



**2012 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
GENOMICS FEEDING THE FUTURE
PRE-APPLICATION
GENOME BC REVIEW FORM - EXTERNAL REVIEWER**

Project Leader(s): Rieseberg and Burke

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Section I: Summary of the Project

Summary of the project : The summary should be able to stand alone. It should clearly articulate the following points in a cohesive and coherent story:

- Context: Is the problem/issue/ opportunity clearly articulated?
 - Is the scope and scale of the problem in Canada clearly evidenced in appropriate economic and societal terms?
- Research Plan: Will the proposed research address the problem/issue/opportunity?
 - Are the right scientific methods / technology being deployed and applied?
 - Does the research plan integrate appropriate GE3Ls research or methodology?
 - Does the research team contain the expertise and capacity to execute the research plan?
- Are the expected deliverables clearly articulated?
- Are the anticipated social and or economic benefits clearly articulated?

This doesn't sound particularly compelling to me. I get no indication of the size of the issue (economically and socially) nor the effect that the research will have on the issue. Yet, when I read the Research Proposal I could see that this could be an exciting project. That excitement needs to be duplicated in the Summary.

Is sunflower being used as a model system for all oil seed crops or is it being used to improve sunflower cultivation (or both – in SEB section it seems to be this)? State whichever is the correct answer. Whatever the answer, there must be some \$ figures involved with the issues and \$ figures involved in improvements. In the Research Proposal you state that “Sunflower is one of the world’s most important oilseed crops, with production valued at ca. \$20B/year”; this should also be mentioned in the Summary as it puts sunflower into perspective with some of the other crops for which GC funding is being sought. Also, that it’s a global priority food. And it’s importance to Canada and the issues for Canadian production such as you’re indicated in the SEB section “Currently, the main challenges for sunflower production in Canada are salt and flooding tolerance, although low nutrient and drought resistance are likely to become increasingly important in the future as marginal lands are brought into production and as the southern prairies become warmer and drier”. And the potential for new sunflower strains to be used in currently unused marginal land bringing in \$1B/yr.

There needs to be a sentence stating how the team are leaders in sunflower genomics and contains end-users that will be able to translate the findings to the “market”. You mention in the Research Proposal that you were involved in creating many genomics resources (even in sequencing the sunflower genome?) – that info is needed here. There are an impressive number of end users involved in the project and this should be emphasized.

There needs to be a brief description of how the deliverables will be used to produce social/economic benefits.



Section II: Research Proposal (including Science and GE3LS)

- Research Context and Originality
 - To what extent does the proposed research lead, extend and/or complement national and international work in the area?
 - To what extent does the proposed research reflect creative, original thinking?
 - To what extent is the research relevant to the end-users identified?
- Research Plans and Execution
 - How appropriate are the methods and approaches proposed (including handling of data and resources) in terms of the research objectives?
 - How feasible is the research, given the projected resources and timelines?
 - How suitable are the available facilities, equipment and services?
 - Does the GE3LS research address the most salient aspects of the project and is it closely related to the overall project's objectives, deliverables and potential social and/or economic benefits?
 - Is the integrated GE3LS research plan closely aligned with, and complementary to, the overall project milestones?
 - Is the GE3LS research plan sufficiently robust and systematic to advance generalizable knowledge in relevant academic fields?

This isn't bad but I think it could be made clearer as indicated below.

You state "Sunflower is also an important ornamental crop and source of confectionery seeds – the main focus of Canadian production." – can you put a \$ number on this?

In Figure 1, it looks as if there will be 3 different silos of research which will yield different types of results as listed in the outcomes/ deliverables. Is this correct or do any of the results from the silos actually inform the other silos or feed into them? Surely there must be some relationship between the silos? Otherwise, it looks as if you are trying to obtain funding for 3 different projects. If these truly are separate, then which silo produces which outcome/ deliverable? And then, how do these deliverables interact to actually improve sunflower production? Incidentally, it seems to me that there are too many deliverables and many of these are maybe milestones en route to one or 2 main deliverables. So, e.g., in the final section of the Research Proposal, you list 9 deliverables. But I think the key one is #7 – germplasm that will be used by breeders *worldwide* (to incorporate the GE3LS data) to produce better sunflower. All the others are components to reach that end. And, if they aren't, then what are they for? If #7 is the key, then I think the whole proposal needs to be re-focused towards reaching that deliverable and its realization in terms of major benefits. This will certainly address the evaluation criterion of "To what extent is the research relevant to the end-users identified?"

In Activity 3, it seems as if a key outcome is "RIL availability by year 3 of the project". What is RIL? Also, this activity seems to be the one where end-users are heavily involved and where the deliverables will be useful in actually improving sunflower productivity. On the other hand, Activities 1 and 2 sound more like the production of more basic data (although from the SEBs, #2 is also intended to go straight to users). If this isn't the case, and the data produced in 1 and 2 will allow 3 to happen, then this should be made very clear. I emphasize this as these are supposed to be applied projects so we need to clearly show that they are applied.

Also, I am assuming the genes targeted in Activity 4 are those identified in the other 3 activities. This needs to be made clear. I mention all this because I think there needs to be a good story about why each of the components of the research are important and how they all link up.

I don't think the text for Activity 5 is well structured. I was reading the first paras on the Treaty and thinking, "why is this relevant?" Further down you state "The goal of the GE3LS research is



to work with the project team to develop strategies on how to access and utilize plant genetic resources in a way that facilitates research while ensuring ready uptake by breeders and industry.” This presumably is why it’s relevant. But there needs to be a lead into this – either the project can’t be completed without access to international genomic resources or the benefits of the project can’t be realized without complying with the Treaty or both. If any of this is true then the GE3LS component is vital and that should be made clear. However, if the aim of the project truly is “to use the project as a case study for navigating and resolving the ambiguities in the CBD and Treaty.”, then this isn’t a really important or integrated part of the project. But, from my reading, I think the GE3LS will be important to realizing the benefits and the text should be spun as such, with the case study aspect as an additional academic benefit. If this is correct, then it definitely addresses evaluation criteria:

- Does the GE3LS research address the most salient aspects of the project and is it closely related to the overall project’s objectives, deliverables and potential social and/or economic benefits?
- Is the integrated GE3LS research plan closely aligned with, and complementary to, the overall project milestones?

Other:

The following evaluation criteria could do with being better addressed:

- To what extent does the proposed research lead, extend and/or complement national and international work in the area?

You point out on p 8 that you have developed lots of resources – does this mean you are all global leaders in the field? If so, say so. Will you be building upon other people’s work too?

- How feasible is the research, given the projected resources and timelines?

I didn’t see anything about the risks of what you’re doing or its feasibility. Please add a sentence about that.

- How suitable are the available facilities, equipment and services?

Are you going to use in-house resources or contract out? If the latter, indicate who the provider will be. If the former, say so.

Section III: Project Team

- How appropriate is the expertise and track record of the research team in terms of realizing the research goals?
- How appropriate is the expertise and track record of the team that will further develop and implement the strategy for realizing benefits?
- How well will different types of expertise be integrated?

I think additional info needs to be added here. Whether you co-wrote the proposal isn’t particularly important. What is important and missing is some info on project management. Who will be managing what? Who will have overall responsibility for management and has he got a lot of experience in that? How will he ensure integration of all the components?

Also, I think it better not to say “expertise” in a field, but that they will be conducting that part of the research and have a good track record in the field (see evaluation criteria above).



A key component is whether you have the expertise on board to realize benefits. You have lots of end-user collaborators – who will be the point person working with them? Also, it seems as if some of these collaborators will also be involved in doing some of the genomics research as well as conducting some of the breeding experiments. Make it clear what everyone will be doing.

What about an overall project manager? This is a requirement for the GC project and he/she should be part of the project team.

One collaborator (Anyanga) will be spending 15hr/wk on the project just doing breeding. Is that really the case? If so, this didn't come out in the Research Proposal.

Section IV: Socio-Economic Benefits

There is limited space allotted for this section and many points to cover. Any suggestions around how to make this as coherent as possible will be appreciated by the team. All else being equal between two proposals, the one which makes a stronger case for benefits to be achieved sooner will be assessed more favourably.

- Deliverables
 - To what extent have the applicants identified appropriate deliverables in terms of their potential to have impact on food safety, security and/or sustainable production?
 - What is the likelihood that the deliverables will be achieved by the end of the funding period?
- Expected Benefits
 - How significant are the anticipated benefits described in terms of their potential of contributing to food safety, security and/or sustainable production?
 - Will the benefits be realized within a short time-frame after the end of the project, taking into consideration what is reasonable for the different research areas in these sectors?
- Strategy for realizing benefits
 - How persuasive is the strategy set out by the applicants for realizing benefits from their research?
 - How strong is the plan for knowledge translation and development of benefits, i.e., how well does the plan explain the next steps of how the deliverables from the research will be transferred, disseminated, used, and/or applied to realize the social and/or economic benefits?
 - How closely aligned is the plan for knowledge translation with the GE3LS research and the overall deliverables and outcomes of the project?
- Expertise for realizing benefits
 - To what extent are likely end-users involved in the project and the strategy to realize benefits?
 - If the strategy includes commercialization, to what extent has appropriate technology transfer expertise been included?

This is quite comprehensive. A few important points however:

I don't have a clear idea of whether the breeders can just use the deliverables with no further work. It sounds as if what you are providing is information to improve breeding as well as some specific seeds. You state that many of your deliverables can be moved into public and private breeding programs and state that the end-users involved in the project will integrate them into their plant production processes. Do these breeders need to have genomics equipment to do that (particularly for the information and genotypes) and, if so, have they got it (particularly in Uganda)? If not, how are they going to be able to use such things as marker assisted selection. How long will it be until they have sunflowers that can be planted to produce oil/ seeds/ confectionary? How long does it take to harvest following planting? (presumably one year or



GenomeBritishColumbia

less but need to make it clear as that's when the SEBs will start to flow). Each deliverable may need a different amount of time to become integrated into the plant production process – some may need additional research although this isn't stated. Need to be clear about what's required to realize the SEBs for each deliverable (which is why I'm wondering whether you really want to have so many deliverables to get to breeders as the more you have, the more info you need to squeeze into this section – see also above comments).

I am also a bit confused about the genes you're hoping to deliver. At least some of these will be included in the genotypes you'll be delivering so how will the potential patents affect the use of the genotypes?

The GE3LS deliverable seems a bit wishy washy – see my comments in the Research Proposal section to better address this.

To make space for this, you may want to summarize the background info a bit more.



**2014 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
FEEDING THE FUTURE
PRE-APPLICATION
GENOME BC REVIEW FORM - EXTERNAL REVIEWER**

Project Leader(s): Rieseberg and Burke

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Overall Comments

This draft of the Sunflower project is quite good – but I believe the presentation should be improved to ensure as high a grade as possible in a very competitive competition

Section I: Summary of the Project

A listing of anticipated outcomes and deliverables is provided in all three sections. The presentations should vary. The instruction for the Summary asks for a description of the deliverables expected at the end of the project and the social and/or economic benefits anticipated from their subsequent practical application (note no mention of anticipated outcomes). So follow this as closely as possible. Especially important is an indication of the scale of the potential benefits. How many people might benefit (xx millions?) what could be the economic impact? Will this happen over a decade or more – or sooner? Simply put – what does success look like – and when?

Eligibility to the Program

Eligibility Criteria

Each pre-application will be reviewed for eligibility. The following criteria will be used.

Does the proposal:

- respond to the objectives of the Genome Canada competition as described in the RFA;
- include genomics approaches as essential components in terms of importance to the overall outcomes of the project;
- address food productivity, safety etc; and,
- possess a scale and scope such that it is able to address challenges requiring a genomics approach, be internationally competitive and have potential to have a major impact?

There is no reference to the eligibility criteria in the RFA or the Genome Canada strategy document in the pre-application. This needs to be addressed. Because of the nature of the potential benefits, it is essential that opportunities be taken to relate back to the Sector Strategy – and to the RFA – with quotations from both. This project more than others does relate to “feeding the future”.



Section II: Research Proposal

The brief statement that “our efforts all fit well within the stated goals of the program” needs to be stronger – relate specifically to the RFA (especially the eligibility criteria) – and back to the Sector Strategy, using quotations from both. This is a key strength of this project – make sure the benefits reviewers can refer to this in their written reviews.

The box in the diagram “Anticipated Outcomes and Deliverables” needs to follow the instruction carefully – which asks for “how the expected scientific outcomes and deliverables will be achieved....”. So insert scientific in front of outcomes – a small point maybe – but outcomes could be interpreted differently if you don’t. Also I found it difficult to follow the logic of how the points in each of the three top boxes related to the nine bullets in the bottom box. Do you need all nine and in what order?

The reference in Activity 4 to soybean and canola includes reference to Parrott’s group’s experience with soybean. Is there a possible collaborator for canola – and is this sufficiently likely to be successful that the downstream potential of this should be referred to in the Benefits section?

Section D repeats the nine bullets in the diagram – with more specificity for some. Much of this information is then provided again in the Benefits section. So I suggest some reorganization. More important as an ending to the Research Proposal section is to follow the instruction “how end-users are engaged in the development and execution of the research plan in order to help ensure receptor uptake”.

Section IV: Socio-Economic Benefits

I suggest some significant reorganization of this section – following the instructions more closely.

You only have two pages for the Benefits section – but it could represent roughly half of the overall assessment – so the space must be used as effectively as possible. The instructions call for including (1) a description with justification of the deliverables and (2) a description of the potential of those deliverables to lead to significant benefits.

The current draft uses 3/4 of the first page to provide Background material that repeats some at least of what was provided in the introduction to the Research Proposal. I suggest you start with what is currently Part B and then use the most relevant material out of the Background in your description of the potential benefits. Remember to quote from the GC Sector Strategy when appropriate to strengthen the link with the themes of the Competition.

Your Part C should provide more detail about some aspects of the Plan – e.g. about “with an industrial collaborator” and strengthen the description of “how end-users are engaged in the plan to in order to help ensure receptor uptake”.

2014 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
GENOMICS FEEDING THE FUTURE
PRE-APPLICATION
GENOME BC REVIEW FORM - EXTERNAL REVIEWER

Project Leader(s): Rieseberg and Burke

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Section I: Summary of the Project

The context is very well articulated and I have no constructive comments to suggest. On the “science” side, the team is very strong and I appreciated being able to review the CVs. The bibliography is also extensive and excellent as are the explanatory flow charts/graphics. However, in reviewing the team composition, I would suggest an explicit, strong role be given to a GE3LS expert. There is reference to Emily Marden but she does not appear in the project team. Is that an oversight? In the section entitled “Functional validation of 10-15 candidate genes”, are the applicants oversimplifying the IP / patenting process? Also, what about risks in terms of public understanding and acceptance? They may wish to address this and include a plan on how to mitigate/proactively deal with such issues. In the section entitled “Engagement of end uses” (and indeed in the rest of the proposal), it is not altogether clear to me who is selling what to whom (licensing how to “crack the code” and identify markers?) and when. This should be more clearly spelled out to be understandable to an educated multidisciplinary review panel. Also, all technical terminology should be fully explained.

Section II: Research Proposal (including Science and GE3LS)

There might be an opportunity to argue the relationship with international work a bit more strongly (ie sunflower breeders, distributors and oil producers, particularly in developing countries, have expressed their urgent desire to improve resistance to abiotic stresses, etc. given trends in the market and production environment, etc.). As per earlier comment, it is not crystal clear to me what data will be proprietary versus open source. As per previous comments, authors may wish to further explain and unpack IP issues, associated potential risks, give an explicit leadership role in the team for GE3LS work and flesh out the related section of the Gantt chart. The GE3LS portion of the overall budget is likely too small to be able to grapple with the potential issues. This, in addition to the fact that there is no explicit GE3LS leader in the team, will give reviewers the impression that GE3LS is “token” at best. Regarding Activity 5 on p. 12, authors should elaborate, particularly on paragraph 2 as It’s not clear what is meant by “benefit sharing terms”, for example.



Section III: Project Team

The proposal is very strong on the “science” side but is weak with respect to GE3LS as previously mentioned. Nice integration of plant science and bioinformatics. Paragraph D on page 20 could be expanded a bit. There appears to be room. I would suggest mentioning specific examples of end-users rather than making a general reference. Good discussion in the text on GE3LS but weaker with respect to indicating Marden is a full team member, in addition to the small budget, lack of reference to GE3LS in the Gantt chart etc. which appears disconnected from the main text on GE3LS issues. The current project team is quite large and this may be difficult to manage. How will the governance work? This is not discussed and should be, given the complexity of the project, including significant international collaboration.

Section IV: Socio-Economic Benefits

As per previous comments, I don't know if there's a way the applicants can argue that this is similar to other initiatives and thereby demonstrate that the timelines are reasonable for the deliverables being proposed in order to convince the reviewers of this (I hope so). Significant economic benefits are well articulated. Potential environmental impacts, however, are not clear. This may require explicit discussion in the proposal. In some ways, the GE3LS analysis should be kickstarted in the project early on to inform how feasible the proposed timelines are in terms of implications of various treaties mentioned, etc. As per previous comments, IP issues not clear (open source versus proprietary). □ Should CFIA not be involved/engaged? As per previous comments, the proposal needs to “walk the talk” more on GE3LS. The ideas are sound but need to map out more in the work plan and budget. As per previous comments, the question of time-frame for realizing benefits needs to be fleshed out further. Are there other examples that can be drawn on (Canola?). IP issues are some of the thorniest in the genomics business. As per previous remarks, it's not clear to me what, in the end will be “sold” or commercialized – perhaps this needs to be more clearly laid out in laymen's terms with concrete examples of what has been done elsewhere. On p. 4, the keywords listed under “methods” for GE3LS (Lit review, legal analysis, survey, IP landscape analysis) need to feature more prominently in the actual application. The same can be said for the GE3LS research questions (ie flesh out “access and benefit sharing, genomic data sharing, proprietary interests and open access).



2014 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
GENOMICS FEEDING THE FUTURE
PRE-APPLICATION
GENOME BC REVIEW FORM - EXTERNAL REVIEWER

Project Leader(s): Rieseberg and Burke

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Section I: Summary of the Project

Context:

- o Context is clear, but reads rather flat - scale of importance is not evident
- o No economic justifications are offered. A reviewer unfamiliar with the importance of sunflower production will require some \$\$\$ information.
- o Later in the proposal there is a single sentence on the possible application to other crops, which would seem to be the 500 lb. gorilla in the room - in a good way! Worth emphasis?

Research Plan:

- o The Summary section discusses the goals of each research theme, but does not discuss the research plan itself - no discussion of methods, technologies, sampling, theoretical and experimental approaches, etc. (perhaps this is impossible within the page limit)
- o However, GE3LS is usefully, if briefly, discussed
- o The research team's expertise and capacity to execute the project is not discussed.

Expected deliverables

- o The deliverables are clearly laid out and (to a lay eye) sensible

Social and economic benefits.

- o The qualitative aspects are discussed.
- o Adding quantitative discussion would be very useful to allow comparison to other LOIs that do so.

Section II: Research Proposal (including Science and GE3LS)

To a lay reader, sensible and well laid out, clearly linked to stated problem.

To me it was unclear how the presence and extent of trade-offs was to be determined. It is discussed very briefly (one sentence), but as it's a key concern, perhaps more detail is needed (e.g., presumably many of the wild varieties to be studied exhibit non-desirable traits)?

Re. GE3LS, the discussion is excellent. Two points:



- Are there not also Canadian regulatory hurdles, and should not CFIA also be involved, or is this embedded within the SMTA, CBD, and Treaty?
- The non-participation of the US is highlighted, but not discussed. Does this pose some risks to either the research or its take-up?

Would it be useful to discuss the expertise of key relevant team members within each research activity?

Section III: Project Team

To my lay eye, this section is insufficient, certainly if I didn't already know all the individuals involved. My understanding is that the principals are renowned, but is everyone, especially from the private sector?

Section IV: Socio-Economic Benefits

Background is rather lengthy and takes away from detailed discussion afterwards. Suggest some cuts.

Deliverables

- Stated deliverables are clearly described and clearly linked to research plan.
- I cannot comment on the likelihood of achieving deliverables by project's end.

Expected Benefits

- The benefits world-wide appear significant, although information is sketchy (e.g., why Uganda alone?).
- The discussion of *Canadian* benefits (re. sunflowers alone) is given short shrift and is not very convincing - e.g., why would marginal lands in the Prairies be planted in sunflowers rather than other crops? And what would be the net values? (Marginal land often has high production costs; will farmers run a profit or a loss?)
- Overall, the text reads as though most Canadian sunflowers are for ornamental use and snacks, which doesn't light a fire as to their importance to the nation, and there is no discussion of current Canadian revenues from sunflowers. This leads me to think that the true importance of this project is its potential applicability as a model for other crops - while too early to say too much about this, a bit more discussion might



highlight the project's importance.

Strategy for realizing benefits

- General strategy appears realistic and appropriate, if somewhat vague; e.g., what kind of workshops and presentations, and to whom?
- It is unclear to lay eyes whether we're talking GMOs here - needs clarification in GE3LS discussion if so.
- Unclear if any *Canadian* firms will benefit.
- Links to commercial end-users in general are said to be strong, but few details offered as to their roles and contributions - could 1-2 sentences be inserted as appropriate in various sections of the research plan, to make these links more plausible?

Expertise for realizing benefits

- Specific roles of end-users not explained in detail (not much space here; see comment above re. putting a bit in the research plan)
- Technology transfer expertise is discussed for "a trait the Rieseberg lab is currently commercializing", but more information would be quite helpful; this is pretty opaque.

2014 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
GENOMICS FEEDING THE FUTURE
PRE-APPLICATION EXTERNAL REVIEW

Project Leader(s): Rieseberg and Burke

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Section I: Summary of the Project

Rieseberg and Burke propose a broad and integrative approach for exploring the mechanistic basis of abiotic stress tolerance in wild and cultivated sunflowers. The proposal summary is clear and concise, well-motivated, the proposed research approaches make sense, and the deliverables the type of outcomes desired by the overall program. My only comment would be to try and better articulate why these particular stresses (drought, flooding, salt, and low nutrient conditions) are targeted. Do these abiotic stress all imposed yield losses in Canada? Can the research effort be prioritized or narrowed to better ensure success? I fear that the breadth may dilute effort and therefore risk the proposed goal of making mechanistic links and discovering useful alleles.

Section II: Research Proposal (including Science and GE3LS)

Rieseberg and Burke propose a novel approach for exploring the mechanistic basis of abiotic stress tolerance in sunflowers, focused on mining evolved adaptations in wild relatives. I like this idea - I think it takes advantage of the unique natural history in the group and leverages the prior work studying the wild species. The proposal is based on scoring a series of traits putatively involved in stress adaptation in relevant environments and associating these with genomic regions using resequenced genomes of domesticated accessions and wild relatives. The research will complete these studies in both a large association population as well as multi-parent line crosses. These methods are well developed and have been successful in other plant systems (e.g., maize, rice, sorghum, Arabidopsis) but are a relatively new strategy in sunflowers.

The proposal would be strengthened by providing more detail concerning the genomic data available in sunflowers, the patterns of genomic variation within domesticated and wild sunflowers, and the potential challenges or limitations of the proposed work. As currently written, the proposal is so light on these details that it is difficult to evaluate the feasibility of the work or the likelihood for success. Has a GWAS study been published in sunflowers? How dense are the marker genotypes? Is there population structure of concern? What is the expected power for association mapping using the 288 inbred line population? The authors cite one GWAS paper but do not discuss the results. How complicated and challenging will the addition of wild relatives be in the implementation of association or population genomic analyses? What is the status of the wild relative genomes? How variable are their genome sizes? How deeply diverged are the wild relatives from the domesticated accessions? Is it reasonable to score genotypes in the wild relatives based on calls against the domesticated reference? Is there much reproductive isolation between the domesticated and wild relatives? And if so, how severely will this impose selection on the construction of the MAGIC



line population? I believe the mouse complex cross study (the original implementation of this approach) has been plagued by non-syntenic LD and segregation distortion in the inbred mapping population. I realize the grant space is limited, but additional detail will provide for a more meaningful presentation to the reviewers.

The abiotic stress screening is ambitious - again, better justification for the proposed traits/environments would strengthen the proposal. Physiology reviewers may be concerned about the limited sampled of stress levels (control versus stressed) - the outcomes may be critically dependent on the levels chosen. I wonder whether it would be good to prioritize the stresses, maybe even focusing on two and suggest additional work on other stresses if possible. It's also important to consider when the stress occurs in the agronomic plantings - are sunflowers susceptible to terminal drought? Or intermittent drought? Do they typically show patterns of drought escape or drought avoidance? Can this ecological background help target and justify the traits studied? It seems that sunflower agronomists should be able to say rank the relative impact of the mentioned stress on yield - or concern in the context of future climate change.

How much developmental or phenological variation segregates in the SAM population? if it is substantial will be challenging to complete some of the stress assays proposed because it will be difficult to evaluate physiology/responses at comparable developmental stages.

I really like the emphasis on tradeoffs and the identification of prioritizing candidates based on lack of severe antagonistic correlations.

The transcriptome analyses comparing tolerant and susceptible lines is a nice component, but also a substantial cost to the project (~ 480 samples). The specific details of the activity should be better justified - does it make sense to work with seedlings (is this when they experience stresses in an agronomic setting)? Does it make sense to use whole seedling preps? This will result in a hodgepodge of tissue and cell types that may dilute the interesting responses. Why the heavy focus on sampling a timecourse? Will the timecourse be the same for differing stress environments? Why complete total RNA-sequencing? Why not make better use of you sequencing effort using a "tag" based method, especially if you only intend to tallying counts of molecules. Perhaps this activity could be broken into two components - a smaller pilot studies to test timing/tissue and sequencing depth requirements and the full blown experiment.

I like activity 2 - this would be a really neat dataset and may give some especially interesting insights. Would be nice to include some more information on the scale of divergence and challenges associated with different genomes. It seems like some of the especially interesting novel adaptations may be novel to particular species - but, these genomic regions may be absent from the references available. How will these orphan regions be treated?

I like activity 3 too - but, worry about making "wide crosses". Perhaps there is already enough experience with these crosses to easily address these concerns - If not, it may make sense to discuss what backup plans can be followed if breeding challenges and incompatibilities arise.

I like the prioritization scheme for functional validation of candidate genes. This seems a smart way to go. The authors mention some experience/success with transgenic approaches in sunflower- based on this experience, it would be good to clarify the possible scope and



timeline for validation. Will the research team explore only a few targets? Or will they have the capacity to screen dozens?

Evaluation of activity 5 is a bit outside my expertise....

Section III: Project Team

The research team is extensive and experienced in the tasks proposed. Rieseberg and Burke are experts in sunflower genomics, genetic mapping, and evolutionary genetic inferences. Donovan has built her career studying ecophysiology and adaptation to abiotic stresses in sunflowers. In addition, the team includes a number of important sunflower breeders and end-users - my guess is they add the needed practical/agronomic perspective to the mix. This seems like the appropriate team for the projects proposed.

Section IV: Socio-Economic Benefits

This section (at the end of the grant) is the first place where various abiotic stresses are prioritized with respect to sunflower production. It would be good to bring this up sooner in the proposal, and perhaps to think about prioritizing effort.

The deliverables discussed seem relevant and realistic in terms of a 5 year timeline. My main concern would be with the timeline for functional validation of material - the grant mentions 10-15 candidates. How quickly will the research group identify these candidates and initiate functional studies? It seems much of the data for making prioritized choices will not be available for several years - but the timeline suggestions functional validation will begin as soon as the 5th quarter. This seems unlikely.....

The authors mention that a deliverable will be the discovery of useful alleles and the benefits these may have to marker assisted breeding programs. I was a bit surprised that the authors do not discuss or consider 'genomic selection' approaches for rapidly selecting for increased abiotic stress - it seems their data could potentially leverage this approach for rapid impacts.

2012 LARGE-SCALE APPLIED RESEARCH PROJECT COMPETITION
GENOMICS FEEDING THE FUTURE
PRE-APPLICATION EXTERNAL REVIEW

Project Leader(s): **Loren H. Rieseberg & John M. Burke**

Project Title: Genomics of Abiotic Stress Resistance in Wild and Cultivated Sunflowers

Section I: Summary of the Project

The summary is well written, clearly stated the importance of this research project, goals and deliverables. Reviewer has following comments:

It will be good that applicants could highlight or emphasize the impact of abiotic stresses on sunflower yield in Canada or in the world, i.e., to provide an estimate of yield reduction in sunflower due to abiotic stress. The applicants may need to provide a statement whether cultivated or wild sunflower germplasm with abiotic stress tolerance have been identified which can be used for further proposed research.

In the summary, it appears that the right scientific methods will be applied to the project and applicants will integrate appropriate GE3LS methodologies in the proposal. Since the summary should be able to stand alone, it did not include any information with regards to the research team and their capacity. The reviewer thinks it will be good to include a statement for the research team and their capacity to perform such proposed research.

Section II: Research Proposal (including Science and GE3LS)

Research Context and Originality

Abiotic stress is one of important yield limitation factors that result in reduction of crop yield in the world. The proposed project tries to access the genetic variation, particularly abiotic stress resistance in both wild and cultivated sunflower using traditional phenotyping and sensor-based HTP approaches, identify QTL and favorable alleles and develop genomics tools as well as germplasm to support sunflower breeding efforts. The proposal is very well written and has sound workflow and approaches. The genetic information and genomic tools developed from this proposal could help advance the knowledge and understanding of the QTL and gene network, molecular mechanism of abiotic tolerance in sunflower. It will benefit the research community as well as private companies for sunflower breeding, eventually help improve productivity of sunflower in Canada as well as in the world. The information could be used by the scientists in other crops as well.

The proposed research will utilize new phenotyping technologies for phenotyping the abiotic stress tolerance, identify the genetic factors to controlling these stress tolerance, and then utilize the genomic tools to mine the favorable germplasm alleles and develop next generation sunflower germplasm. Reviewer thinks proposed research will lead the international work in high throughput phenotyping and genomics research in sunflower. The research will generate lots of interesting results and could greatly



benefit both public and private sunflower breeders

Research Plans and Execution

In general, the experimental plan is sound and well-designed. With such plan in place, reviewer would think many interesting results will be generated from this project. However, I have following comments for proposal improvement.

Since the proposal will particularly focuses on the stress-tolerance evaluation and genomics starting by evaluating 288 lines, the proposal lacks details about the likelihood that researchers could identify the lines with abiotic stress tolerance from these 288 lines. It appears that the selection of these 288 lines was solely based on the allele diversity. Since these 288 lines are important foundation for this project and are keys to the success of this project, reviewer would suggest that it is very important to select some lines with prior knowledge for abiotic stress tolerance or from abiotic stress prone regions, not just solely based on the allele diversity.

In the study system section, applicants indicated that numerous genetic mapping populations were developed through previously Genome Canada funded project, however, I did not see any indication that the new project will utilize the populations developed from previous cycle of the project. I would think it is important to leverage the information and materials from previous funded projects

In general, the methods and approaches proposed are appropriate in the proposal. However, the sunflower lines have different maturity and plant height. The proposal lacks strategy how to handle the lines with different maturities during the phenotyping process, which might affect the accuracy of phenotyping in the field and ability of conducting the genome-wide associate mapping.

The proposal will use two locations for evaluation of these lines for abiotic stress tolerance which is a foundation for this project. Reviewer would suggest to use at least two years for such evaluation so that the effects of genotype x year could be well estimated and understood as well. Also the proposal lacks the steps to confirm the QTL or gene identified through genome-wide association mapping in the field.

The applicants indicated that they chose the elite wild donor (do not know what they meant elite wild donor) in consultation with public and private partners to represent a broad cross-section of cultivated and wild sunflower diversity. This proposal is focused on the abiotic stress tolerance study instead of genetic diversity. I was wondering if any parents used in this MAGIC population have any abiotic stress tolerance traits. If not, it will be very important to include lines with abiotic stress tolerance to make such MAGIC populations.

Lot of genomic data and field phenotype data will be generated from this project. Applicants did not mention how they would handle the data flow and how to make the data available to the public and private scientists to be used in their programs

In activity 1.4, if they have RIL mapping populations available, it will be good to use the selected RILs for such study because these lines will have reduced background noises for transcriptomic analyses. In addition, applicants may need to specify the location they will conduct such studies

Reviewer would think that adequate resources, facility and equipment are provided for the research in the proposal. It is also great to see the project team consists of international researchers and also include the scientists from private companies. This will help the results generated from this project

quickly be utilized in the private companies.

The proposal indicated the phenotyping will be conducted in the greenhouse and growth chambers, but failed indicating the locations that the phenotyping will be conducted. Proposal also mentioned that “Drought field trials will take place in Uganda and at the U. California Desert Research & Extension Center (DREC), which offers sensor-based HTP approaches for leaf and canopy traits using tractor-mounted sensors”. It will be important clarify if the project team will rent the facility to conduct the phenotyping or utilize the center as a service. In addition, the proposal lacks the details about specific responsibility of each researcher for each activity.

Section III: Project Team

I think the research team in this proposal is very strong and has the expertise, outstanding track record and capability to perform this project which will help succeed in this project. In addition, the team has leveraged the expertise internationally as well as partnered with industry to help them achieve the project goals

Lot of greenhouse and field phenotyping work will be involved which are a key to the success of this project, relatively speaking, this might be a gap for this team. Reviewer would suggest that the team may need to collaborate with a scientist who has the expertise in abiotic stress phenotyping especially with sensor-based HTP approach so that the field testing and phenotyping, trait priority could be well planned and designed.

The proposal indicated that USDA and other five companies will provide \$300,000 in kind support to this project. However, I did not see where this in-kind support will be built in or employed in the project. It will be good to clarify how exactly the companies will be involved in this research.

Overall Comments

In summary, reviewer would fully support funding this project if the applicants could incorporate the comments into the full proposal. It is my belief that the new phenotyping technology, germplasm, QTL/allele information and genomic results generated from this project will greatly advance the knowledge and sciences, and help the sunflower breeding.

