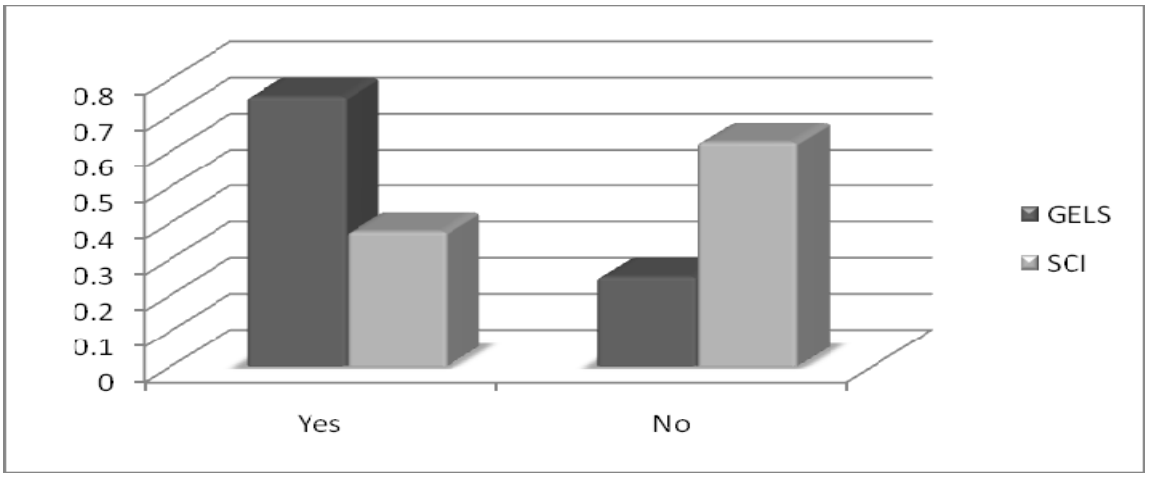

Figure 13: Did you know what GE^{3}LS was prior to the Genome Canada ABC Competition? (%)

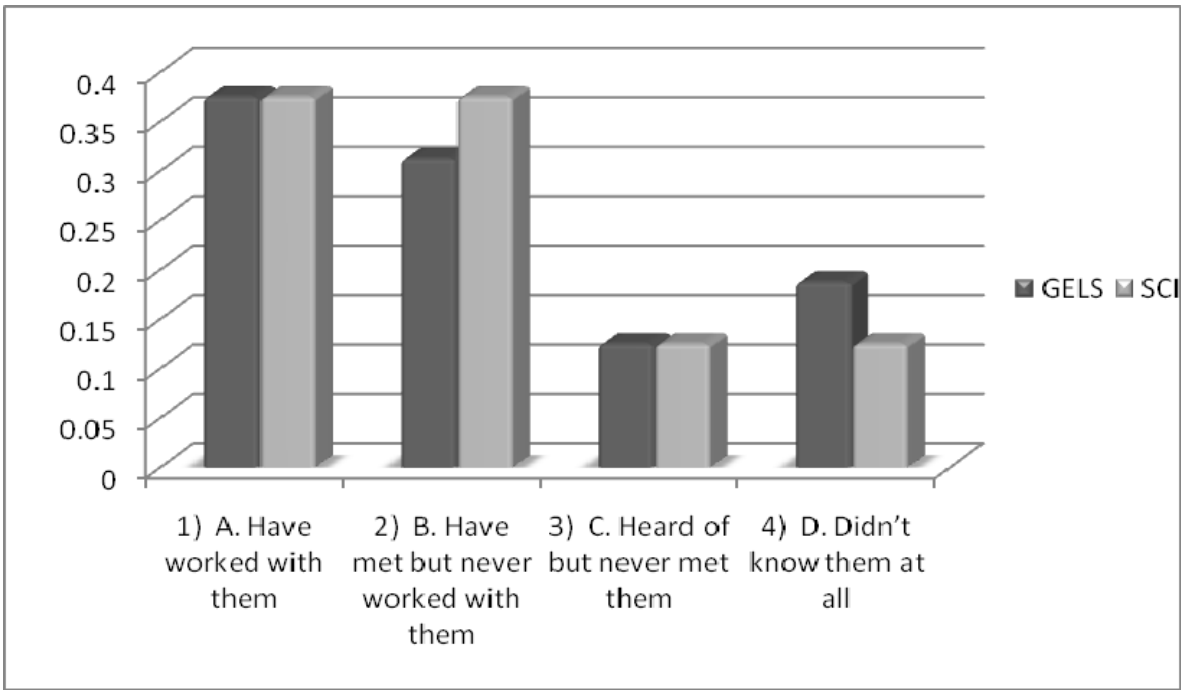

Figure 14. Did you know your project GE^{3}LS or Science counterparts prior to submitting your Letter of Intent for the GC ABC competition? (%)

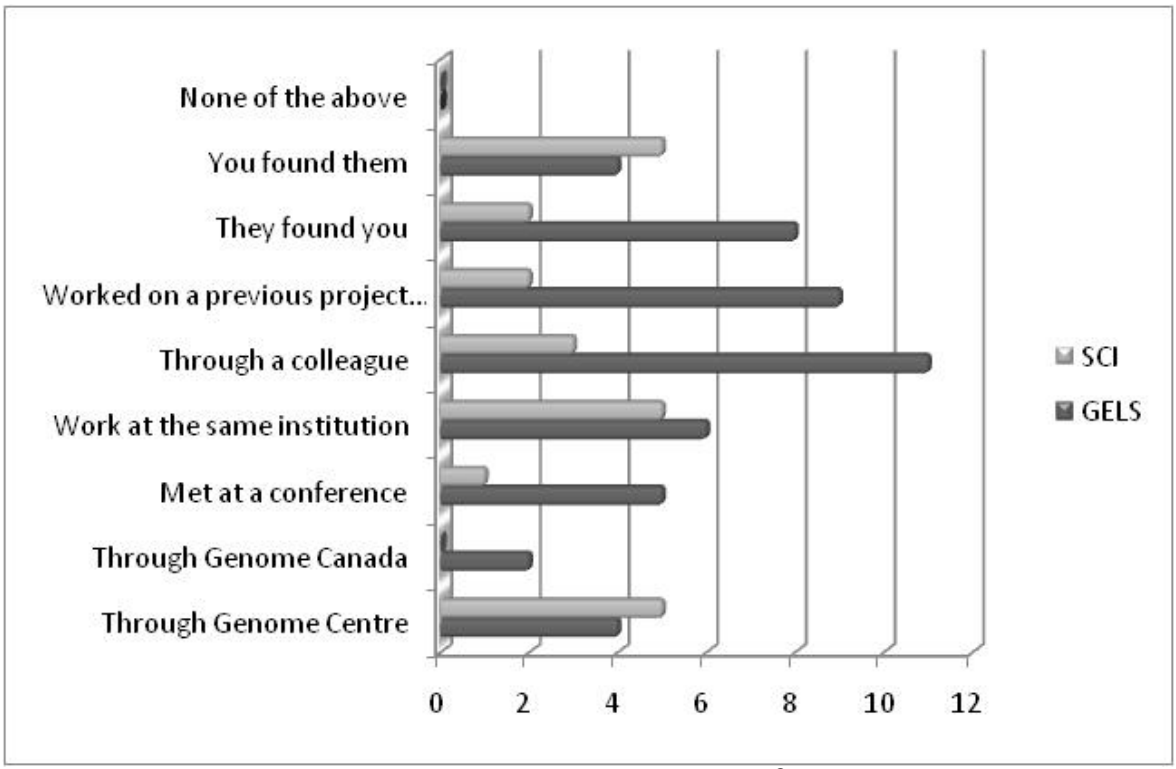

Figure 15: How did you and your science/GE^{3}LS counterpart come together to formulate your project? (#)

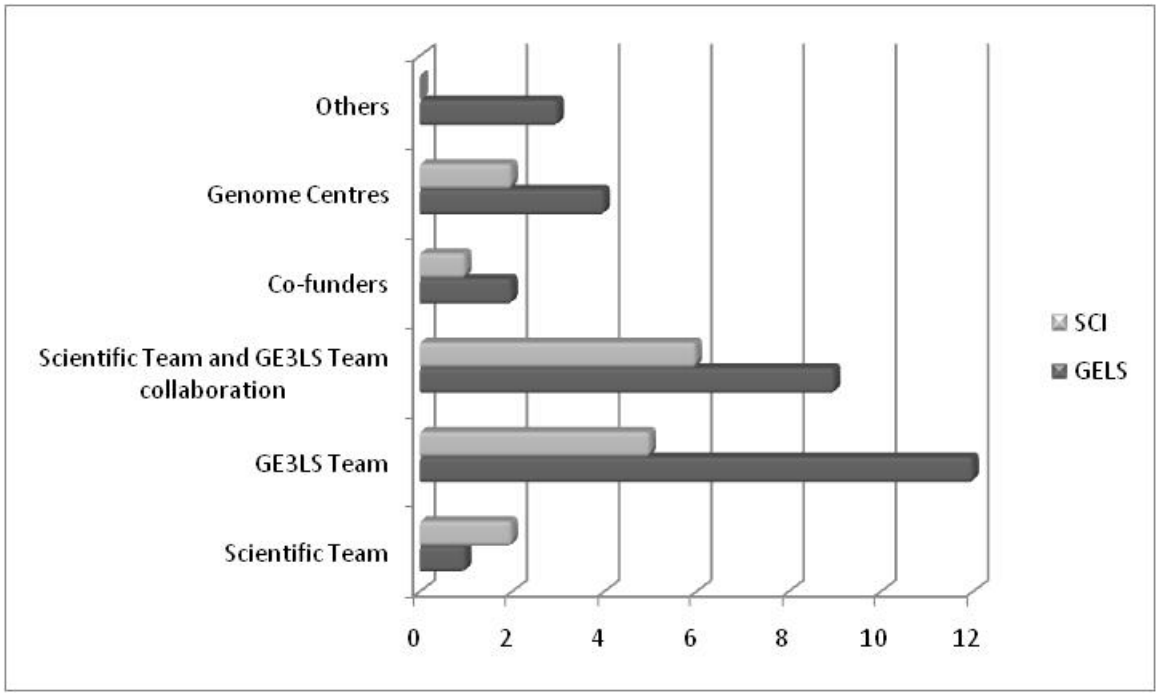

Figure 16: Who identified the scope and method of the GE^{3}LS research? (#)

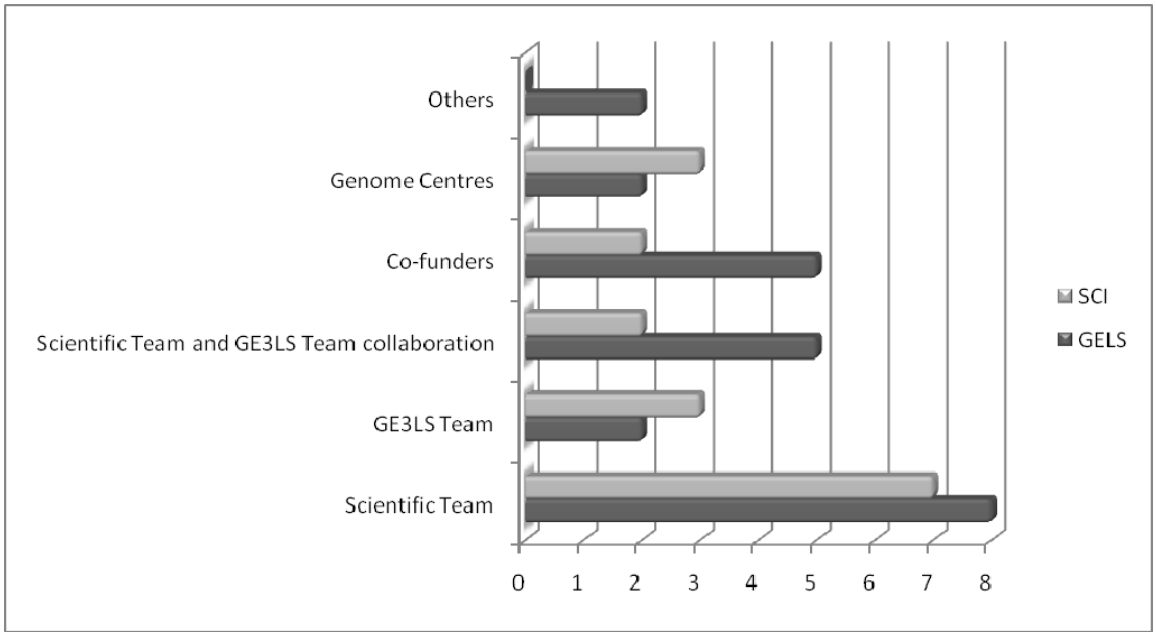

Figure 17: Who identified the scope and method of the science research? (#)

With respect to how projects were formulated, a high number of GE^{3}LS actor responses revolve around "networking" efforts, such as talking with colleagues and previous work experience. This suggests an important role for networks (working relationships, second order relationships and institutional connections). In contrast, science researchers tend to 'seek out' GE^{3}LS counterparts. For both GE^{3}LS and science, the Genome Centres appear to be an important catalyst for science to non-science relationships, although this catalyst was cited as being more important to the science researchers.

In terms of activities, GE^{3}LS researchers have been more active in public advisory processes, public engagement, and in talking with regulatory bodies while scientists appears to be more active in 'task related' activities (such as negotiating MTAs and licensing). This latter science-related observation appears to be in accordance with the tasks generally required of these researchers.

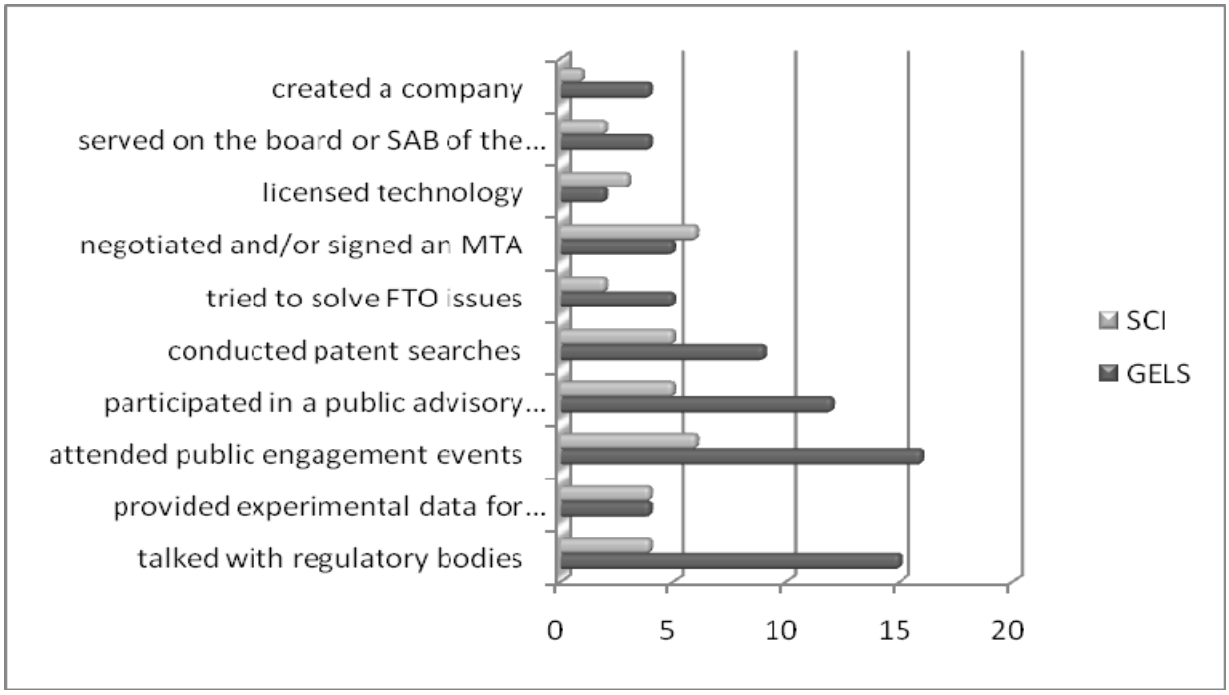

Figure 18: Have you done any of the following? (#)

Generally, the solitudes between the science and GE^{3}LS communities are not as high as some might suspect. The scholars in the ABC science projects reported that both the GE^{3}LS investigators and collaborations between the science/GE^{3}LS team helped to identify the key GE3LS issues to investigate; meanwhile, most of the respondents reported that the science team led in identifying the scope and method of the science research.

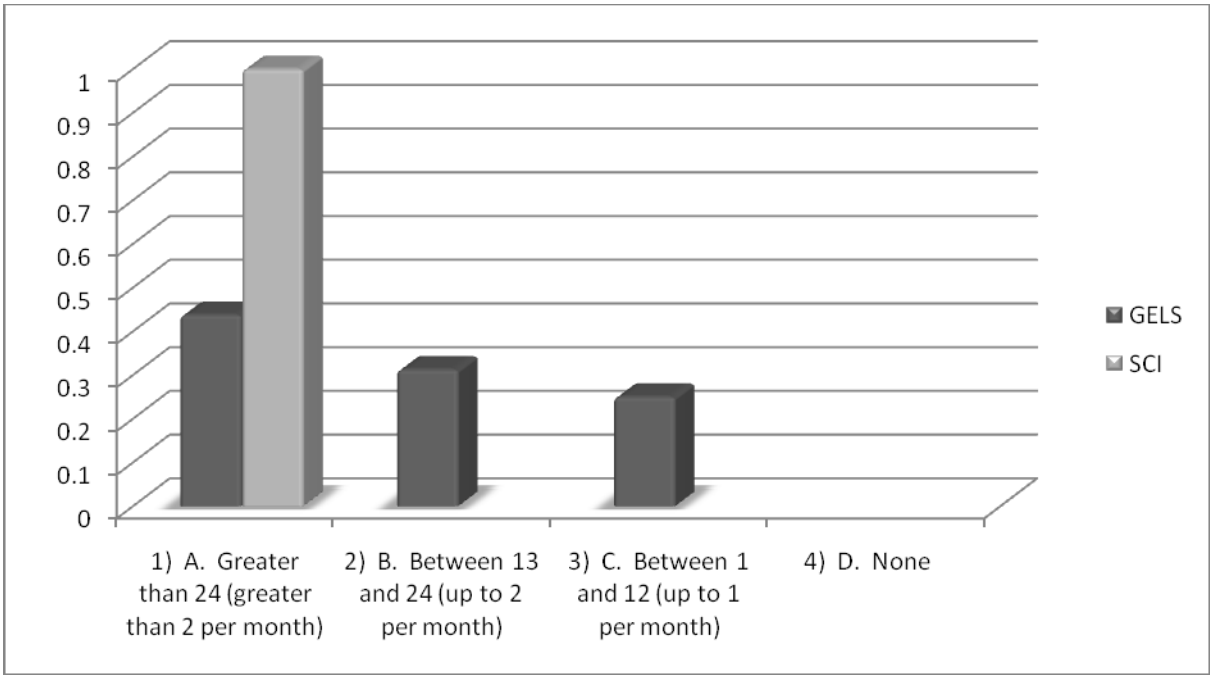

Figure 19: How many science-based articles do you read per year? (%)

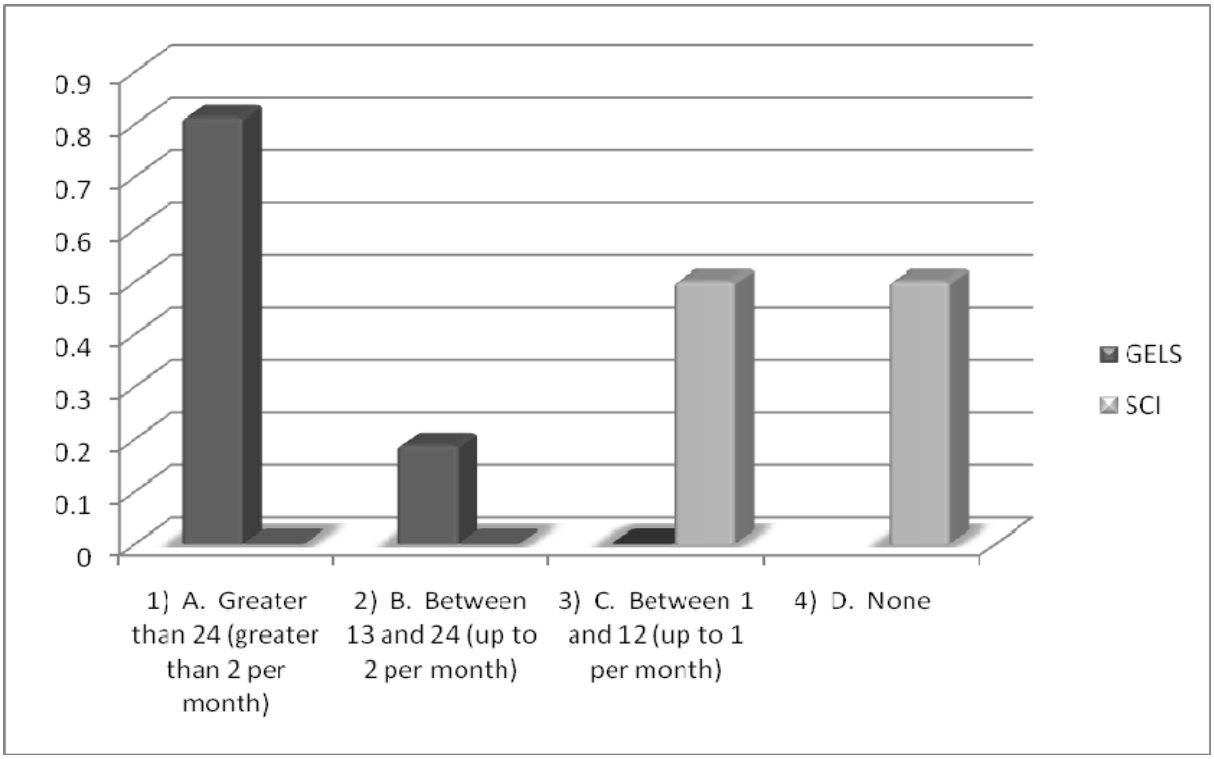

Figure 20: How many social science articles do you read per year? (%)

One reason might be because of the different research strategies of the two communities. We learned that GE^{3}LS researchers read far more science articles than science researchers read social science articles (100% of science researchers reported reading 0-12 social science articles per month, whereas, approximately 70% of GE^{3}LS researchers reported reading over 24 science articles a month). It seems that while the GE^{3}LS community may be more educated on science issues than vice-versa, the relationship between the two appeared to be more geared to the needs of the science portion of the research. This may be indicative of current integration practices. Based on these findings, it appears as though the current integration model is to 'tack on' GE^{3}LS initiatives to a pre-existing scientific endeavour, rather than a purely collaborative approach or having science adapt to GE^{3}LS research.

The results of the Delphi indicated that communication appears to be the most significant factor in ensuring a successful GE^{3}LS integration. Several comments were made to the effect that in order to have successful communication between the science and GE^{3}LS counterparts, there needed to be a common understanding of each other's 'languages'. The interactive polls indicated, however, that while 100% of the science researchers answered that they read at least 24 science articles a year, 50% of them answered that they did not read any social science articles at all (the other 50% responded as reading 1-12 articles a year). There was a similar, but less dramatic, trend with the GE^{3}LS personnel. Where 100% of the GE^{3}LS researchers responded that they read at least 13 social science articles a year, only 70% read at least 13 science articles a year. This either identifies a need for science actors to begin to read more social science articles in order to improve communication with their GE^{3}LS counterparts, or that reading journal articles is not the best way to learn the language of other disciplines.

c. Poll #3: Communication/Knowledge Sharing

Science researchers tend to identify more "sheltered" exchanges of knowledge/communication (i.e. in-house) while GE^{3}LS researchers favour more broadly disseminated knowledge strategies (including web-mediated sharing, sharing of papers, etc). In terms of key outreach activities, GE^{3}LS researchers most often identify working with NGOS and undertaking policy briefings while science researchers appear to favour interviews with media and public lectures.

When queried about strategies for dissemination of information and knowledge external to the project, GE^{3}LS and science researchers agree on the importance of academic conferences and peer reviewed publications. GE^{3}LS researchers view web-mediated sharing and websites as key dissemination tools while science researchers see databases and repositories as most useful. It is interesting to note that GE^{3}LS researchers value media and interviews as a key dissemination tool, suggesting that they view the downstream public as direct recipients of knowledge dissemination without limiting dissemination to academic peers. Involvements with the media or interviews were not a priority for scientists. GE^{3}LS researchers also regard patents as a knowledge dissemination tool, while science researchers tend to think of them more in terms of protecting, rather than disseminating, knowledge.

In reference to integrative outputs, science and GE^{3}LS researchers agree that peer reviewed integrated publications/reports, joint panels/papers at conferences and talks or panels at public conferences are the most important.

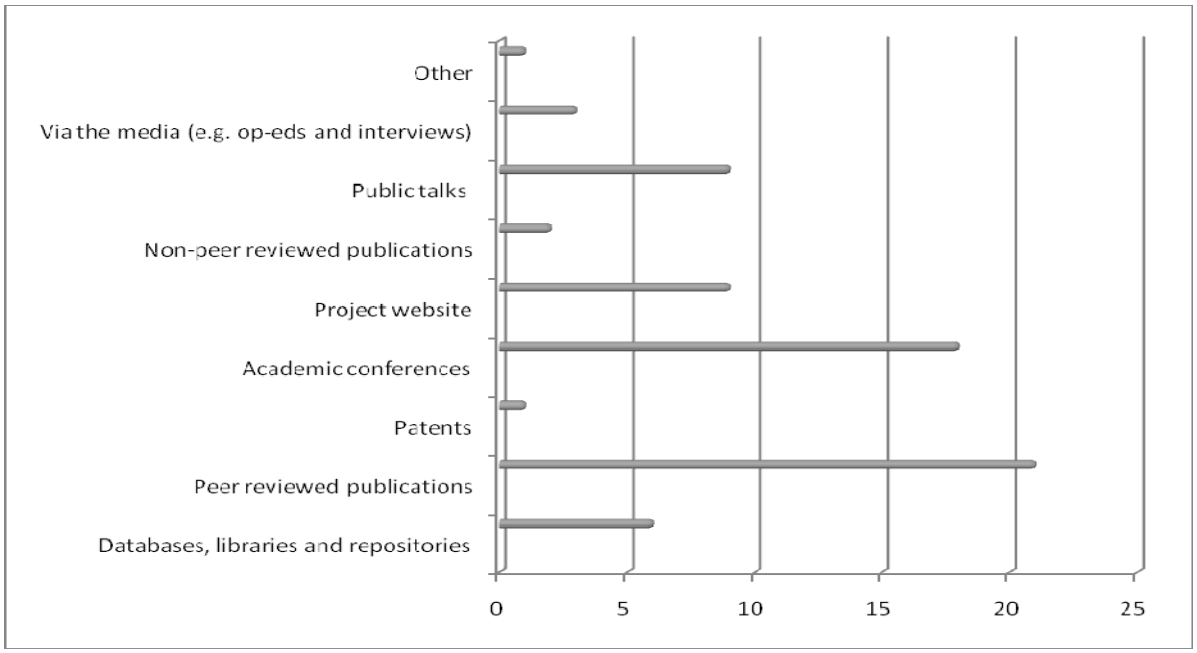

Figure 21: What are the three most important ways your project plans to disseminate your research results to those outside your project team? (%)

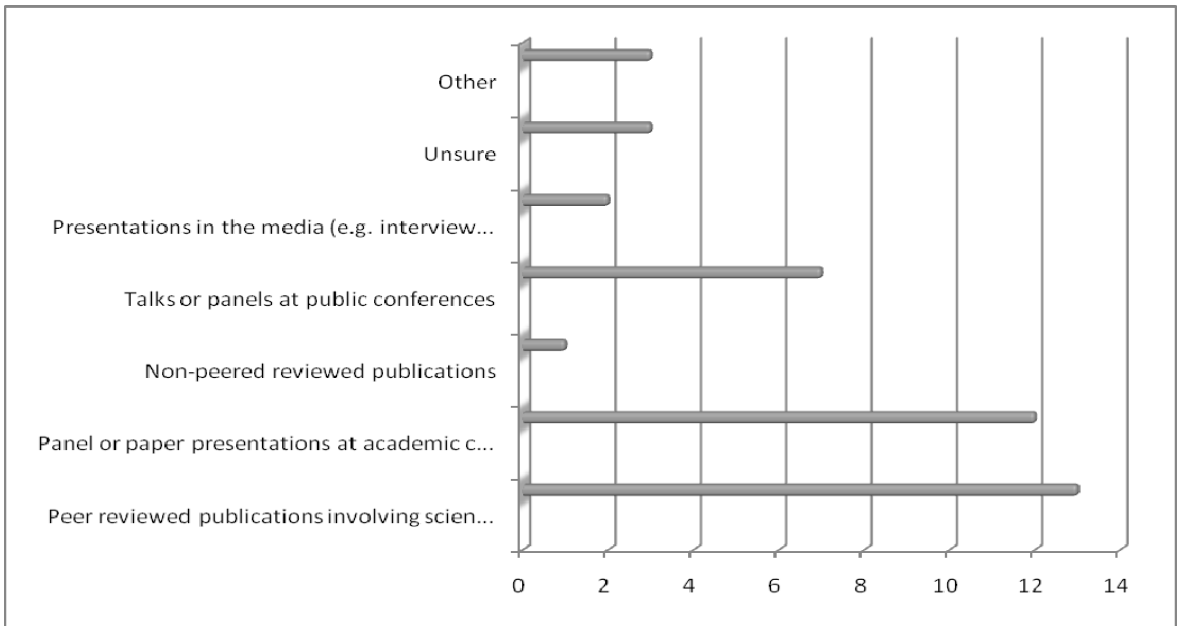

Figure 22: In your project, what key outputs do you expect to produce that integrate the science and GE^{3}LS produced in your project (#)?

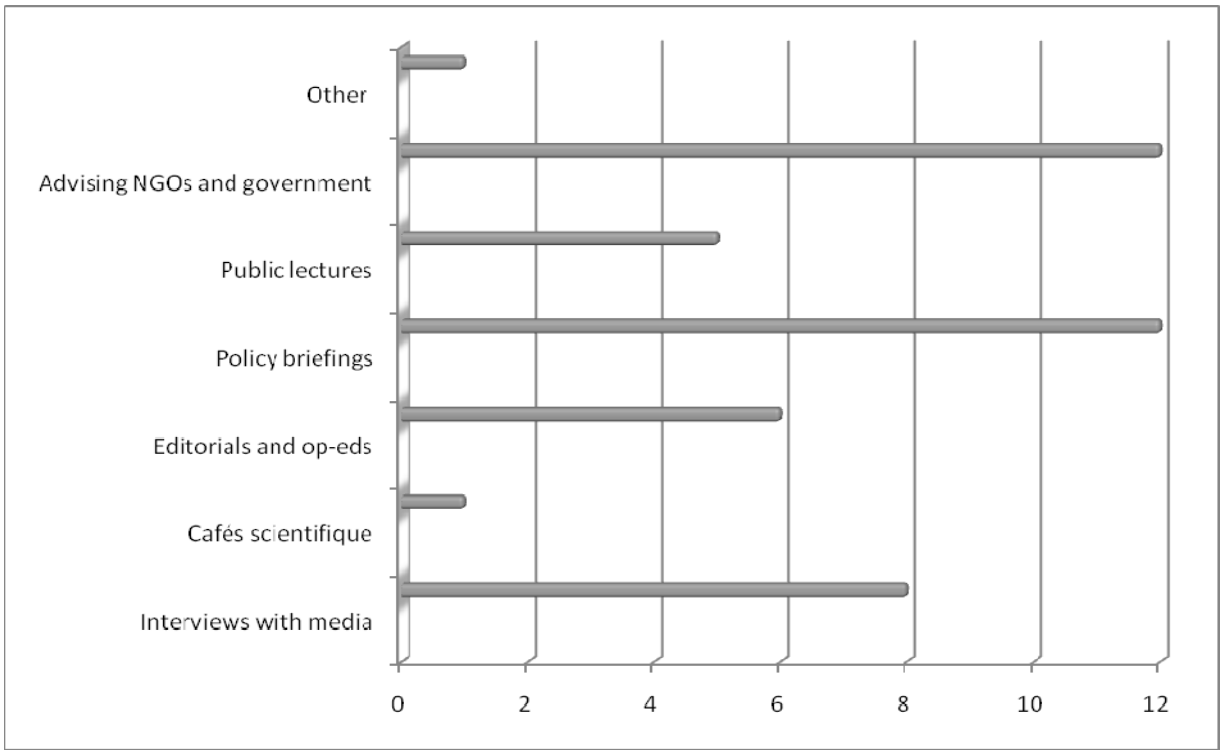

Figure 23: What two outreach activities do you think offer the most important impact (#)?

As for VALGEN-mediated alliance building activities that would be considered of the highest value to researchers, GE^{3}LS and science researchers were generally in agreement. Workshops or conferences, team building for joint projects and grants and providing a clearinghouse for data and people were deemed valuable. There was also some interest in development of fora to reach decision makers. Facilitating joint responses to policy issues was deemed less valuable. While public perception was overwhelmingly identified as a barrier to both science and GE^{3}LS ABC research in the Delphi, the results of the interactive poll indicate that researchers may not be planning to disseminate their research in a way which effectively communicates with the publics. In the poll question that asked, "What are the three most important ways your project plans to disseminate your research results to those outside your project team?" the results were not consistent with the concerns expressed in the Delphi. Probably not surprisingly, the answers with the greatest votes were academic conferences (26%) and peer reviewed publications (30%). Dissemination avenues that directly involve those outside the ABC research community, government and industry made up less than 20% (13% answered public talks and 4% answered the media). Given the way the field operates, conferences and peer reviewed publication would be among the most important ways to disseminate research, but since participants were asked to select the three most important ways, it is surprising that methods which engage the public were so undervalued.

Table 11: Which of the following alliance-building activities would add the highest value to GE^{3}LS in the ABC space

Actvities	Highly Valuable (%)	Valuable (%)	Not Valuable (%)
Workshops	63	25	13
Build teams	54	29	17
Clearing house	21	71	8
Policy response	45	32	23
Forums	39	52	9

The Delphi identified regulation/governance/policy to be major barriers to both science and GE^{3}LS ABC research, which was reflected in the polls. When asked, "What two outreach activities do you think offer the most important impact?", "Advising NGOs and Government" (27%) and "Policy Briefings" (27%) made up more than 50% of the responses.

5.3 Workshop outcomes related to the workshop goals

a. Goal #1: Bring ABC community together for the first time

The workshop took place and eleven of the twelve ABC projects were present. Participants indicated that they felt there was value in bringing the leads from the projects together. A number of participants expressed enthusiasm that this network and community should stay connected over the next four years. One participant asserted: "...this presents a unique opportunity to bring together the best minds in genome science as it relates to ABC… and if we can develop a unified voice with VALGEN taking the lead and at the end of four years developing some policy work."
One follow-up item suggested was that the ABC community should plan to respond to certain issues as a unified group.

b. Goal #2: Share cross-project information

The round table introductions and project summaries allowed an opportunity for members of all projects to learn about the other projects in the ABC competition. The desk analyses of the scientific and GE^{3}LS research activities provided another opportunity to examine the 12 projects. Questions were by those at the meeting about both the scientific and GE^{3}LS components of the projects.
One early follow-up is that a number of the science leads indicated that they would continue the conversation about the synergies between their projects.

c. Goal #3: Identify opportunities for, and barriers to, ABC genomics research

The Delphi survey prior to the workshop asked participants to identity opportunities for, and barriers to, both science and GE^{3}LS research within the ABC community. In open discussions at the workshop further opportunities and barriers were discussed in detail (see section 5.1). Project leaders were able to share commercialization success stories during the discussion period and provide advice to those who have not experienced the commercialization barriers, especially related to dealing with regulatory authorities.

d. Goal #4: Share best practices regarding GE^{3}LS integration

Discussion took place around GE^{3}LS integration, which allowed participants to share their experiences with different forms of integration. During the round table discussions, three projects (VEGI, Genozymes, and BEEM) noted that their iGE^{3}LS research will assist in shaping the scientific research and vice versa.

A number of opportunities were identified to improve our integration practices:

- Broaden public engagement to the end-users of the products.
- The participants suggested that there is a need for training/education opportunities for GE3LS researchers to learn the genomics science, and vice versa.
- Scientists are not currently being asked to review articles on GE3LS issues they have expert knowledge of, such as policy and intellectual property. Increasing their engagement would be a good to improve integration.
- There was some interest in VALGEN acting as a interdisciplinary information clearing house.
- Some suggested that a key part of integration lies in understanding others; there was a suggestion that VALGEN might spearhead the development of a lexicon of common social science and science terms.
- There was some interest in webinars between science and GE^{3}LS new researchers to help promote interdisciplinary collaboration.

e. Goal #5: Structure relationships between VALGEN and S&T projects

There was significant discussion around the specific role that VALGEN might take. Possible areas for collaboration between VALGEN and some projects were identified and discussed. Several suggestions were made on how VALGEN can add value to the scientific projects, including:

- expanding the stakeholders involved in dialogue regarding future barriers (to government, ministry, farmers etc);
- producing communications products;
- conceptualizing barriers and blockages and then identifying what new business models will look like;

- acting as a storing house in respect to soliciting and storing GE^{3}LS related elements that all projects will need;
- managing a website platform that makes available to all the participants details of their work so that synergies can be created more easily;
- focusing explicitly on commercialization;
- engaging ethanol producers and helping them find a path through the commercialization process; and
- broadening public engagement to the end-users of the products.

Table 12: Summary of action items resulting from the workshop

Action	Status (1/3/10)
1. Sustain communication by circulating e-mail addresses of the attendees, publications and websites of interest	Complete
2. Plan a process to respond to policy issues as a unified group	The VALGEN team is presently working on a response to the Nuffield Report on Biofuels in collaboration with David Levin and Hank Venema
3. Follow-up with Terry McIntyre regarding the GRDI Annual Performance Report	Complete and circulated to participants
4. Create a space to connect the 12 ABC projects on the VALGEN website.	In progress
5. Create and circulate a list of interdisciplinary journals where scientists and GE3LS researchers can publish together	In progress
6. Create and circulate a list of events where end-users and industry can be engaged	In progress
7. Engage government, industry, policy makers in further discussion	SIGNET (Genome Prairie's WED Network) event planned for April 29th, 2010
8. Develop a Communications and Branding Strategy in the ABC space	In progress
9. Plan a first collaboration among the iGE^{3}LS community (possibly parallel case studies, methods evaluation, foresighting)	In progress
10. Evaluate opportunities to establish a consultancy for one or all of the stakeholder groups identified during the workshop.	In progress

Appendix 1: Agenda

Thursday, January 28th	
8 am	Breakfast (Hawthorne C)
8:30 am	Roundtable introductions (Hawthorne A/B)
8:45 am	Introduction to VALGEN and workshop goals
9:30 am	Discussion
10:00 am	Break
10:30 am	Science and integrated GE^{3}LS projects overview
12:30 pm	Lunch
2 pm	GE ^{3}LS integration in theory & practice
3 pm	Break
3:30 pm	Discussion
5:30 pm	Break
6:30 pm	Dinner (Primrose Restaurant)
Friday, January 29th	
8 am	Breakfast
9 am	Presentation of survey results
9:30 am	Discussion and future directions
11:30 am	Lunch
1 pm	Departure