UR-T1182: Promoting Productive Transformation and Competitiveness of Uruguay's Agri-Food Industry based on Science Technology and Innovation

Crop Sector Assessments

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INSTITUTES OF GREEN BIO SCIENCE AND TECHNOLOGY

SEOUL NATIONAL UNIVERSITY

A. Sector Performance, problems and opportunities

A-1. Sector Performance

Agribusiness in Crop Sector

- Uruguay plays an important role in world food exports

- The main export crops are soybean and rice (world export market share 13% and 7%)
- Soybean ranks within the top three exports along with pulp and beef in Uruguay
- Soybean mainly exports to China (88%), Rice mainly travels to Brazil

- Most of the export beans are Genetically Modified Organisms (GMOs)

- Rice is not GMO, because the importing country demands non-GMO rice

- Uruguay has great potential to increase agricultural production

- However, recently, agricultural production was subject to unusual weather events
- Severe droughts in 2017-18 drastically reduced the production of grain & oilseeds

R&D system

- Uruguay has excellent and well organized crop R&D system

- INIA is a main crop research institute with a good breeding program.
- UdelaR is systematically conducting research on sustainable agriculture such as crop cultivation systems as well as basic research on crop physiology, molecular biology, biochemistry, etc.
- INASE is conducting co-research with INIA and UdelaR for the quality control of new or commercialized varieties.
- LATU is also carrying out joint research on quality improvement to obtain high quality crop product

- ANII plays an important role in linking joint researches

- INIA and UdelaR have well established joint research, education, and manpower exchange systems

*There are many producer cooperatives and private companies that participate in this system

Biotech R&D activity

- Agricultural biotechnology research activities do not meet the needs of its industry

- Uruguay is a major exporter of biotech soybeans, but there are no locally developed GM varieties

- INIA and Universities have BT R&D program, but not sufficient for global competitiveness

- Lack of research activities on the research in advanced biotechnology such as genome editing

- The main problems is lack of investment

- Shortage of research facilities & equipment for BT research, and research funds are very limited

- Necessary to establish a national BT center and formulate a national road map

- Need more investment & active international joint research activities as soon as possible

A-2. Problems and Opportunities

Problems

- Advanced technologies are not employed to find solutions and remedy crop problems

- All GM soybeans are foreign varieties, not locally developed GM soybean variety

*Conventional breeding programs are considered to have made significant progress (3 local soybean cultivars)

- Lack of research on the advanced biotechnology technologies such as genome editing

- This could result to a weakening of agricultural technology competitiveness in the future

- The risk of lower production due to climate change is also a big problem

* In Uruguay, the most important consideration in agriculture is the maintenance of a sustainable agricultural environment

In that sense, it will be necessary to apply BT that can improve the genetic quality aimed at reducing environmental concerns

- R&D funding and research facilities need to be enlarged and improved

- Export dependence on certain countries is high

- China, for example, accounts for over 80% of Uruguay's soybean export market

- Crop industry mainly focuses on on-site farm productivity

- Looks weak links between the academic/research institutions and the industry

Opportunities

- Uruguay's farm size is sufficient for export competitiveness in agricultural products

- Uruguay has excellent research organizations and also has an excellent collaboration system

- Good conditions to apply advanced biotechnology to develop high-value biotech crops

- Uruguay possesses experience in growing and exporting biotechnology crops such as soybeans
- There is well-established bio-safety management system for the cultivation and export of these crops

☞ **Based on this, if Uruguay aims to develop major global biotech crops such as soybeans and maize, it can take up a significant portion of the global biotechnology seed market**

* In Uruguay, the most important consideration in agriculture is the maintenance of a sustainable agricultural environment
In that sense, it will be necessary to apply biotech that can improve the genetic quality aimed at reducing environmental concerns

- Recently, the prospect of commercialization of genome editing technology is very high

- This will create a new biotechnology seed market that is easier to enter than GMOs

- Uruguay government and its leadership are strongly committed to developing and encouraging techno-innovation in green bio-industry

B. Sector Strategy

Establish Crop Biotechnology Institute

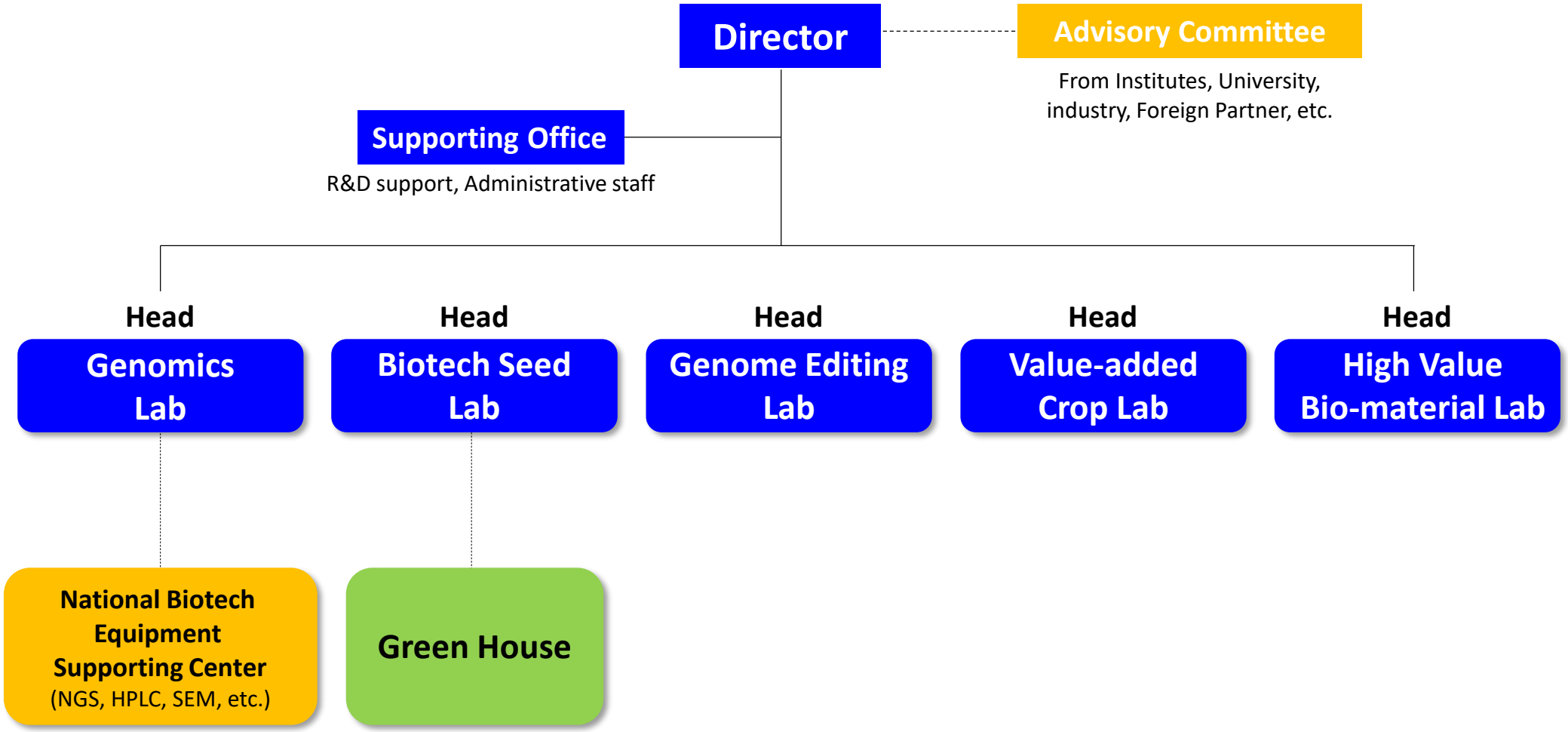
Mission

- Plays the role of national core institute for crop BT R&D

Function

- Secure BT competitiveness in the crop sector
- Provide technical solutions for main problems in the crop sector
- Technical support for local seed industry to share the global BT seed market
- Technical support for Innovation in the National Green Bio industry
- Establish a National Crop BT R&D Program

Organization



Establishing research projects

Breeding Target and Necessary Technology

Crop	Target Trait									Necessary Biotechnology		
	Productivity (Low input High Yield)	High Quality	Abiotic stress			Biotic stress		Nitrogen use efficiency	Weed control	Genomics MAS	GMO Technic	Genome Editing
			Drought	Water logging	Others	Diseases	Insect					
Soybean	V	V	V	V	V		V		V	V	V	V
Rice	V	V				V		V		V		V
Wheat	V	V	V	V		V				V		V
Barley	V	V		V		V				V		V
Corn	V	V	V				V	V		V	V	V
Forage crops	V	V	V									V
Horticultural crops	V	V	V	V		V	V			V		V

Status of Biotech R&D Activity

Technique		Status of Capability				Status of Application	
		None	Basic Research	Application research	Industry	Whole Crops	Partial
GMO Technology	Gene Identification						
	Trasnformation						
	Event Development						
	Safety Test						
Genomics, MAS	Genome Sequencing						
	Bioinformatics						
	Marker Development						
	GWAS, etc.						
Genome Editing	Target Site Identification						
	Vector Construction						
	Transformation						
	Molecular work & Bioassay						

Research in progress

Proposal of Research projects

Research Project	Target Crop	Target Trait	Collaboration Partner
Development of GM Seeds	**Soybean**	Drought tolerance Herbicide tolerance Insect resistance	Seoul National University (SNU) & Local Research Institutes
	Corn	Drought tolerance Insect resistance Nitrogen use efficiency	SNU, Local & International Research Institutes
Development of Genome Edited Crops	**Soybean**	High quality	SNU & Local Research Institutes
	Rice	High quality Pest resistance	SNU & Local Research Institutes
	Wheat	*Fusarium* resistance waterlogging resistance	Local & International Research Institutes
	Forage Crops	Yield Feeding efficiency	Local & International Research Institutes
Development of Molecular Markers through NGS/Bioinformatics	**All Crops**	Productivity, Quality, Biotic/Abiotic Stress	Local & International Research Institutes
Metabolic Engineering for Value Addition	**All Crops**	High Quality Value addition	Industry, Local & International Research Institutes

Operation strategy

- Improve industry support with more industry-oriented research
- Reinforce and enhance research capacity through cutting-edge technology research
- Improve research efficiency through collaboration with local partners
- Active international collaboration to become a world-class institution as soon as possible
- Active participation of Seoul National University to achieve the goals

Role of Seoul National University

✓ Install and operate a Collaboration Lab

- Biotech Seed Lab (main) and Genome Editing Lab (participating)

✓ Support capacity building

- BT research capacity (manpower training)
- Planning for R&D program, etc.

✓ Perform research projects

- Potential Projects of Joint Research with SNU

❖ **Develop transgenic soybean & corn** (Drought, Herbicide, Insect, Nitrogen use efficiency)

❖ **Develop high quality rice using genome editing technology**

C. Sector Roadmap

Roadmap of the new Crop BT Institution

Crops	2021~2025	2025~2030
Soy	Development of GM Seed (Drought, Weed, Nitogen, Insect) Establishment of Genome Editing Technique	Export GM Seed (Drought/ Herbicide toleant) Development of GE Seed (High quality)
Corn	Establishment of GM seed Technique Establishment of Genome Editing Technique	Development of GM Seed (Drought, Insect, Nitogen use efficiency) Development of GE Seed (Nitrogen use efficiency)
Rice	Establishment of Genome Editing Technique	Development of GE Seed (High Quality, Pest resistance)
Wheat	Establishment of Genome Editing Technique	Development of GE Seed (Fusarium resistance)
Foreage Crop	Establishment of Genome Editing Technique	Development of GE Seed (Productivity, Feeding efficiency)
All Crops	Development of Molecular Marker (Genomics/Bioinformatics) Development of High Value Molecules (Metabolomics) Identification of Signal Pathway & Key Genes Related to Agricultural Traits	

D. Conclusion

- Uruguay has excellent conditions to employ cutting-edge technologies to develop high-value biotech crops

- What is more important is that the Uruguay government and its leadership are strongly committed to encouraging techno-innovation in green bio-industry

- Considering the current crop breeding programs and BT research activities of Uruguay, SNU proposes a number of research projects that could be carried out in the Crop BT Institute

- Target crops for research and joint research strategies were also suggested

- Increasing R&D investment on those proposed researches is highly recommended

We will update and supplement this report with due diligence by collecting more input and comments from an expanded set of involved stakeholders

Technical road map to achieve the goal