

RIKEN Plant Science Center

PSAC Report 2011

July 2011

The RIKEN Plant Science Center Advisory Council

The 5th RIKEN Plant Science Center Advisory Council (PSAC) meeting was held from July 19-21, 2011 at the RIKEN Yokohama Institute. The 2011 PSAC Report is based on the comprehensive report and presentation of PSC current activities and future directions provided by Director Dr. Kazuo Shinozaki, and on research presentations provided by the Group Directors, Team and Unit Leaders. The report summarizes the evaluations of the PSAC members present at the meeting and addresses the PSC Strategic Research Plan as well as the terms of reference by President Ryoji Noyori.

Members of the RIKEN PSC Advisory Council present at the 2011 meeting

Dr. Wilhelm Gruissem, Chair
ETH Zurich (Swiss Federal Institute of Technology), Switzerland

Dr. Peter McCourt
University of Toronto, Canada

Dr. Naoto Shibuya
Meiji University, Japan

Dr. Yoshikazu Tanaka
Suntory Limited, Japan

Executive Summary

Research in the RIKEN Plant Science Center continues to be excellent and of highest national and international visibility, despite a continuously eroding budget. New funding for programs in Green Innovation and Biomass Engineering are buffering the research programs, but to continue on a successful trajectory additional measures and funding are needed. PSC has built cutting edge technology platforms that drive innovative research in metabolism. Similar investments are needed to implement other quantitative technologies for systems biology to strengthen and expand translational research. The commitment to excellence will assure that PSC remains competitive among the internationally leading plant science centers.

General Comments

During phase 2 of the proposed 15-year program to improve plant productivity, PSC made strong investments in functional genomics technology platforms and outstanding advances in understanding **metabolic systems** associated with plant productivity in crops, trees and medicinal plants. Therefore PSC is now excellently positioned to address **Green Innovation** and **Life Innovation**, two key strategies of RIKEN and the Government of Japan. Considering our dwindling natural resources and increasing pressures on sustainable agriculture for food security, innovative plant research is becoming increasingly critical to

- replace fossil fuels and nuclear power with renewable resources (bioenergy)
- provide long-term sustainable food supply and increase the domestic supply of crops
- build renewable feedstocks for the chemical industry (bioproducts, nutri-pharmaceuticals)
- use plants as the basis for green innovation and the future of human society

The global challenges, but also recent tragic events in Japan have made clear that leading edge plant research must be at the center of Green Innovation, and that Japan, **RIKEN and PSC must take international leadership to provide solutions**. To accomplish the tasks required for Green Innovation requires a strong commitment not only to basic and applied

plant research, but also to strong and long-term funding—even considering the increase of funding plant research. PSAC members were therefore pleased to learn that despite budget pressures during the last three years RIKEN has now combined its “wisdom” and biomass research to launch the innovative **RIKEN Biomass Engineering Program** led by Director Kazuo Shinozaki and involving several universities and companies in Japan. Together with increasing success of PSC scientists to attract third party support for their research, RIKEN plant scientists are increasingly addressing the challenges for the society in Japan, but also challenges that humankind is facing (climate change, food security, energy security, sustainable economy, and bioproducts). They do this by **translating innovative research and discoveries in model plants to crops**. For example, new technologies to discover metabolite quantitative trait loci (QTLs) and hormone QTLs developed in PSC are now delivering important new findings for crop breeding strategies. Similarly, PSC scientists are developing mechanisms for mitigating abiotic (drought, heat, cold) and biotic stress (diseases), which are critical to world food security. This also includes environmental sustainability, such as removing heavy metal pollutants from the environment. PSC scientists are also beginning to address the **constraints of photosynthesis for biomass production**, which requires new approaches such **systems biology** to understand the function of underlying plant networks.

This exciting new development in RIKEN plant biology is only possible with the excellent technology infrastructure that allows PSC to do forefront plant research and thereby **advancing crop science**. However, PSC scientists also recognize their constraints in developing on site breeding strategies and testing crop plants in RIKEN. Therefore they collaborate with crop breeders in Japan and internationally to build a translational pipeline for their research program. Thus, PSC increasingly serves as an important **research hub** that links, for example, with innovative breeding strategies that are being developed in the Ministry of Agriculture and that are needed in the 21st century.

The Green Innovation strategy and especially the biomass engineering project represent an important and critical addition to the current and future PSC basic and applied research program. Many of the technologies and discoveries needed for Green Innovation and biomass engineering are already in place and therefore PSC scientists in collaboration with other plant scientists in Japan are in an excellent position to **tackle emerging problems**. PSC has accomplished this by responding thoughtfully to the Advisory Committee recommendations from 2008, especially also with respect to the Terms of Reference of President Noyori. Since it was established as part of the Millennium Project in 2000, PSC has rapidly become one of the internationally leading plant science centers in the world (comparable to Max-Planck Institutes in Germany, the John Innes Centre in the UK, or plant science at UC Berkeley). PSC research had and in the future will have enormous impact on plant science, especially for model plants, because of its commitment to contribute key resources and infrastructure to the plant science community in Japan and internationally.

During the last five years, PSC research has also expanded to important crop plants (rice, wheat, cassava, poplar) in translating discoveries from model plants to crop improvement. For example, the discovery of **strigolactones** has important implications for agriculture in Africa and the developing world. Similarly, the **RIKEN metabolomics platform** has delivered many new plant compounds and key genes that are of interest to the pharmaceutical and food industries. Also, transcription factors involved in **drought tolerance** that were discovered at RIKEN are now being tested in crop improvement programs at centers of the Consultative Group on International Agricultural Research (CGIAR) around the world. PSC scientists are also internationally leading the unraveling of **plant hormone networks** that underlie plant performance and production.

While driving a world-class research program, PSC also has a key role in education and training of young scientists, of whom many have left for academic and industrial positions

not only in Japan, but also internationally. Thus, plant scientists educated at RIKEN are internationally competitive for faculty positions.

In summary, PSAC members applaud RIKEN and PSC for their vision and commitment to strengthen basic and applied plant research for the benefit of mankind. The investments made today will have important payoffs in the future and position Japan among the nations that have responsibility to solve global problems. PSAC members remain unanimous in their opinion that the challenges addressed by PSC are of national and international importance and therefore must also be of highest priority for RIKEN and the Government of Japan.

Terms of Reference

The PSAC carefully reviewed the performance of PSC with respect to the Terms of Reference. The PSC mission, operations and strategic plans are well aligned with national needs and RIKEN's vision for society. As already noted in the last report, the PSC has clearly established itself a **key national plant research institute** that focuses on problems relevant for agriculture and society. The PSC technology platforms represent **important national resources** for the scientific community. Center operations and strategic planning under the leadership of Director Kazuo Shinozaki and Deputy Director Kazuki Saito are exemplary and contribute to the success of PSC.

Research themes are carefully chosen and built on the strong expertise of PSC scientists, as reflected by their involvement in new research strategies of national and international importance. **PSC scientists remain at the forefront of research** in plant metabolism, hormonal regulation of plant functions, as well as stress tolerance and yield stability. At the same time PSC has been building leading-edge functional genomics technologies for gene discovery and understanding metabolic networks.

With respect to the appropriateness of research promotion in terms of approach to research, research systems, equipment, budgets, etc., PSC in general follows a balanced policy that builds on excellence in basic and translational research. Strong investments were made recently in upgrading research instrumentation, especially in the metabolomics area. Similar **investments must now be made in proteomics**, which is becoming increasingly important to link the metabolites to their respective enzymes and genes. The infrastructure for quantitative proteomics in PSC is currently subcritical and needs further attention. To increase the value of their translational research, PSC should also **establish closer links to breeders in Japan**, especially molecular breeders who are familiar with the cutting edge technologies that drive the research in PSC. For example, PSC should invite breeders to the on a regular basis for seminars, symposia and discussions to inform PSC researchers about their needs and the real world of agriculture.

PSC continues to have an impressive output of **significant publications in high-ranking journals** and **patent applications**. Together with the John Innes Centre (UK), RIKEN PSC continues to have the highest impact in terms of citation per paper of institutions around the world. While many of the PSC research results address basic problems of plant function, the recent discoveries from research on striga, new methods for metabolic profiling, or phytoremediation of heavy metals clearly have potential for industrial and societal impact.

Since the last review **PSC has adopted a flat structure** that strengthens the leadership and responsibilities of team and unit leaders. This cohesive structure will further increase synergies among the members of different groups, which is key for the successful development of systems-oriented approaches in plant research.

Hiring, education and training of young RIKEN plant scientists remains excellent. During the last few years PSC has also made a strong efforts to hire **international young researchers**

and to **promote female scientists** into team leader positions. The PSC team and unit leaders are successful in securing third-party support, indicating that their research is competitive and well recognized. PSC has an impressive record of placing their researchers in highly competitive academic positions, both in Japan and internationally.

During the last three years, PSC has established **collaborations with other institutions in Japan** to build a leading-edge research infrastructure for realizing a low-carbon society. At the same time PSC has also consolidated interactions with international partner institutions and most importantly, established collaborations with CGIAR research centers.

Summary Recommendations:

- PSC continues to excel and remains internationally competitive despite the eroding RIKEN budget. The PSAC recommends, however, that strong and continued funding will be available for the **development of core programs**, especially for quantitative systems biology approaches related to translational research. PSC is internationally leading in this area, which spans from hormones (nanomolar scale) to metabolites (millimolar scale).
- Funding must be improved for **young PSC scientists to allow them to be competitive**. This includes competition for funding at the national level, to which young PSC scientists must have full and fair access, especially when submitting proposals in English. Foreign PSC (and RIKEN) scientists should not have to translate their proposals into Japanese!
- The U.S. and Europe are making strong investments in plant research for production of biomass and industrial feedstocks. Japan cannot fall behind, and a strong commitment should be made to maximize the synergy between PSC and the RIKEN Biomass Engineering Program by a coherent and effective alliance at the highest possible level.
- Considering global challenges discussed above, additional funding should be made available to **develop a coherent and internationally leading strategy for Green Innovation Technologies**. PSC scientists need to reach out to other research groups in chemistry, engineering, breeding, forestry, etc. to build linkages for their translational research. This is especially important because of the vast genomics information and expertise in PSC, which will be the foundation of Green Innovation Technologies.