Identifying Surrogate Environments to Facilitate Data Transportability for ERA

DR. ANDREW F. ROBERTS
Contents of the presentation

Introduction to the ILSI Research Foundation

Outlining the Challenge:
- Why are we interested in identifying surrogate environments?
- Data Transportability and regulation of GM crops
- Confined Field Trials – what do they look at and why?

ILSI Research Foundations Work on Identifying Surrogate Environments
- Expert Working Group 1: Publication in Transgenic Research
- Expert Working Group 2: Identifying criteria for an appropriate global agroclimatic zonation
- Introducing the surrogate environment approach in cooperation with COMESA
ILSI Research Foundation - Mission

Bringing scientists together to improve environmental sustainability and human health globally
Part of the global ILSI network
2017 Scientific Portfolio

- Biosafety Capacity Building
- Data Transportability for Field Trial Research
- Environmental Risk Assessment of Genetically Engineered Crops
- Environmental Risk Assessment of Gene Drives
- Genetically Engineered Food and Feed Safety Assessment
- Genetically Engineered Food Safety Capacity Building
- Nutrition
- South Asia Biosafety Program
- Sustainable Nutrition Security
- UNEP-GEF Phase II Project
What is the challenge?

We live in a global economy
- Agriculture is a global enterprise

Genetically engineered (GE) crops typically require approvals in multiple countries
- True for food and feed use
- Also true for cultivation
- For high value crops (e.g. maize, cotton)
- For nutritionally important (e.g. cassava, bean)

For cultivation approval, countries typically require local confined field trials (CFTs)
Cost of repeating trials can be prohibitive
Challenging for regional cooperation on ERA
Governments often require data from local field trials for cultivation approvals

For a variety of reasons

- Misunderstanding of the “stepwise” approach in the 1993 OECD Scale-Up Document – development proceeds from the lab to the greenhouse to the field
- Issues of trust and control
  - “We just want to see what happens when we grow it here.”

Sometimes this is codified in laws or regulations

- Sometimes it is not codified, but it is a practical requirement

But is this really necessary?

- Scientifically justified?
- What is the data being collected in CFTs and how is it used?
Developers conduct field trials for a variety of purposes:

- Basic Research
- Collecting experimental biosafety information
- Generating material for laboratory testing
- Agronomic testing - which is different than biosafety testing
Confined field trial data

Agro-phenotypic characteristics
  ◦ Collected primarily to assess unintended effects
  ◦ To verify there are no changes in reproductive biology or growth habits that could have an adverse environmental impact

All the data is comparative
  ◦ With one or more comparators grown in the same trial as the GE event
  ◦ The comparator is typically the non-transformed or near isogenic parental line
Do additional CFTs provide worthwhile data?

In most cases, GE plants are evaluated in multi-location confined field trials in the country of origin
- Typically over multiple growing seasons

In light of the fact that most of the data collected from these trials is used to assess unintended effects, there may be no scientific rationale for conducting additional trials
- If there is, then the risk hypotheses should be clearly articulated

Nevertheless, many countries still require in-country CFTs as a routine undertaking, even when data from CFTs in the country of origin is sufficient to demonstrate environmental safety
The physical environment provides the key variables that characterize a CFT site

- Climate
- Cultivation practices

The biotic environment is tightly controlled

- This is by design to achieve consistent results in comparisons between the GE plant and controls
- Therefore biotic variables don’t have a significant influence on the comparative assessments resulting from CFTs
“Surrogate environment” approach

Because agro-climate is the key driver influencing differences between trial site locations

- CFT data collected from trial sites with the same or similar agroclimatic conditions is expected to be the same
- Regardless of what countries those sites are in

Can be used to support cultivation assessments without the additional requirement of local CFTs

- Or to demonstrate the equivalence of a CFT conducted outside of a country in order to satisfy the requirements for in-country CFTs
The Conceptual Framework is now being applied in other research and programs.
EWG 1: Some key recommendations

Consider preparation of a tool to identify agroclimatic zones where CFTs would be expected to produce similar results

Produced a “Conceptual Framework” for doing that

Identified some outstanding scientific issues

- Would a map need to be crop specific?
- Can a generic global zonation scheme be applied for this purpose?
- Would local or regional maps add value?

Expert Working Group 2 Formed in 2015 to address these

- Supported by another grant from USDA
Conclusions from EWG # 2

A global stratification system is appropriate to identify climatic zones expected to produce similar field trial results

Identified criteria for a preferred system

- Global stratification is preferred, as regional strata may mis-identify zones
- Sufficiently high number of zones to indicate homogeneity within a zone
- Data sources should be transparent and preferably accessible to users
- Scheme should be flexible to allow modification over time
  - Including to incorporate changes in climate and cropping over time.
Global Environment Stratification (GEnS) selected for pilot

Peer reviewed
- Published and demonstrated applications for multiple purposes and regions

Sufficient number of strata

Fully transparent

Freely accessible

Largely data driven rather than subjectively chosen zones
- Exclusively climatic data

Well justified selection of variables

Statistically hierarchical

Flexible

The statistical method aims for maximizing within-strata homogeneity

Uses real data rather than modeling data

Base spatial resolution is fit for purpose

Uses well accepted global data

Validates successfully against zonations developed by other means
Based on the conclusions we have proceeded with some additional work

Using GEnS to map crop production areas (as identified in Monfreda et al. 2008)

Overlaying the GEnS agroclimatic zones over those crop production areas

I will present two examples:
- Maize
- Cassava
Global maize production
Production intersected with agro-ecozones
How does global maize production look, across environments?
Maize production in Africa
Global cassava production
Production environments for cassava
Cassava production by volume across environments
Cassava production in Africa
Cassava production environments
What’s next?

Continue producing crop production area and climate maps
- Ultimately working towards an online tool that allows the use of these maps to identify surrogate environments

Additional Scientific Refinement
- Identify some parameters around an “ideal” stratification
- Balancing homogeneity of zones with practical utility

Proposed work with COMESA
- Supported by a USDA grant
- Introduces the surrogate environment concept
- Facilitate the regional risk assessment model adopted by COMESA
The goal is to produce a tool for identifying surrogate environments

This will facilitate CFT planning
  - Particularly for public sector developers or others that don’t have the resources to conduct redundant CFTs in multiple countries

Can provide a credible, evidence based rationale that CFTs conducted outside of the country can be used to satisfy regulatory requirements for in-country field trials
A surrogate environment is not a requirement for data transportability!

It is a tool for satisfying existing regulatory requirements

Conclusions based on CFT data may be much more broadly transportable

- For example: If a field trial demonstrates that there is no observable difference in phenotype between a GE plant and it’s conventional counterpart, this is a good indication that there have not been metabolic or transcriptional changes in the plant as a result of the engineering
- This is true regardless of the environment where the data was collected
“Data transportability” is the concept that data produced to support regulatory assessments in one country can be used to support a similar assessment in other countries

- It is linked with regulatory harmonization and mutual acceptance of data
- All data for food/feed safety assessments are transportable
- Most data for ERA are routinely transportable (e.g. lab-based ecotoxicology tests)
- Agro-phenotypic data from CFTs can also be “transportable” – risk assessors should be considering this more routinely

Surrogate environment approach may be useful to satisfy requirements for local CFT data

- Using data generated outside the country
Acknowledgments

USDA – EMP Program (conceptual framework, COMESA project)

USDA Foreign Agricultural Service (support for EWG 2)

EWG 1
- Monica Garcia-Alonso, Paul Hendley, Franz Bigler, Edgar Mayereggger, Ronald Parker, Clara Rubinstein, Emilio Satorre, Fernando Solari, Morven McLean

EWG 2
- Monica Garcia-Alonso, Dave Gustafson, Paul Hendley, Marc Metzger, Navin Ramankutty, Andrew Roberts