Global Station for Food, Land and Water Resources

Global Institution for Collaborative Research and Education(GI-CoRE)

Hokkaido University

Final Evaluation Report

北海道大学　国際連携研究教育局

食水土資源グローバルステーション

外部評価報告書

July 2020

2020年7月

Final Evaluation Report
(brief version in Japanese)

外部評価報告書（日本語・概要版）

もくじ（日本語版）

はじめに

国際連携研究教育局（GI-CoRE）は、北海道大学の強みや特色を活かした国際連携研究教育の推進と、部局が独自に進める国際連携研究教育の支援を目的とし、世界トップレベルの教員を国内外及び学内から結集した総長直轄の教員組織です。

GI-CoRE 内には研究領域ごとの活動拠点である「グローバルステーション（GS）」を置き、各 GS において、原則 5 年間の設置期間内に重点的に研究教育活動を進めています。これまでに、延べ７つの GS（下記※を参照）を設置し、研究活動を推進するとともに、最先端の研究成果を大学院教育などに還元してきました。

GI-CoRE では、GS の設置期間満了を迎える年度に、各 GS でのこれまでの活動を振り返るとともに、今後、より強固かつ持続可能な研究教育体制を確立していくため、国内外の有識者により構成される外部評価委員会において、評価を実施することとしています。

この外部評価報告書は、2019 年 7 月に実施した食水土資源 GS の自己点検成果報告書及び外部評価結果を一冊に収録した、いわば GS の研究教育活動の集大成です。

なお、設置期間を満了した食水土資源 GS は、関連部局等に定着化し、2020 年 4 月以降も「GI-CoRE 協力拠点」として、GI-CoRE と連携しながら研究教育活動を継続しています。

本学では、外部評価結果を踏まえ、より充実した研究教育活動を実践していくことにより、世界の課題解決に貢献していきたいと考えております。

北海道大学 国際連携研究教育局
局長代行（総長代行）
笠　原　正　典

※これまでに設置したグローバルステーション（GS）

GS 名	設置期間（年度）	主な学内連携部局等
量子医理工学	2014～2019	医学研究院、大学病院ほか
人獣共通感染症	2014～2019	人獣共通感染症リサーチセンター、獣医学研究院
食水土資源	2015～2019	農学研究院ほか
ソフトマター	2016～2020	先端生命科学研究院ほか
ビッグデータ・サイバーセキュリティ	2016～2020	情報科学研究院ほか
北極域研究	2016～2020	北極域研究センターほか
バイオサーフィス創薬	2019～2023	薬学研究院ほか

国際連携研究教育局(GI-CoRE)
食水土資源グローバルステーション
外部評価委員

*元　筑波大学・生命環境系教授　奥野　員敏　氏

ビクトリア州農業庁事務局次長 兼 農業研究部門長
ラ・トローブ大学応用システム生物学部長
ハーマーン・スパンゲンベルグ　氏

シンガポール国立大学　准教授・副学長補佐
タン・チョーン・エ・ロジャー　氏

*委員長

国際連携研究教育局(GI-CoRE)
食水土資源グローバルステーション
外部評価委員会実地調査要領

１．調査日程

令和元（2019）年 7 月 23 日（火）～25 日（木）

２．詳細スケジュール

7 月 23 日（火）	
9:00～15:00	（Tan 委員のみ） 木村水産学研究院長との懇談 水産科学研究院における GSF 活動の視察・調査

7 月 24 日（水）	
9:30～9:55	笠原 GI-CoRE 局長職務代理からの挨拶・趣旨説明

7 月 25 日（木）	
9:00～9:45	GI-CoRE 及び食資源学院の概要説明（井上 GS 長）
9:45～10:00	授業見学（「食資源学総論」（山田教授＋パウエル教授）
	休憩
10:30～12:00	施設見学
12:00～13:10	ランチミーティング（井上 GS 長及び関係教員）
13:15～13:30	西邑農学研究院長との懇談・農学研究院の概要説明
13:30～16:00	評価委員打合せ
16:00～17:00	評価委員による講評

国際連携研究教育局(GI-CoRE)
食水土資源グローバルステーション
外部評価調書の概要（参考和訳）

1. 外部評価委員会

（委員長）元 筑波大学教授　奥野　員敏（オクノ カズトシ）
Dr. Kazutoshi Okuno, Former Professor, University of Tsukuba
（委　員）ビクトリア州農業庁、ラ・トローブ大学（オーストラリア）
ハーマーン・スパンゲンベルグ
Dr. German C. Spangenberg, Agriculture Victoria / La Trobe University (Australia)
（委　員）シンガポール国立大学（シンガポール）　タン・チョーン・エ・ロジャー
Dr. Roger Choon Ee Tan, National University of Singapore (Singapore)

2. 外部評価委員会の任務

2015 年度に国際連携研究教育局（GI-CoRE）の三番目のグローバルステーションとして設置された食水土資源グローバルステーション（GSF）は、北大の内外より卓越した研究者を招へいし、国際連携研究・教育に従事している。評価にあたって提供された書類全般と現地調査をふまえ、外部評価委員会による GSF の第一期である 2015 年から 2019 年の最終評価を行う。

3. 評価

総合評価：A

最終評価および現地調査に係る自己点検成果報告書に基づき、国際連携研究教育局の GSF における第一期である 2015 年から 2019 年の総合評価は“**非常に優れている（A）**”である。

（コメント）

１）北海道大学の学際的組織の補完的な強みと、海外大学および海外機関との連携により、５件の国際連携研究・教育プロジェクトが確立された。

２）これらの研究テーマは、持続可能な開発目標（SDGs）に沿って、食料、土地、水資源に関する特定の地域は元より世界規模での問題解決に焦点を当てている。研究成果は、国際食資源学院の教育プログラムの強化策としてフィードバックされている。

３）先導的な成果と関連した影響を強化するための戦略的かつ主要なプロジェクトの開発のために、研究活動を支援するための外部資金の獲得、成果を向上させるための海外連携先からの共同資金調達、および海外連携機関の選択に関する明確な基準の定義が必要である。

４）2015 年から 2019 年の期間に GI-CoRE に参画する北大教員による査読済み論文の質と量は、GSF の今後の研究プロジェクトの発展に向けては、優れたベースラインであると言える。しかし、上記と比較すると、国際共著論文は現段階においては、消極的

であることは否めない。主に国際共同研究において求められる論文の数および質を向上させるためには、明確な評価指標（KPI）を設定する必要がある。

５）グローバルな視点での GI-CoRE の研究アウトカムは、人類にとって喫緊の課題である飢えと貧困、食の安全と教育など、SDG s と完全に一致している。しかし現時点で、社会実装について研究成果を評価するのは時期尚早である。研究プロジェクトのうち、バイオマーカーを使用したセンシング技術および漁業管理対策に関する二つのプロジェクトには、それぞれ農業生産および食料資源の収穫後の品質管理における地方とグローバルな関連性、東南アジアにおける持続可能な漁業社会的影響の実装につながる可能性を秘めている。

６）研究成果と予測に対応する管理の評価を促進するためには、独自の評価システムの開発を強く推奨する。次の段階では、研究成果を即時に社会的アウトカムへの実装を促進するために、新たな資金源が望まれる。

７）国際食資源学院は、専門的な知識を有し積極的に国際社会で活躍する能力を備えた人材育成のための教育上の枠組と課程として機能している。大学院プログラムは、研究成果の投下、海外連携機関の教員による講義、海外でのワンダーフォーゲル型実習という斬新な現場体験により活用され、グローバルな視点を持つ卒業生を生み出している。

８）今後取るべきフォローアップとして、大学院における所期の教育および学修効果があがっているかどうかを、より適切に測定するために、卒業生および雇用先企業等のフィードバックを取り入れる必要がある。

９）GSF には国際連携研究・教育を遂行する制度と枠組みは確立されている。今後農学研究院に定着化した後も連携研究・教育を支援するための日常的な事務支援体制は継続していくべきである。

１０）北海道大学の可能性を最大限に引き出すために、より多くの北大教員が積極的に参画し、彼らがこの革新的な研究・教育の取り組みにどのように関与できるのかについて学内でさらに調査、審議、検討していく必要がある。

包括的な提言

１）委員会は、2020 年度以降、GSF を第二期へ継承されることを強く推奨する。

２）委員会は、農学研究院への定着化について受け入れるものの、うまく機能していた GI-CoRE の基本概念との調和が図られるよう、勧告する。

３）委員会は、GSF に参画する各教員に対して、外部の競争的資金を獲得するための大規模な学際的補助金申請の立ち上げに重点的に取り組むことを強く推奨する。例えば、SATREPS（サトレップス-地球規模課題対応国際科学技術協力）や食農ビジネス推進センターの革新的研究プログラムは日本における潜在的な資金源として有力な候補である。

Final Evaluation Report
(original version in English)

外部評価報告書（英語・オリジナル版）

Contents

Foreword

Hokkaido University established the Global Institution for Collaborative Research and Education (GI-CoRE) as a faculty organization under the direct control of the President that brings together world-class researchers from around the world and within the University. It aims to promote international collaborative research and education that leverages the University's strengths and distinctive features as well as to provide support for international collaborative research and education promoted by faculties and centers, respectively.

Under the GI-CoRE system, a research and education hub known as a Global Station (GS) is implemented for each research field. GSs have a finite implementation period of five (5) years in principle to conduct intensive research and education activities. Thus far, seven (7) GSs in total (see * below) have been implemented to further develop research activities and contribute the resulting cutting-edge research outcomes to graduate school education.

In the final year of the GI-CoRE project period, a Final Evaluation is conducted by the External Evaluation Committee composed of global experts outside Hokkaido University for each GS to not only review GS activities from past years but also build a stronger and more sustainable research and education system in the future.

This Final Evaluation Report contains the Research Progress Report of GS for Food, Land and Water Resources (GSF) conducted in July 2019 and the evaluation results. This report is a compilation of the research and education activities of GSF.

After the implementation period, GS projects are transitioned into affiliated faculties and centers, then certified as "GI-CoRE Cooperating Hubs" to continue research and education activities in cooperation with GI-CoRE after April 2020.

Hokkaido University remains committed to continuing its efforts to contribute to resolving global issues by conducting advanced research and education activities based on evaluation results.

Professor Masanori Kasahara, M.D., Ph. D.
Interim Director
Global Institution for Collaborative Research and Education (GI-CoRE)
Hokkaido University
(Interim President, Hokkaido University)

*The Global Stations (GSs) implemented thus far.

Name of the GS	Implementation Period (FY)	Main Internal Affiliation
Quantum Medical Science and Engineering	2014–2019	Faculty of Medicine, University Hospital, and others
Zoonosis Control	2014–2019	Research Center for Zoonosis Control and Faculty of Veterinary Medicine
Food, Land and Water Resources	2015–2019	Research Faculty of Agriculture and others
Soft Matter	2016–2020	Faculty of Advanced Life Science and others
Big Data and Cybersecurity	2016–2020	Faculty of Information Science and Technology and others
Arctic Research	2016–2020	Arctic Research Center and others
Biosurfaces and Drug Discovery	2019–2023	Faculty of Pharmaceutical Sciences and others

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
External Evaluation Committee

*Dr. Kazutoshi Okuno,
Former Professor, Faculty of Life and Environmental Sciences,
University of Tsukuba (Japan)

Dr. German C. Spangenberg,
Deputy Secretary, Agriculture Research and Head, Agriculture Victoria Research,
Agriculture Victoria; Head, School of Applied Systems Biology, La Trobe University (Australia)

Dr. Tan Choon Ee Roger,
Associate Professor/Associate Vice President in the Office of the President,
National University of Singapore (Singapore)

*Chair

平成３１年３月18日

国立大学法人北海道大学　国際連携研究教育局
局長職務代理　殿

元 筑波大学生命環境系教授　奥野 員敏

職員の任命について（回答）

平成３１年３月１３日付け海大国連第６号で依頼のありましたこのことについて，下記のとおり回答します。

記

☑　承諾いたします。

職名・氏名　　元 筑波大学生命環境系教授　奥野 員敏
任命期間　　平成３１年４月１日～平成３２年３月３１日

☐　承諾いたしかねます。

Attachment

Letter of Acceptance

11 / 07 / 2019

To Acting Director Masanori Kasahara of the Global Institution for Collaborative Research and Education (GI-CoRE), the National University Corporation Hokkaido University.

I hereby accept my appointment to serve as a member of the External Evaluation Committee for the Global Station for Food, Land and Water Resources at the Global Institution for Collaborative Research and Education (GI-CoRE), Hokkaido University.

Signature

Professor German Spangenberg

Attachment

Letter of Acceptance

16 /03/ 2019

To Acting Director Masanori Kasahara of the Global Institution for Collaborative Research and Education (GI-CoRE), the National University Corporation Hokkaido University.

I hereby accept my appointment to serve as a member of the External Evaluation Committee for the Global Station for Food, Land and Water Resources at the Global Institution for Collaborative Research and Education (GI-CoRE), Hokkaido University.

Signature

Dr. Tan Choon Ee Roger

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education(GI-CoRE)
Schedule of the External Evaluation Committee

1. Date of Implementation
   Tuesday, July 23 - Thursday, July 25, 2019

2. On-site Investigation Schedule

Tuesday, July 23	
9:00am - 3:00pm	（Committee Member Tan only） Casual meeting with Dean Nobuo Kimura, Faculty of Fisheries Sciences On-site Investigation for GSF activities at Faculty of Fisheries Sciences

Wednesday, July 24	
9:30am - 9:55am	Casual meeting and briefing with Acting Director, Masanori Kasahara, GI-CoRE

Thursday, July 25	
9:00am - 9:45am	Briefing about GSF-GI-CoRE/Graduate School of Global Food Resources by Prof. Takashi Inoue, Director of GSF
9:45am - 10:00am	Lecture review（”Introduction to Global Food Resources” by Prof. Toshihiko Yamada & Prof. Wayne Powell）
	Break
10:30am - 2:00pm	Facility tour
12:00pm - 1:10pm	Luncheon meeting with Prof. Takashi Inoue and other faculty members
1:15pm - 1:30pm	Casual meeting and briefing with Dean Takanori Nishimura, Research Faculty of Agriculture
1:30pm - 4:00pm	Discussion among committee members
4:00pm - 5:00pm	Review from the committee to the faculty members

Results of the Evaluation Committee

Evaluation Committee
Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
Hokkaido University

October 2019

Summary Report

1. External Evaluation Committee
   Dr. Kazutoshi Okuno, formerly University of Tsukuba, Japan (chair)
   Dr. German Spangenberg, Agriculture Victoria / La Trobe University, Australia
   Dr. Roger Choon Ee Tan, National University of Singapore, Singapore

2. Mission of the Committee
   Since the Global Station for Food, Land and Water Resources (GSF) was launched as the third global station in the Global Institute for Collaborative Research and Education (GI-CoRE) in FY2015, GSF has conducted international collaborative research and educational project that gathers outstanding researchers from both within and outside of Hokkaido University. Based on consideration of all the documents provided as the basis for the review and on-site investigation, the External Evaluation Committee undertakes the final evaluation of the performances of GSF in the first phase for the period of 2015-2019.

3. Evaluation

Overall evaluation

Based on the Research Progress Report provided for review and the on-site investigation, the overall evaluation of GI-CoRE GSF in the first phase for the period of 2015-2019 is considered as “Excellent (A)”.

Comments

1) Five international research and educational projects have been established by leveraging on complementary strengths in interdisciplinary organization at HU and in collaboration with overseas universities and institutes.
2) These research topics focus on the challenges for solving both local problems and some global issues in food, land and water resources, aligned with Sustainable Development Goals (SDGs). Research outputs are in turn fed back to enhance the educational programs at the Graduate School of Global Food Resources.
3) Development of strategic key projects to enhance initiative outcomes and associated impact, attracting external funding to support research endeavors, co-funding from overseas partners to enhance outcomes and defining clear criteria for the choice of overseas partners are required.
4) The number and quality of the peer-reviewed publications by HU faculties involved GI-CoRE for the period of 2015-2019 are excellent baseline for building future progress in research projects of GSF. However, compared with the above, the number of joint publications generated by international collaborative researches are modest at the current stage. Setting clear Key Performance Indicator (KPI) is required to enhance the number and quality of publications expected, primarily arising from international collaborative research.
5) Research outcomes from GI-CoRE with global perspectives are in full alignment with SDGs including hunger and poverty, food security and education which are essential social issues for mankind. However, it is premature to assess research achievements based on the social implementation at the current stage. Among research projects, two projects on sensing technologies using biomarkers and fisheries management measures have the potential for social impact implementation in agricultural production and post-harvest quality management of food resources which have local and global relevance and sustainable fisheries in Southeast Asia, respectively.

6) Development of a novel evaluation system is highly recommended to facilitate assessment of outcomes and management of corresponding expectations. New source of funding is desired to facilitate immediate implementation of research outputs to achieve societal outcomes in the next phase.
7) The Graduate School for Global Food Resources has served as educational structures and courses to produce human resources with expert knowledge and ability to play an active role internationally. The graduate programs have been leveraged by investment of research outputs, lectures by overseas partners and novel on-site Wandervogel study field trip abroad to produce graduates with global perspectives.
8) Follow-up action to take should include the adoption of graduates and employers' feedback to better measure whether the teaching and learning outcomes are met as set out by the graduate school.
9) The system and framework to conduct international collaborative research and education project in GSF have been established. Administrative support has been put in place to assist collaborative research and education in daily operations and should be extended to the next phase when GSF is subsumed in the Research Faculty of Agriculture.
10) The active participation of more HU faculties and how they can be involved in this innovative research and education endeavor should be further explored, deliberated and discussed internally in HU to optimize the full potential of Hokkaido University.

Comprehensive recommendations

1) The Committee highly recommends that GSF is extended to the second phase from FY2020.
2) Although the Committee accepts that the GSF will be internalized within the Research Faculty of Agriculture, it cautions that the attention is paid to harmonization with the fundamental concept of GI-CoRE that has served and worked well.
3) The Committee strongly recommends that each of the GSF faculty members should focus on efforts developing large scale multidisciplinary grant application to attract external competitive funds. For instance, SATREPS (Science and Technology Research Partnership for Sustainable Development) and the innovative research program of Agri-Food Business Innovation Center are influential candidates for potential funding sources in Japan.

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
Final Evaluation

External Evaluation Committee Member Name:　Dr. Kazutoshi Okuno

Choose one of the five Evaluation Ratings options below as explained by the Evaluation Explanation for each Evaluation Item on the form.

Evaluation Ratings	Evaluation Explanation
S	Achieved outcomes surpassed the original plan (Outstanding)
A	Good progress has been maintained and expected outcomes have been achieved (Excellent)
B	Most expected outcomes have been achieved with some slight delays (Good)
C	Although certain outcomes were achieved, overall results were insufficient (Satisfactory)
D	No expected outcomes were achieved (Unsatisfactory)

I.　Research

1.　Has construction of an international research and education center capable of attracting outstanding researchers from around the world (including from HU) been achieved?

Evaluation Results and Reasons

(Your Evaluation Results)

S /Ⓐ/ B / C / D (circle one)

(Reasons)

Since Global Station for Food, Land and Water Resources (GSF) was launched as the third global station under the concept in Global Institution for Collaborative Research and Education (GI-CoRE) in April, 2015, GSF has constructed the platform to strengthen international collaborative research and education projects by great efforts of interdisciplinary faculty members at Hokkaido University in collaboration with leading overseas universities and research institutions. GSF has focused on the following collaborative research projects, (1) Sensing technologies for detection of biomarkers in animals, plants and microbes, (2) Nitrogen cycles and microbes in the environment, (3) Collaborative effort on utilization of enzyme-assisted kelp for production of biofuels and health benefits, (4) Mechanism of fungicide resistance in pathosystems and host-pathogen interactions in grasses and (5) Fisheries management measures for multi-species, multi-method fisheries in Asia. These research projects are underway involving challenges for the resolution of some global issues associated with food, land and water resources. Based on research activities and achievements in the past four years, the researches at GSF are highly

expected to be further accelerated in the next phase. On the other hand, since the Graduate School for Global Food Resources was opened in FY2017, education program at the graduate school has been well managed and improved by leveraging strengths of GI-CoRE initiative.

Specific points
(Outstanding points)
Interdisciplinary organization within Hokkaido University is an indispensable and unique structure to develop new research fields in collaboration with leading overseas universities and research institutions and to produce comprehensive research outputs and outcomes. GSF has given a great impact on younger faculties and graduate students to grow up and upgrade their talents through international collaboration on research and education. GSF has made progress in five collaborative research topics, particularly the topic on "Sensing technologies for detection of biomarkers in animals, plants and microbes" has been investigated by the international collaboration among Hokkaido University, University of Sydney and Iowa State University and the integration between public and private sectors within Japan. This research group has produced remarkable outputs which can be applied to a broad range of academic and practical uses to monitor the metabolic changes in animals, plants and microbes.

(Suggestions for improvement)
When GSF will move on the second phase in FY2020, Hokkaido University has a strategic initiative for funding to secure sustainable actions of GSF. Emphasis should be placed on consistent efforts of GSF faculty members to capture competitive funds from diverse funding mechanisms by leveraging GSF's strengths on basis of interdisciplinary organization and international research collaboration. In addition to Hokkaido University, overseas researchers in collaborating universities and institutions may be also required to share a part of the responsivities to ensure the research funds.

2. Based on the tradition of Sapporo College and strengths of Hokkaido University, is world-leading cutting-edge international cooperative research in the field of food, land, and water resources studies underway?

Evaluation Results and Reasons
(Your Evaluation Results)
S /Ⓐ/ B / C / D (circle one)

(Reasons)
GSF has facilitated five joint research projects which focus on challenges for some globally important issues on food, land and water resources. Although the progress of each project is variable, all the projects are underway in the collaboration of Hokkaido University with overseas universities and institutions. The number and quality of the peer-reviewed articles published in international journals by Hokkaido University faculties participating in GI-CoRE GSF in the past four years are excellent in addition to oral presentations.
Specific points
(Outstanding points)

The identified research topics in GI-CoRE GSF have tackled globally important issues toward similar goals to the Sustainable Development Goals (SDGs) including hunger and poverty, food security, education equalization and conservation of biological diversity. Many publications involving international joint papers are excellent and may form the baseline for future actions of GSF.

(Suggestions for improvement)
If agreeable, annual evaluation system at advisory committee can be built up to discuss annual research performances, goal attainment level and next year's plan. The number of international joint papers published in international high-quality journals during the period of 2015-2019 seem to be unsatisfactory but it may be enhanced with the advance in collaborative researches in the next phase. Overall international collaborative research projects at GSF should be more accelerated to lead these research areas worldwide in the next phase.

3. Are research outcomes from GI-CoRE being actively utilized to solve social issues?

Evaluation Results and Reasons
(Your Evaluation Results)
S / A /Ⓑ/ C / D (circle one)

(Reasons)
Most of research projects are currently ongoing at basic science and technology level. The present time may not be appropriate to assess the utilization of research outcomes from GI-CoRE to solve social issues. In general, since there is time lag between research outputs and outcomes, inputs of personnel allocation and budget specified for social implementation research are required to generate outcomes. Research outcomes from GI-CoRE will be efficiently and effectively used for the resolution of global and local problems associated with food, land and water resources in the next phase.

Specific points
(Outstanding points)
Among five research projects, the project on "Sensing technologies for detection of biomarkers in animals, plants and microbes" has been conducted by the international collaboration among Hokkaido University, University of Sydney and Iowa State University and the close relation between public and private sectors within Japan. This research group has produced remarkable outputs which can be applied to a broad range of academic and practical uses to monitor the metabolic changes in animals, plants and microbes. Moreover, research outcomes generated by this group have a great impact on agricultural production and post-harvest quality management of food resources in both developed and developing countries worldwide.

(Suggestions for improvement)
It is necessary to clarify the road map which indicates shifting process from research outputs to outcomes, involving the representative recipients of outcomes and the examples of social issues to be solved.

II. Education

Is the educational system and curriculum designed to help develop researchers who possess specialized knowledge and are capable of working internationally?

Evaluation Results and Reasons

(Your Evaluation Results)

S /Ⓐ/ B / C / D (circle one)

(Reasons)

The Graduate School for Global Food Resources was set up in FY2017. The educational structures of the graduate school are well designed and managed in close integration with fruits generated from GI-CoRE GSF. The activities and achievements of GSF have been fed back to teaching and learning programs for graduate students. Therefore, it is concluded that the Graduate School for Global Food Resources has served as educational structures and courses to raise human resources with both global and local expert knowledges and ability to play an active part internationally and nationally.

Specific points

(Outstanding points)

Teaching programs by visitors from collaborating overseas universities and institutes are successfully incorporated into the curriculum for graduate students. Such programs can highly contribute to upgrading the knowledge and research skills associated with global food, land and water resources. On-site work in the Wandervogel Study program is an innovative experience for learning current global constraints of food resources in both developed and developing countries.

(Suggestions for improvement)

Follow-up of graduates is required to improve the educational structures and curriculum at the Graduate Scholl for Global Food Resources. Moreover, employers' assessment of graduates is recommended to be conducted by interviewing or questionnaire survey.

III. Establishment of Framework

Are the necessary systems and frameworks being established in order to conduct international cooperative research and education?

Evaluation Results and Reasons

(Your Evaluation Results)

S /Ⓐ/ B / C / D (circle one)

(Reasons)

The system and framework necessary to conduct international collaborative research and education have been established based on the collaborative activities and achievements gained over the past four years. Further progress

in international collaborative research and education will be made year by year.

Specific points

(Outstanding points)

Interdisciplinary approach at GSF has played a significant role in promoting international collaborative research and education and in generating a new comprehensive research area comprising production, environment and governance. Management system necessary to accept overseas researchers and administrative system has been fully established and improved.

(Suggestions for improvement)

In the second phase starting from FY2020, it is proposed that GSF may be internalized and fixed in the Research Faculty of Agriculture, instead of keeping the current organization under the direct affiliate of GI-CoRE. Although this rearrangement of GSF is a realistic choice to maintain its activities and to solve budgetary problems, it may conflict with the concept of GI-CoRE. It is necessary to more discuss the internalization and fixation of GSF in Research Faculty of Agriculture to reach to the final decision.

IV. Overall Evaluation

Based on the Self-assessed Progress Report provided to review and on-site investigation, the overall assessment of the performances of GI-CoRE GSF at the first stage during the period 2015-2019 is ranked as “excellent”.

Recommendations are as follows.

1. It is highly recommended that GSF will be extended to the second phase starting from FY2020 in leveraging strengths excellent performances accumulated in the first stage. In the next phase, GSF is planned to be internalized and fixed in the Research Faculty of Agriculture. While considering the reduction of university’s core budget, the internalization and fixation of GSF in the Research Faculty of Agriculture is a realistic alternative to sustain successful research activities in GSF. Attentions should be paid to the harmonization between new organization and the concept of GI-CoRE initiative.
2. GSF is challenging to solve the current global issues including poverty and hunger in developing countries under global warming. Researches associated with the enhancement of crop productivity and production in arid land and under water deficit conditions are recommended during the period of the next phase.
3. Funding strategies are quite required to sustain research activities in GSF. In addition to KAKENHI, each research group should concentrate on the gain of relatively large scale of research budgets from various funding mechanisms. For instance, SATREPS (Science and Technology Research Partnership for Sustainable Development) and innovative research program of Agri-Food Business Innovation Center, NARO are influential candidates of budgetary sources in Japan.
4. Follow-up of graduates and assessment by employers are recommended to upgrade teaching and learning materials at the Graduate School of Global Food Resources in near future.

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
Final Evaluation

External Evaluation Committee Member Name: Dr. German Spangenberg FTSE PSM

Choose one of the five Evaluation Ratings options below as explained by the Evaluation Explanation for each Evaluation Item on the form.

Evaluation Ratings	Evaluation Explanation
S	Achieved outcomes surpassed the original plan (Outstanding)
A	Good progress has been maintained and expected outcomes have been achieved (Excellent)
B	Most expected outcomes have been achieved with some slight delays (Good)
C	Although certain outcomes were achieved, overall results were insufficient (Satisfactory)
D	No expected outcomes were achieved (Unsatisfactory)

I. Research

1. Has construction of an international research and education center capable of attracting outstanding researchers from around the world (including from HU) been achieved?

Evaluation Results and Reasons

Your Evaluation Results: **A**

Five international research and educational projects bringing together researchers from within and outside of Hokkaido University were established. The projects currently underway are: 1. Sensing technologies for detection of biomarkers in animals, plants and microbes; 2. Nitrogen cycles and microbes in the environment; 3. Utilization of enzyme-assisted kelp for production of biofuels and health benefits; 4. Mechanisms of fungicide resistance in patho-systems and host-pathogen interactions in grasses; and 5. Fisheries management measures for multi-species, multi-method fisheries in Asia.

This provides evidence for the objective having been achieved. These projects involve faculty members from Hokkaido University and overseas Universities and research organizations in USA, Australia, New Zealand and Thailand.

Specific points

It is highly commendable for Hokkaido University to have established a GI-CoRE in the field of agriculture

resources and global food systems. The leadership of Hokkaido University should be applauded for this most important initiative to harness multi-disciplinarity and inter-disciplinarity in research and innovation addressing important humanitarian outcomes as outlined in the Millennium Development Goals. It is further important to note that the level of investment in this initiative is relatively low comparatively with its grand ambitions. Consequently, it is recommended that Hokkaido University retains same (if not increased) level of investment in this essential and noble initiative.

An overarching opportunity for improvement in shaping the next phase of this initiative is the definition of key performance indicators (KPIs) that are SMART (i.e. specific, measurable, achievable, realistic and timebound) and provide Headline Indicators of impact and Specific Targets* that inform an *ex ante* economic analysis and the scoping and resourcing of a research and innovation program that is strictly aligned to and addressed these. Being clearer about the strategic intent and the specific outcomes being sought will provide a better foundation for the future. There would also be merit in considering as further opportunities for improvement:

a) Developing a broader based, larger-scale, multi-faculty, priority, strategic key project (rather than what appears to be a seemingly *ad-hoc* suite of small-scale research projects) to enhance initiative outcomes and associated impact;
b) Attracting external (i.e. non-Hokkaido University) funding to support research endeavors with particularly emphasis to be placed here and external revenue targets being embedded in KPIs for the next phase of the initiative;
c) Leveraging resources and investment from Hokkaido University by securing co-investment contributed from overseas partner research organization to enhance outcomes;
d) Defining criteria for the choice of the overseas collaborating partner research organizations and embracing an element of renewal/rejuvenation of collaborating research partner organizations/faculty.

Considering current capabilities and status of this GI-CoRE and underpinning GFS as well as the above opportunities for improvement, the development of a larger key project – genuinely integrative – building on sensor technologies as a platform; aligning associated industry and agribusiness potential partnerships and co-investment; converging science discipline expertise of faculty across the GI-CoRE; converting the research farm at the Hokkaido University into a 'SmartFarm' innovating, integrating, validating and demonstrating novel AgTech technologies; is recommended as an opportunity for GI-CoRE to seek a major grant from Japanese funding agencies (rather than smaller grants) and leveraging it with significant external co-investment.

*Examples of Headline Indicators and Specific Targets in Strategic Action Plans from Agriculture Victoria Research provided

2. Based on the tradition of Sapporo Agricultural College and strengths of Hokkaido University, is world-leading cutting-edge international cooperative research in the field of food, land, and water resources studies underway?

Evaluation Results and Reasons

Your Evaluation Results: **A - B**

Cooperative research in the field of food, land and water resources is currently underway in this GI-CoRE. The suite of collaborative research projects involve faculty from leading Universities, obviously including Hokkaido University. Whilst assessment of leadership qualities is relative; and would thus be facilitated by the *a priori*

definition of KPIs.

Specific points

The number and quality of the peer-reviewed publications generated by Hokkaido University faculty involved in this GI-CoRE over the 2015-2018 period is excellent, including the wide range of national and international presentations. This is an excellent foundation for the future and could be further enhanced by setting SMART KPIs. Comparatively, the publication outcomes from international collaborative research is very modest at the current stage, however, it is expected/hoped to increase as manuscripts arising from the collaborative research projects between Hokkaido University faculty and collaborating overseas faculty in this GI-CoRE are submitted and published over the next couple of years. Particular attention should be paid to monitoring publication outcomes in this context; and as referred to in the comments to the previous question – this could be included as specific KPIs as well as criteria for the selection/renewal of overseas collaborating research organizations and faculty. A significant increase in the science outputs (i.e. peer-reviewed international publications in high-impact journals) as well as intellectual property outputs (i.e. patent applications) and external revenues (i.e. grant funding and co-investment from non-Hokkaido University sources) must be essential targets closely monitored and evaluated in the next phase of the GI-CoRE initiative.

3. Are research outcomes from GI-CoRE being actively utilized to solve social issues?

Evaluation Results and Reasons

Your Evaluation Results: **A - B**

The outcomes from GI-CoRE as a combined, multi-disciplinary research and education initiative with a global perspective in a most fundamental field such as global agriculture resources and foods systems in full alignment with the Millennium Development Goals including reducing poverty, enhancing food security, improving education, reducing inequality unequivocally addresses essential social issues for humankind.

Specific points

The integrative approach including production, environment and governance lenses in shaping GSF and GI-CoRE is most appropriate. Reframing it in alignment with the Sustainable Development Goals provides a renewed opportunity for the next phase of this GI-CoRE. Needless to stress that demonstrating the delivery of outputs aligned with outcomes to achieve impact requires time. Consequently, it is too premature to assess achievement of outcomes at this timepoint. It is not unusual for utilization of research and innovation outputs in agriculture sciences to have a lead time of 5 – 10 years before impact realization and with follow-up adoption rates to peak at 20 years timepoint post publication of research outputs. However, the on-site investigation unequivocally demonstrated a strong commitment to genuinely deliver social outcomes. Here again, the articulation of headline indicators as stretched targets that reflect the strategic intent of the next phase of the GI-CoRE initiative and drive its research and innovation portfolio (including *ex ante* impact analyses) would facilitate future assessment of outcomes and management of corresponding expectations. The development of a Monitoring and Evaluation Framework (MEF) for the next phase of this GI-CoRE initiative is strongly recommended.

II. Education

Is the educational system and curriculum designed to help develop researchers who possess specialized knowledge and are capable of working internationally?

Evaluation Results and Reasons

Your Evaluation Results: **A - B**

The Graduate Schools seem to serve well as educational structures and courses to develop human resources with expert knowledge and ability to take an active role internationally. The GS GFR has met its objectives in supporting and contributing to the achievement of the educational outcomes of this GI-CoRE.

Specific points

The Graduate Schools form a wonderful resource to deliver the educational outcomes expected of the GI-CoRE in its pursuit of developing the knowledge workforce of the future with a global citizen perspective, values and skills-base.

There is an opportunity for improvement in developing a clearer strategy for the educational outcomes sought, enhanced *a priori* coordination in the curriculum and scope of the teaching activities undertaken through the courses delivered by Hokkaido University faculty and overseas Universities faculty is essential and particularly important noting the – understandably – wide range of discipline background of students involved.

III. Establishment of Framework

Are the necessary systems and frameworks being established in order to conduct international cooperative research and education?

Evaluation Results and Reasons

Your Evaluation Results: **A**

The system and framework necessary to conduct international collaborative research and education has been certainly established through the formation of this GI-CoRE in such an essential field of human endeavor; establishing a suite of collaborative research projects with leading overseas Universities, and an accompanying educational program of courses delivering research and educational outcomes successfully with a global perspective. This is a most important outcome to be celebrated and forms an excellent foundation for shaping the next phase of this visionary and transformational research, innovation and educational initiative of Hokkaido University.

Specific points

Some suggestions for improvement relating to development of strategy, headline indicators of targeted impact, KPIs, etc. are referred in previous sections.

IV. Overall Evaluation

Based on the site investigation and consideration of all the documentation provided as basis for the review, the overall assessment of GI-CoRE in its initial phase is considered as “excellent”.

It is highly commendable for Hokkaido University to have established a GI-CoRE in the field of agriculture resources and global food systems. The leadership of Hokkaido University should be applauded for this most important initiative to harness multi-disciplinarity and inter-disciplinarity in research, innovation and education addressing important humanitarian outcomes as outlined in the Millennium Development Goals. It is further important to note that the level of investment in this initiative is relatively low comparatively with its grand ambitions. Consequently, it is recommended that Hokkaido University strongly supports this essential and noble initiative in its next phase, providing ongoing funding as well as attracting external co-investment.

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
Final Evaluation

External Evaluation Committee Member Name: Dr. Roger C. E. Tan

Choose one of the five Evaluation Ratings options below as explained by the Evaluation Explanation for each Evaluation Item on the form.

Evaluation Ratings	Evaluation Explanation
S	Achieved outcomes surpassed the original plan (Outstanding)
A	Good progress has been maintained and expected outcomes have been achieved (Excellent)
B	Most expected outcomes have been achieved with some slight delays (Good)
C	Although certain outcomes were achieved, overall results were insufficient (Satisfactory)
D	No expected outcomes were achieved (Unsatisfactory)

I. Research

1. Has construction of an international research and education center capable of attracting outstanding researchers from around the world (including from HU) been achieved?

Evaluation Results and Reasons

(Your Evaluation Results)

S /Ⓐ/ B / C / D (circle one)

(Reasons)

Research teams from within and outside Hokkaido University (HU) have been gathered to leverage on complementary strengths in establishing some strong inter-disciplinary research themes to collaborate on five identified projects, namely, (i) Sensing technologies for detection of biomarkers in animals and microbes; (ii) Nitrogen cycles and microbes in the environment; (iii) Collaborative effort on utilization of enzyme-assisted kelp for production of biofuels and health benefits; (iv) Mechanism of fungicide resistance in pathosystems and host-pathogens interactions in grasses; (v) Fisheries management measures for multi-species, multi-method fisheries in Asia.

Specific points

(Outstanding points)

These five broad research topics have both local relevance as well as international interest to solve some of the global issues and problems in Food, Land and Water Resources. Each of these projects is either headed by a local junior or an experienced Professor from HU with collaboration from a good spread of researchers from some reputable partner universities abroad working in these related areas. There is a good balance of local (within HU system) and international collaborators and this is important to ensure local talent are properly supported and nurtured within the HU system and provide them opportunity to grow and build up these areas of research. Some of the overseas collaborators make regular visits to HU and also contributed to the graduate education through the Graduate School of Global Food Resources (GFR). This is a very good move as research should enhance education and vice versa in a seamless manner. The graduate school is an excellent conduit to sieve out and provide a stream of talented prospective students for their continuation into the PhD programmes and thereby strengthening the various research groups, as this layer of manpower resource is critical in any research group.

(Suggestions for improvement)

To carry out such an ambitious endeavours, it is important to ensure these projects are well supported and funded. Based on feedback gather from the visiting Professors from partner universities, more funding should be provided to allow a longer duration for the visit for more intense discussion and the visits should be arranged with movement of the collaborators in both directions, as much as possible. Longer visit is desired to ensure sufficient quality time is spent on writing good research papers for publication as well as expanding the scope of the projects for possible follow up proposals to seek funding from grant agencies for subsequent projects. A longer visit would also ensure the professors will have sufficient time to be more engaged with students in the Graduate School of GFR. This will enhance the learning of, and interactions with, the students, and thereby allowing the visiting professors to formulate a more coherent lectures, instead of just lecturing on some ad hoc topics.

2. Based on the tradition of Sapporo Agricultural College and strengths of Hokkaido University, is world-leading cutting-edge international cooperative research in the field of food, land, and water resources studies underway?

Evaluation Results and Reasons

(Your Evaluation Results)

S / A /(B)/ C / D (circle one)

(Reasons)

The studies of the five identified projects have yielded some good joint publications in reputable international peer-reviewed journals, and a number of other papers (not listed in the self- appraisal report) are also presently “in preparation”. Although the progress of each project may not be of the same pace, with

some not taken off in resulting in joint publication yet but this is quite understandable. Overall it is a good start and I am sure publication list would continue to grow if more resources and new funding can be sourced to support and build up this momentum.

Specific points

(Outstanding points)

It is good to see that three past successful broad thematic International Symposiums had been organized in the past four years and this has not only lifted the profile of HU but also brought these collaborators and other prominent keynote speakers together for more intense collaboration and discussion. The good keynote speakers have helped to broaden the scope of the symposiums and had covered research topics that are beyond the usual domain research areas, especially in studying the global economic impact and social issues related to these broader themes. Graduate Students also benefited from these broad coverage and are able to relate better and connect to what they have studied and learnt in classroom and in the field work. This good initiative should continue, paying particular attention to global research trends and "hot" topics in choosing the next theme.

(Suggestions for improvement)

Within the HU structure/system, it is essential to first ensure that there are good incentives (and no road block) for staff to want to carry out inter-disciplinary research. This can be built in the KPI of Faculty staff in their annual appraisal system in HU. Another way of doing this is for HU to provide a small seed funding to gather staff to form interdisciplinary teams to explore possible areas and then working towards a good research proposal to secure the next big external research grant.

3. Are research outcomes from GI-CoRE being actively utilized to solve social issues?

Evaluation Results and Reasons

(Your Evaluation Results)

S / A /Ⓑ/ C / D (circle one)

(Reasons)

This has not been fully achieved yet as most groups are still carrying out its own main basic and applied research and more needs to be done to bring in more interested colleagues from within the HU system in the social sciences and humanities schools and even the health sciences and medical school and form inter-disciplinary teams to tap on bigger grants to solve big problems. Research is an expensive endeavour. I think currently this broader social issues is still in its infancy stage as it is only about four years since this Global Station started, although reasonably good progress has been made in some areas.

Specific points

(Outstanding points)

I am particularly impressed for instance with the project on fisheries management measures for multi-species, multi-method fisheries in Asia, headed by Professor Takashi Fritz Matsuishi. Professor Matsuishi has a diverse group of graduate students from the region and Japan who worked closely with him to solve problems which not only has local relevance but also regional relevance as the collaboration includes government agency from the Department of Fisheries of the Royal Thai Government and Southeast Asian Development Center (SEAFDEC) on sustainable fisheries in Southeast Asian region. The research carried out by his team also has impact on sustainability of fisheries and are able to help address some of the global issues on overfishing and food security which has regional relevance in fast growing South East Asia and HU can play a leadership role in this in the region.

(Suggestions for improvement)

HU is a comprehensive University, and should be able to bring in colleagues from within the HU system in the social sciences and humanities school and even the health sciences and medical school to form a more diverse inter-disciplinary teams to broaden the research coverage and address social impact and social issues in a more strategic way as a consequence of tackling these problems. It is good to look outside the Japanese system and see how best to perhaps adopt/adapt what has been the best practices across the globe. One consideration that I think HU can do well and learn from, is to study Cornell Cooperative Extension model (from Cornell University): http://cce.cornell.edu/

and see how to put knowledge to work in pursuit of economic vitality, ecological sustainability and social well-being in a very strategic way. Cornell, through their Cooperative Extension is able to bring local experience and research based solutions together in their various outreach programmes, thereby helping local farmers, families and communities thrive in our rapidly changing world.

II. Education

Is the educational system and curriculum designed to help develop researchers who possess specialized knowledge and are capable of working internationally?

Evaluation Results and Reasons

(Your Evaluation Results)

S /Ⓐ/ B / C / D (circle one)

(Reasons)

The Graduate School of Global Food Resources has been properly set up since April 2017. The organizational structure for the graduate school has also been carefully designed and successfully managed with proper committees set up to take care of admission, curriculum matters, examination and commencement of the graduating cohort. Its first intake in Academic Year 2017 met the quota distribution for local and foreign students set under the HU original plan. Curriculum is well-designed which incorporates experiential learning, problem-based learning approach as well as independent study with teaching instructors from across HU (humanities, social sciences, engineering, etc.) and overseas that contributed to the teaching of this inter-disciplinary programme. Attrition rate is also very low as HU has factored this in and take in an extra few to make up for this for the past cohorts.

Specific points

(Outstanding points)

The curricula of the graduate programme was able to leverage on the academic visitors from the GSF to enhance its teaching and learning for the school. As a comprehensive university, the Graduate School is also able to tap on the diverse expertise from across its faculties to teach in this inter-disciplinary programme. The admission quota has been achieved and are able to sustain the yearly intake to date. The field work courses incorporated in the Wandervogel Study programme is an innovative experiential learning study abroad component that brings students overseas for field studies that enhances its active learning objective very well.

(Suggestions for improvement)

However, it is not clear, based on the data provided, on the student selectivity and quality, whether the programme is attracting the best students locally and internationally. For the international students recruitment, the net needs to be casted wider to recruit top talented students from more countries in the region. This would entail conducting more outreach activities to promote the Graduate School and its programmes.

Students' feedback on the learning outcomes appeared to be very good but subsequently employer's feedback would need to be collated to keep improving and to keep the curriculum current, relevant, and up-to-date. Student learning outcome would also needs to be assessed and evaluated in a balanced and

holistic way taking into account instructors' feedback as well to ensure the curriculum is delivering its key interdisciplinary objective.

As the programme is inter-disciplinary in nature and students comes from diverse background and disciplines, a "bridging module" may be necessary to be incorporated to bridge the gaps that some may need in their first year. It would also be useful to incorporate a capstone module in the final year which can tie in all the contents that students has accumulated into a coherent final module so that they can see the broader picture. This can be in the form of a series of regular dialogue sessions, put together in a coherent manner, with leaders in the Industry and Government organization, who may be future prospective employers of the graduates.

III. Establishment of Framework

Are the necessary systems and frameworks being established in order to conduct international cooperative research and education?

Evaluation Results and Reasons

(Your Evaluation Results)

S / A /Ⓑ/ C / D (circle one)

(Reasons)

The system and framework necessary to conduct international collaborative research and education has generally been established. However, it may not have tapped onto the full potential of HU staff internally in the participation of this innovative research and education endeavour, and so more needs to be done to encourage staff across HU who are interested to be involved.

Specific points

(Outstanding points)

Administrative support structure has been put in place to assist the project teams in handling the day-to-day operations so that the researchers can focus on what they do best and that is to deliver the research and education endeavours. This is an important aspect and should not be neglected when this programme is subsumed under the Faculty once the funding has ended.

(Suggestions for improvement)

The future vision that would lead to sustainable research activities is unclear, as this needs to be well thought-through to ensure what works currently in fostering good collaborative effort will continue to be supported by the home Faculty after the end of this funding support. Incentive must be given to recognise staff for their publication in interdisciplinary work even though some of these journals may not be those with high impact factor.

IV. Overall Evaluation

Hokkaido University has embarked on an ambitious programme to build core competencies in its fifth Global Station for Food, Land and Water Resources under its GI-CoRE initiative. It has been fairly successful in multiple fronts in achieving its objectives. The most immediate task following this mid-end review is to ensure its efforts over the last four years and more, do not go to waste and that it can be leveraged on to build stronger inter-disciplinary core teams to carry out collaborative research within and outside HU. These international teams have indeed sharpened and strengthened HU core research focus and broadened its scope to do applied research which can address societal issues of social nature and global concerns. There is also a need to move into applying some of the current research findings under the five identified projects to examine how the present work can translate to application in industry and help drive the formulation of good policy in time to come. Through this endeavour, there are many opportunities for HU to play at least a regional leadership role in doing so if it can strategically propose to seek new grants from funding agencies and industry and deliver its intended outcome in research and translate some of its results towards innovation and enterprise. The Graduate School complements the research components very well in producing and developing the manpower human resource through its programmes thereby providing the necessary training to learn from a team of international faculty and experts. All these should serve HU well, as it strive to become a global university, addressing issues, and solving problems of global concerns that has local relevance.

Global Station for Food, Land and Water Resources
Global Institution for Collaborative Research and Education (GI-CoRE)
Hokkaido Univeristy

Research Progress Report
(Project Period: Academic Year 2015-2019)

Contents

Appendices

I. Overview

1. Name of Global Station (GS) in GI-CoRE

Global Station for Food, Land and Water Resources (GSF)

2. Project Period

2015-2019 academic years (5 years)

3. Aims and Goals of GI-CoRE GSF

The world's population is currently 7 billion and is forecast to reach 9.5 billion by 2050. In addition to the population explosion, there is a marked concentration of population in certain regions of the globe. Poverty and hunger are wreaking misery in developing countries, and even developed countries are beginning to experience contamination of food and inherited resources, along with shortages of clean tap water and irrigation water for agriculture, which are essential for life. Furthermore, the land and water resources that produce food are itself becoming impoverished and scarce, and desertification is ongoing. Anyone can see that the biggest challenge facing humanity is the securing of sustainable food, water and land resources. Moreover, recent climate change is having a major impact on food, water and land resources around the world. Not only are there shortages in land and water resources nor food, but the quality of food is declining, and contamination of food is a growing concern. Distribution needs to be diversified and new food development methods are required. Many problems cannot be solved by conventional food and ingredient research; collaborative, multidisciplinary research is now needed (Figure 1).

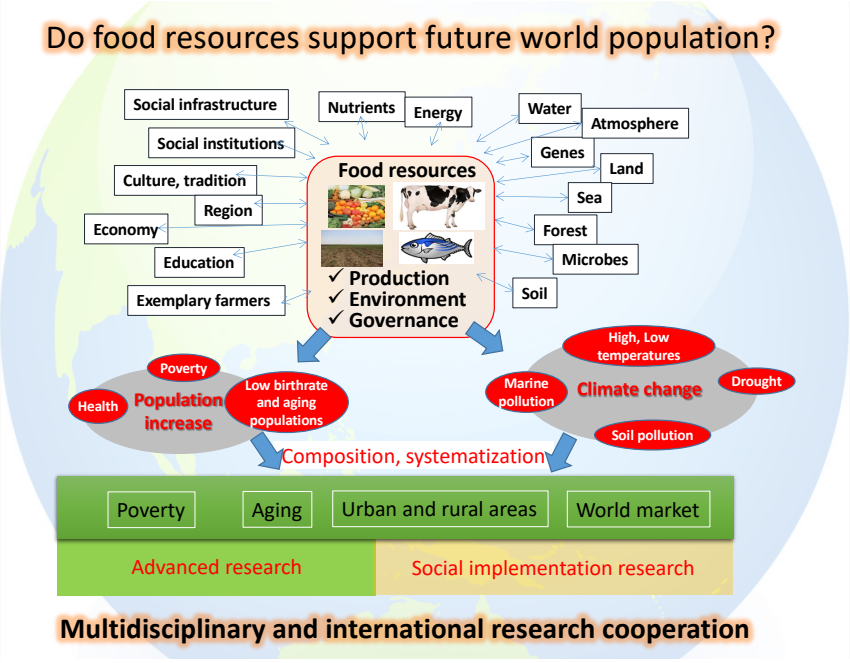


Figure 1. Multiple problems surrounding the supply of global food resources

We develop new research fields through collaborations with leading universities overseas, with the aim of solving challenges such as shortages and imbalances in land and water resources, contamination of food, water, and genetic resources, desertification of agricultural land, increasingly poor sanitation, insufficient food distribution, satiety, hunger, and poverty. We also work on social implementation of our studies in cooperation with international organizations to contribute to wellbeing and sustainable development in both developing and developed countries.

4. Necessity and Urgency of GI-CoRE GSF

The United Nations has been aware of the gap between the rich and the poor in developing countries since the 1990s, and related topics have been discussed in international conferences and the Summit Conference of the Leading Industrialized Nations. These issues were summarized as the Millennium Development Goals (MDGs) in 2000, consisting of 8 goals with 21 targets.

The year 2015 was a critical year for global food resources issues, as it was the year set by the UN for the achievement of the MDGs. The results were summarized in the MDG Report 2015. This report described the changes that took place in the period from 1990 to 2015:

1. Extreme poverty decreased from 47 % to 14 % in the world population.
2. The net enrolment rate in primary school in developing regions increased from 80 % to 91 %.
3. The ratio of boys and girls in primary, secondary and tertiary education became equal in 70 % of developing countries.
4. The global under-five mortality rate decreased from 90 to 43 deaths per 1000 live births.
5. The maternal mortality ratio declined by 45 % worldwide.
6. New HIV infections dropped by 40 %.
7. 91 % of people had access to improved sources of drinking water, compared to 76 % in 1990.
8. Global access to the internet grew from 6 % to 43 %.

It was thus concluded that the MDGs had improved the quality of life in developing countries. However, despite many significant achievements, progress has been uneven across regions and countries. Significant disparities were seen based on the economic situation, gender, age, disability, ethnicity and geography. In other words, the most vulnerable people are being left behind.

The UN therefore launched the Sustainable Development Goals (SDGs) in 2015 as the next step after the MDGs. Seventeen goals need to be achieved through urgent action by all developed and developing countries to improve health and education, reduce inequality, and spur economic growth in the face of the population growth and climate change that the world is experiencing. The MDGs

failed to consider vulnerable people in developed countries, to the detriment of those populations. The SDGs, therefore, seek to create conditions in which the entire human race can thrive.

While actions have been taken to achieve the SDGs, climate change has caused disasters such as elevated temperatures, droughts, floods, more frequent typhoon-hit, severe winter cold, land and marine pollution, severely impacting food, water, and land resources in recent years. These have had devastating effects on food resources and human lives, including food shortages, hunger, and malnutrition. The United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) therefore established the Intergovernmental Panel on Climate Change (IPCC), publishing assessment reports since 1990. IPCC also issued the Summary for Policy-Makers and Technical Summary to call for action against climate change by all nations. Researchers are also urged to participate in actions to mitigate climate change issues.

To figure out the issues for the future food resources from the viewpoints of production, environment and governance, the Global Station for Food, Land and Water Resources (GSF) in the Global Institution for Collaborative Research and Education (GI-CoRE), Hokkaido University, has been organized and launched in April 2015 by consisting of researchers in the fields of production, environment, and governance.

Thus far, conventional studies of food resources have been conducted from the professional standpoints of the production, environment, and governance. In order to solve the imbalance in food resources, it is necessary to consider the link between people, regions, and society. Academic collaboration is therefore needed between the research fields of the production, environment, and governance to overcome the challenges facing food, land and water resources.

5. Originality and Novelty of GI-CoRE GSF

Conventional studies of food resources have been carried out from the professional standpoints of the production, environment, and governance, and the innovative technologies contributed on an academia and industries. Now that the SDGs and IPCC have pointed out the challenges facing human society and food resources due to population growth and climate change, all of academia must work together to address these issues. Solving food resources issues requires consideration not only of natural scientific technologies but also governance at the levels of people, regions, and societies. The GSF is one of the first interdisciplinary organization in Japan that aims to approach food resource science with a fusion of academic fields.

Science of Global Food Resources is a new field of research, and collaboration with leading universities overseas is important in order to raise global awareness of this new science.

Strengthening the relationship and cooperation with international organizations are equally indispensable to solve the challenges facing global food resources, such as shortages and imbalances in land and water resources, contamination of food, water, and genetic resources, desertification of agricultural land, increasingly poor sanitation, insufficient food distribution, satiety, hunger, and poverty. It should also be noted that the social implementation of studies that have been conducted is one of the features of this research field.

II. Budget

Unit: 1,000 JPY

	Category	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019 (projected)	Total
GI-CoRE administrative framework	Personnel cost (for researchers from overseas)	2,540	1,209	4,948	2,345	4,100	15,142
	Administrative cost	7,930	10,998	12,378	14,473	14,656	60,435
	Operating and research cost	-	-	* 15,579	* 15,982	* 19,200	* 50,761
Graduate School of Global Food Resources		*, ** 64,883	*, ** 41,143	56,445	56,550	49,964	268,985
Total		75,353	53,350	89,350	89,350	87,920	395,323

* Including travel expenses for invited researchers from overseas

** Including preparation costs for Graduate School of Global Food Resources

III. Detailed Results

1 Research in the Global Station for Food, Land and Water Resources

1.1 Goals

The goal of Global Station for Food, Land and Water Resources (GSF) is to develop new research fields through collaborations with leading universities overseas, with the aim of solving challenges facing global food resources. We also work on the social implementation of our studies in cooperation with international organizations to contribute to wellbeing and sustainable development in both developing and developed countries.

1.2 Current Progress

1.2.1 Construction of the base

- **Role sharing with affiliated universities**

The GSF consists of 19 faculty members from Hokkaido University, along with 19 overseas researchers from Australia, France, Korea, Thailand, and the United States of America (Figure 2). 14 universities are providing support through collaborative research and education in the Graduate School of Global Food Resources.

Innovative and collaborative studies are carried out by faculty members to lead the science of global food resources (Figure 3). These studies fit with our basic philosophies of Hokkaido University, i.e., frontier spirit, global perspectives, all-round education, and practical learning.

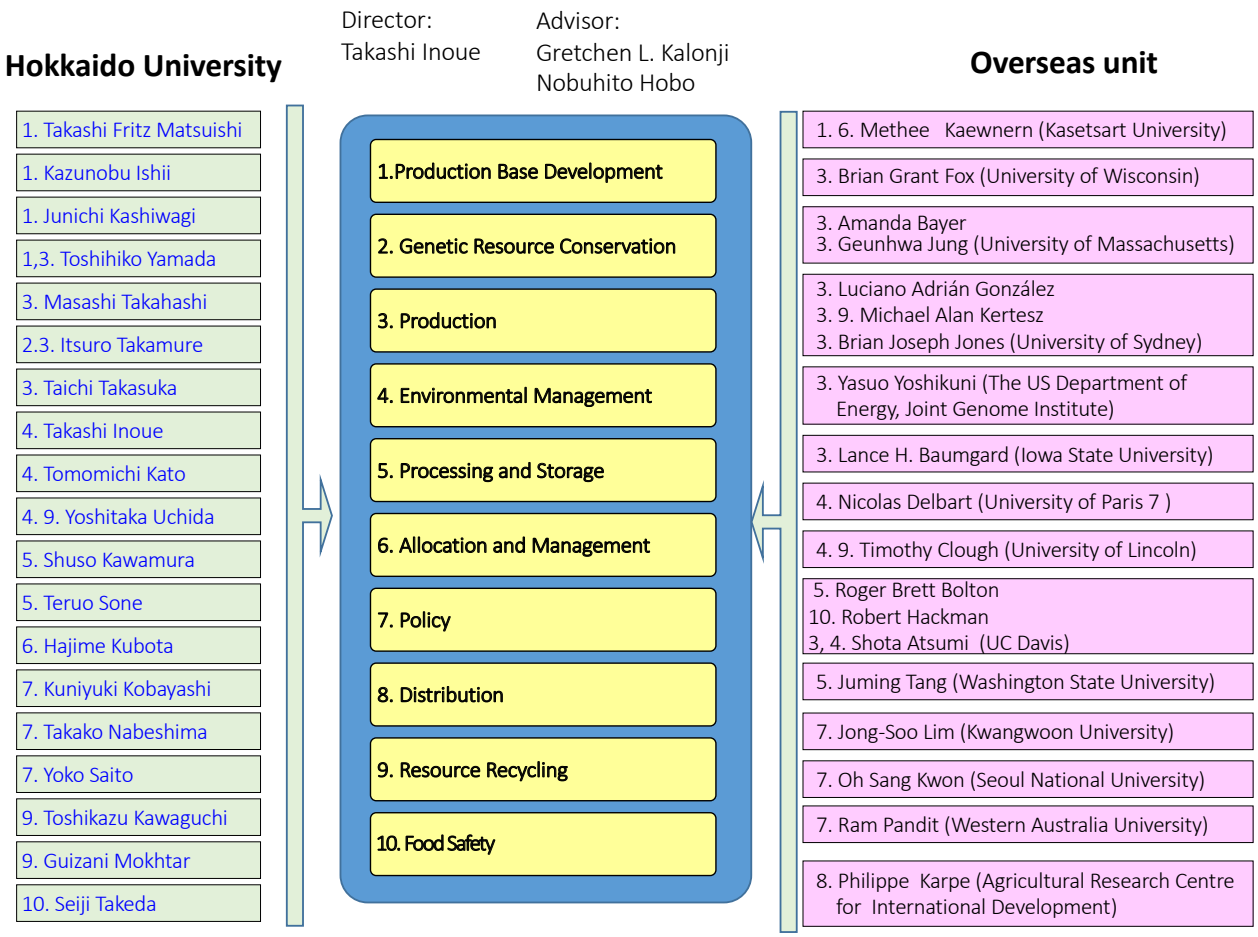


Figure 2. Faculty members from Hokkaido University and overseas

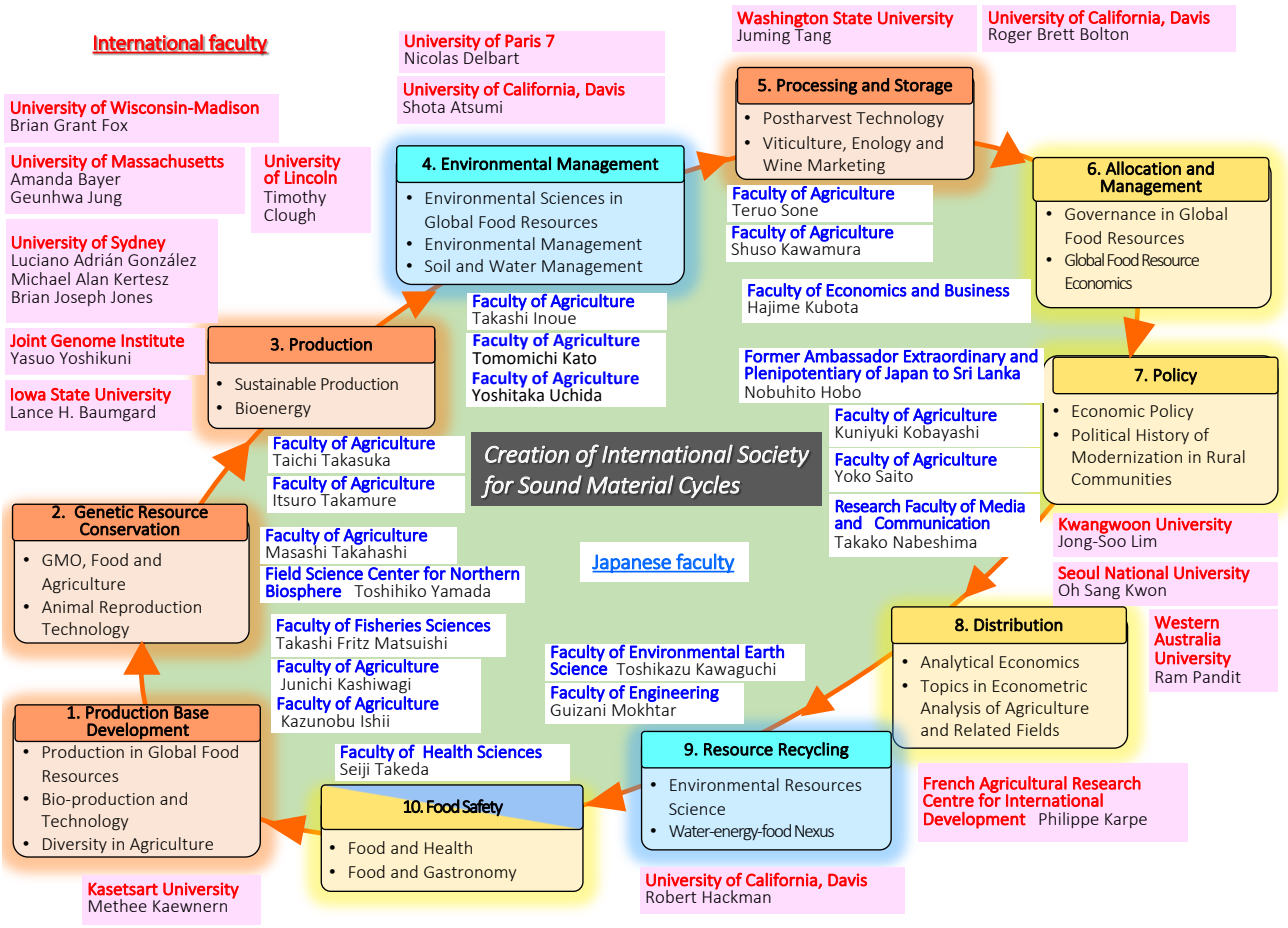


Figure 3. Joint research and education system of the Global Station for Food, Land and Water Resources

➢ **Role sharing between faculty members at Hokkaido University**

Faculty members of Hokkaido University manage the international projects, submit proposals for national grants, and prepare projects involving industry-academia collaboration. Faculty members mainly educate the students in the Graduate School of Global Food Resources and provide opportunities to work with major international researchers overseas.

Prior to the creation of these international collaborative projects, domestic researchers have worked together to address global food resources issues. Group chart is shown in Figure 4. For instance, the wine project by Prof. Sone and Prof. Kawaguchi will be referenced in the collaborative project with the University of California, Davis, very soon. Prof. Guizani Mokhtar and Prof. Kawaguchi are running a project on the waste water treatment, funded by Hitachi Chemicals Co. This work will be connected to the collaborative research project with the University of Sydney of Australia. Prof. Takahashi also works with Prof. Kawaguchi on research regarding early pregnancy diagnosis in cattle. The seafood safety project is also being prepared. Prof. Matsuishi mainly manages this project, and we sent students to Kasetsart University for this research.

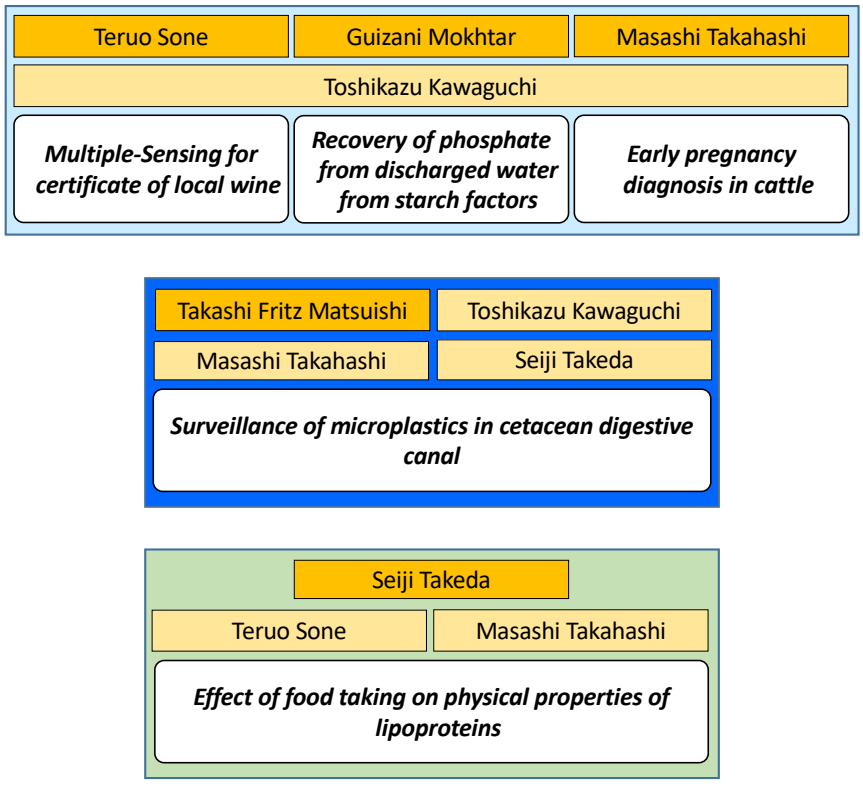


Figure 4. Domestic collaborations between faculty members in Hokkaido University

1.2.2 International Collaborative Researches

- **Assignment of overseas universities**

Faculty members in the overseas unit were invited from major universities overseas. All researchers are not only working with the faculty members of Hokkaido University on international collaborative projects but also contribute to education in the Graduate School of Global Food Resources (Figure 5). They give advice on research to our graduate students and provide students with opportunities to study in their research laboratories and fields overseas. They also give lectures in the Graduate School of Global Food Resources and have received high praise from the students. In addition, they provide a luncheon seminar during lunch break every month, giving students opportunities to communicate frankly with them.

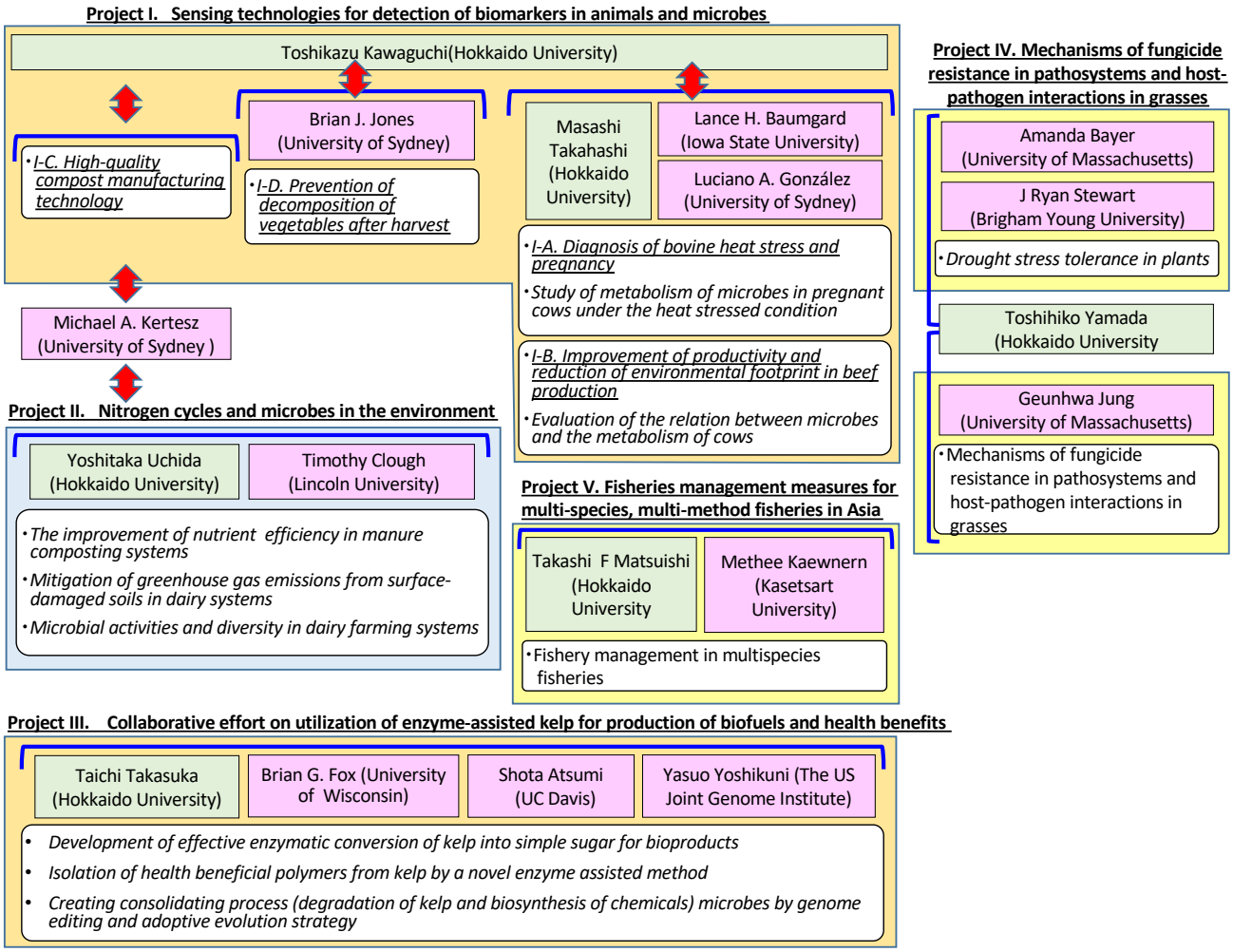


Figure 5. International Collaboration projects between the faculty members from Hokkaido University and the overseas

- **Progress of collaborative researches and their results**

So far, five major international collaborative projects are being conducted by faculty members of Hokkaido University and overseas researchers (Figure 5). We expect that the results of those works will be published in influential journals soon.

Project I: Sensing technologies for detection of biomarkers in animals and microbes

This project consists of four components. Prof. Kawaguchi mainly coordinates Hokkaido University's work on this project. This project is an industry-academia collaboration with funding by Japanese and Australian companies.

Project II: Nitrogen cycles and microbes in the environment

Prof. Uchida manages this project. He is collaborating with Prof. Michael Kertesz of the University of Sydney and Prof. Timothy Clough of Lincoln University. Student exchanges take place between Hokkaido University and both universities.

Project III: Collaborative effort on utilization of enzyme-assisted kelp for production of biofuels and health benefits

Prof. Takasuka manages this project. This project is a collaboration with several universities and research institute in the USA. Prof. Brian Fox of the University of Wisconsin visits at Hokkaido University to provide advice on research involving genomic studies.

Project IV: Mechanisms of fungicide resistance in pathosystems and host-pathogen interactions in grasses

Prof. Yamada manages this project. This project is a collaborative study with the University of Massachusetts, Amherst. Our relationship with this university dates back to 1876, when Dr. William Smith Clark was invited to establish Sapporo Agriculture College (now, Hokkaido University). Prof. Geunhwa Jung often visits Hokkaido University and works with Prof. Yamada.

Project V: Fisheries management measures for multi-species, multi-method fisheries in Asia

This project is managed by Prof. Matsuishi, who works with Prof. Methee Kaewnern of Kasetsart University, a member of a leading university in the field of fisheries sciences in the Southeast Asian region. The collaboration also includes the Department Fisheries of the Royal Thai Government and the Southeast Asian Fisheries Development Center (SEAFDEC), with studies on fisheries management to establish sustainable fisheries in the Southeast Asian region.

Detail of each project is described in Appendix I.

1.3 Future developments

Here, we will describe the future vision and issues of the research activity at GSF from the viewpoints of organization and faculty, budget, and the direction of future researches.

1.3.1 Structural change of GSF and the faculty

As it will be described in detail at the section 3.4.1 of this report, GSF will be internalized and fixated into the Research Faculty of Agriculture from FY2020. Despite such changes on the structure, GSF is required to maintain its properties of a highly independent research-based organization through the collaborative research activities between the cross-appointed overseas researchers and the Hokkaido University faculties.

At this occasion, GSF needs further strengthening of the collaborative research activity and its financial basis. The member of GSF for both overseas unit and Hokkaido University unit need to be examined and carefully re-selected to those who can promote joint research, obtain external research funds, and publish their research achievements.

The current GSF's overseas members should be distinguished into two groups; one is the group of researchers who can afford for collaborative research activities and the others who are more engaged for the education at the Graduate School of Global Food Resources.

Besides, because of the members of the Hokkaido University have decreased slightly since after the establishment of the GSF due to retirement and move-out, we need to promote a more cooperative relationship with other departments within Hokkaido University. It is required to seek and ask for the offer of the talented faculty member, in particular, the young researchers who can contribute to the activities in GSF.

1.3.2 Budget and research funding

As the first phase of the project period for GSF will end by FY2019, GSF's budget is expected to be reduced as a whole from FY2020 (except for personnel expenditures). In order to promote research at GSF, GSF members need to make efforts to obtain external funds. One Grant-in-Aid for Scientific Research (KAKENHI) of Japan Society for the Promotion of Science (JSPS) was acquired in FY2018. Seven applications were submitted for this in 2019, but unfortunately, none of them has been adopted. It is essential to obtain competitive research funds not only for KAKENHI but also for many different sources from outside.

1.3.3 Challenges in research collaborations

Despite the internalization of GSF is an ongoing issue, and the restriction in the budget may cause constraints, it is necessary to further strengthen and promote joint research with overseas universities and institutes. We have the following plans as cores of the research to be developed in the near future.

By accomplishing these research activities for appropriate management, utilization and conservation of food, water and land resources that are indispensable to the stability and development of the world and human society, we hope we can contribute toward the future generation.

In addition, it is necessary to disperse the obtained research achievements to the society through outreach activities, and also to return to education of the Graduate School of Global Food Resources and the others in Hokkaido University. As shown in Appendix II, our faculty members have published many research articles with domestic and overseas universities and research institutes. Municipal governments in Hokkaido such as those of Furano City and Iwamizawa City also support collaborative research and education. We expect our collaborations with government and industries will be expanded more very soon.

Three plans for future directions of the research in GSF

A) In the most advanced food industries, we will organize research teams including students and domestic and international researchers, and conduct research on food resource factors such as distribution, bioenergy, and food development with the aim of creating commodity values that can be explored in international markets. In addition, we will carry out joint research with international companies to contribute to a distribution revolution through the consolidation of processing, storage, and logistic processes.

B) We plan to promote research on securing genetic resources and food production methods in developing countries in regions such as Asia and Africa in order to apply value chains to specific regions, develop food resource allocation, and establish sustainable value chains.

C) We hope to conduct joint research with JICA (Japan International Cooperation Agency) and other international organizations to develop strategies to correct food, land and water imbalances leading to hunger and poverty.

2. Education in the Graduate Schools of Global Food Resources

2.1 Goals

The Graduate School of Global Food Resources has established the following missions to develop personnel who can propose and implement specific solutions to the world's food resource issues. We provide multidisciplinary education that transcends the conventional boundaries between the humanities and sciences.

1. To solve global issues concerning food and the resources that essential for food production such as land and water.
2. To confront climate change issues through the development and popularization of new technology and methods for creating and preserving food production environments.
3. To establish systems to ensure safety for all people and fair distribution and supply of food on a global scale.
4. To foster "glocally" (globally and locally) minded personnel who can think globally and act locally.
5. To develop creative leaders of international teams who possess an indomitable spirit and techniques for creating new resources
6. To develop personnel with both specialist knowledge and practical skills who can think on their feet in initiatives to contribute to economic development in Japan

The course also provides a generalist education on problem-solving methodology, equipping future personnel with the following four skills.

1. Taking action: The ability to engage in problem-solving, based on accurate analysis of situations and strong communication skills.
2. Integration: The ability to understand the realities of global and local issues from a broad, comprehensive and multifaceted perspective and apply knowledge from both the humanities and the sciences.
3. Organization: The ability to engage in discussions and negotiations for the purpose of international cooperation and drive projects with strong leadership skills.
4. Fundamental problem solving: The ability to identify the root of an issue and propose specific methodology that will lead to a solution.

The doctoral course, which started on April 2019, follows on from the master's course, with even more specialist faculty and research to foster the generalist skills and specialist expertise needed to propose multifaceted solutions to issues.

2.2 Current Progress

2.2.1 Organizational Structure of Educational Programs

➢ **Overview of the Graduate School of Global Food Resources**

The purpose of the Graduate School of Global Food Resources is to develop future international leaders who are skilled in taking action, integration, organization and fundamental problem solving and can propose and implement specific solutions to the wide range of food resource issues that are becoming increasingly severe on a global scale. Unlike the usual structure of graduate school education, which specializes in a specific academic field, this new graduate school covers a wide range of academic fields related to food resource issues.

➢ **Connection to GI-CoRE GSF**

GI-CoRE's GSF carries out joint research with top research units invited from overseas. The Graduate School of Global Food Resources was opened in 2017 to use the findings of the GS's research as a base for education (Figure 6).

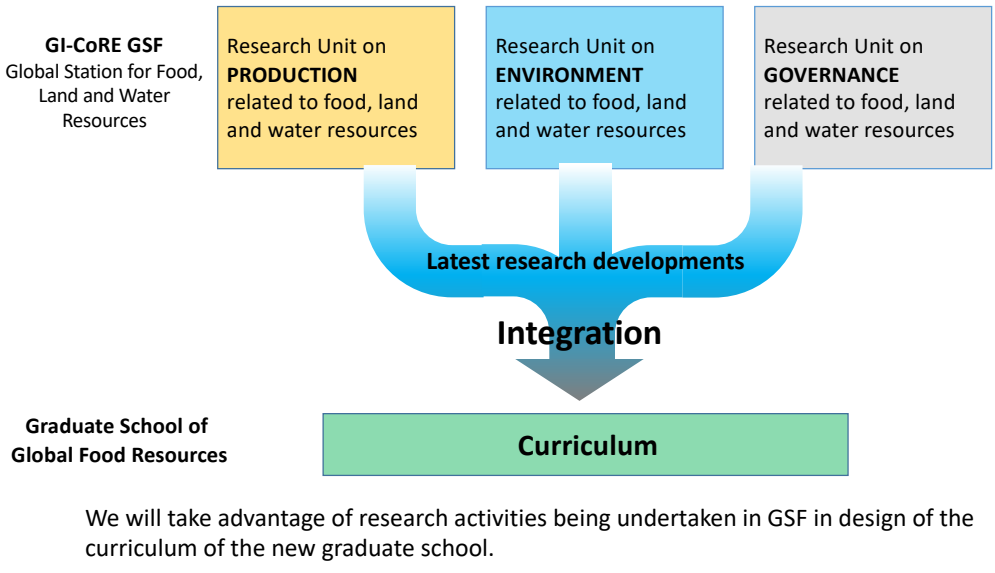


Figure 6. The relationship between GI-CoRE GSF and the Graduate School of Global Food Resources

➢ Details of establishment of the Graduate School

The world's population is currently seven billion and is expected to grow to over nine billion by 2050. This population explosion is unlike anything humanity has experienced before, and it is outstripping the world's food production capacity. Increasingly severe climate change is also taking place on a global scale, threatening the security of resources such as land and water that are essential for the production of food. Unequal access to resources that are necessary for survival and strain on food distribution systems have resulted in even greater economic disparity, worsening the poverty, hunger and spread of infectious diseases in developing countries. Developed countries are also experiencing issues that threaten people's survival and daily lives, such as threats to safety caused by food contamination and the use of toxic substances, dramatic changes in distribution systems and the way food is transported and stored, and a rapid increase in obesity and adult diseases due to poor diet.

Never in history have we faced such a critical food, land and water crisis on a global scale. Caused by a complex combination of wide-ranging and multilayered factors, this crisis is possibly the greatest global issue of the 21st century.

Japan is no exception, with a growing list of problems such as a decline in the number of farmers due to aging and depopulation, a stagnating food self-sufficiency rate, a precarious food production and safety situation linked to political and trade issue, and food safety issues that are becoming more serious at a societal level.

For the purposes of our work, the Graduate School of Global Food Resources defines "food resources" as food, food products and related elements such as land, water, the environment, hygiene, health, policies, economics, education, production, distribution and safety, and "food resource issues" as issues concerning food resources.

Under these circumstances, there is an urgent need to develop international leaders who can tackle the growing food resource issues taking place on a global scale. Thus far, however, Japanese graduate schools have not taken a broad enough approach to food resource issues, focusing primarily on developing researchers and addressing individual issues that are only a small part of the picture, rather than taking a comprehensive view of the world's issues and developing international-minded experts with strong leadership skills. This is a consequence of the way graduate school education is structured at present: courses are designed to provide highly specialist knowledge in a specific field, making it difficult to develop personnel with both wide-ranging knowledge and specialist expertise (T-type personnel training curriculum; Figure 7). To solve this issue, it is vital to think outside existing graduate schools, which specialize in specific fields of academia, and set up an independent educational institute encompassing a wide range of academic fields related to food resource issues.

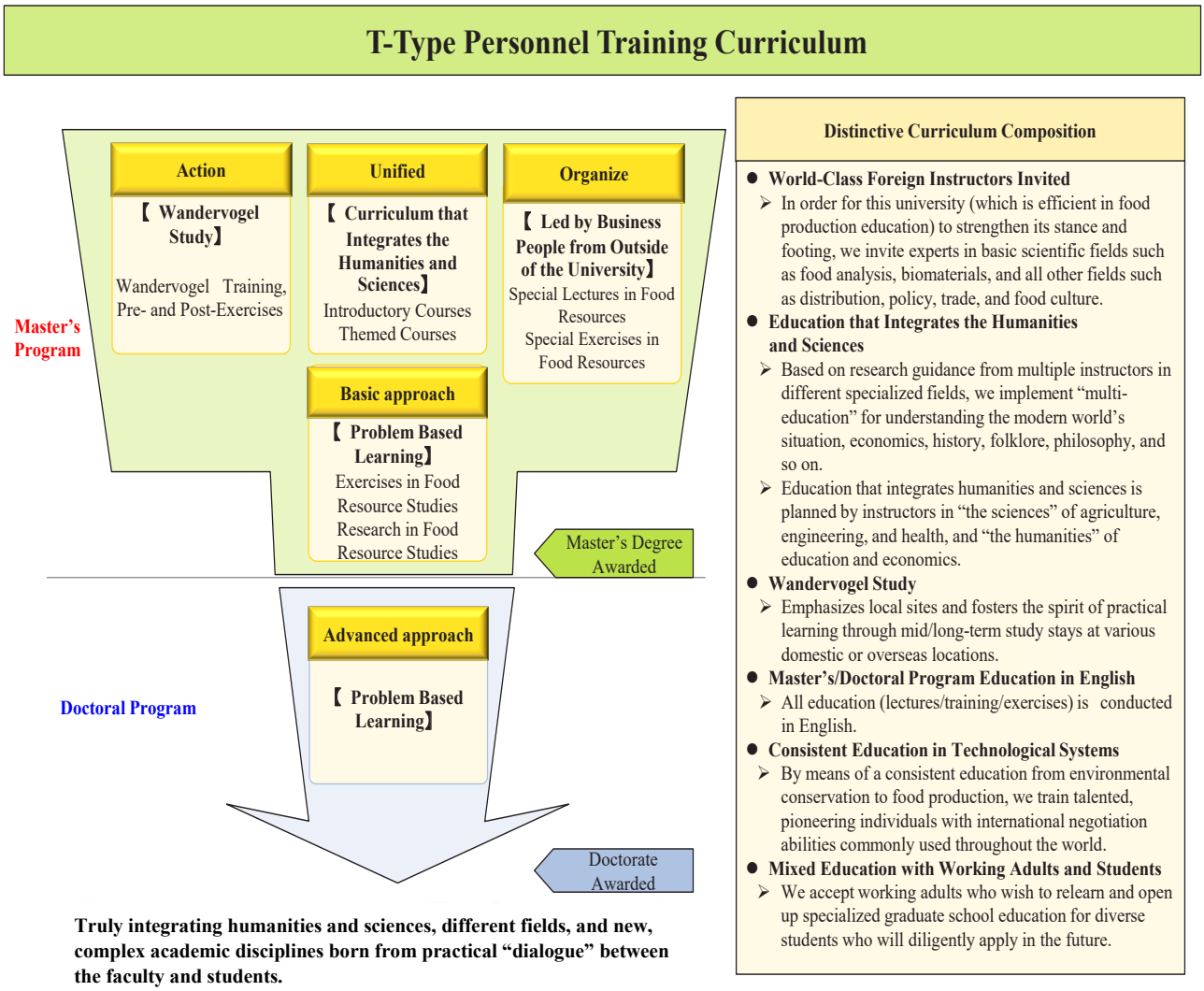


Figure 7. Education in the Graduate School of Global Food Resources with T-type personnel training curriculum

2.2.2 Internationally Cooperative Education

- **Operating system of education and our admission policy**

Our international education framework is achieved by the structure described in Figure 3 (p.10). Under the four basic principles of Hokkaido University, i.e., Frontier Spirit, Global Perspectives, All-round Education and Practical Learning, the Graduate School of Global Food Resources call for the students who;

- ✓ acquire both wide perspectives on a global scale and deep understanding on local societies,
- ✓ are aware of the importance of food resources in the 21st century's strategy for survival,
- ✓ have a noble spirit and a willingness to abandon selfishness and contribute to human society

In more specific terms, we are seeking students who are keen to;

- ✓ approach and solve problems with a broad perspective that encompasses the humanities and sciences,
- ✓ receive hands-on, practical education in both national and international settings,
- ✓ take the initiative to search for, identify, solve, raise and examine issues,
- ✓ work in a global society with a pioneer spirit,
- ✓ develop strong communication skills, team work and turning ideas into action,
- ✓ seek the diverse practical job opportunities beyond academic research.

The Graduate School of Global Food Resources willing to accepts students from a wide variety of backgrounds, with the aim of finding highly ambitious and talented students and providing them with an education that encompasses the humanities and sciences to foster personnel that will meet society's wide-ranging needs.

- **Framework for selection of students**

For Master's course, students are selected through a comprehensive assessment comprising 1) an English proficiency test, 2) a short essay exam, and 3) an oral test. Doctor's course students are required to take an oral test for their ability of study and research through the course.

The general entrance exam for both Master's and Doctor's course is carried twice a year (part 1 and 2). In addition, we have special entrance exam for international students.

➢ Acceptance of students

Master's Course

(capacity: 15 students)

Year	Enrolled students	Passes			Students who declined their offer of admission
		General selection (Part 1)	Special selection of international students	General selection (Part 2)	
2017 academic year	17	15	5	1	4
	(3)	(1)	(5)	(0)	(3)
2018 academic year	16	13	2	3	2
	(3)	(2)	(2)	(0)	(1)
2019 academic year	19	17	1	2	1
	(4)	(1)	(1)	(2)	(0)

*Parentheses indicate international students.

Doctor's Course

(capacity: 6 students)

Year	Enrolled students	Passes			Students who declined their offer of admission
		General selection (Part 1)	Special selection of international students	General selection (Part 2)	
2019 academic year	6	4	1	1	0
	(4)	(3)	(1)	(0)	(0)

*Parentheses indicate international students.

- **Good practices at the Graduate School**

1. Luncheon seminars were held for our faculty and students with talks by experts in each field who have been invited from universities and other institutions overseas. Nine luncheon seminars were held in 2017 academic year and seven were held in 2018 academic year.
2. Field work courses (Wandervogel Study I (Compulsory subject)) is held in Denmark every June and Wandervogel Study II (Compulsory subject) is held in Myanmar every February to promote exchange between our students and the students in these two countries. Wandervogel Study I and II employ active learning methods such as a presentation session in English at the end of each course.
3. From 2018 academic year, Wandervogel Study III is held in Australia, the Philippines and New Zealand in September and Wandervogel Study IV is held in Furano City in October. Active learning is used, with plenty of discussions with local faculty and engineers.
4. The English education program combines intensive courses with small class sizes taught by external lecturers and a self-study program using e-learning.
5. An elective course on International Understanding is offered. Japanese and overseas lecturers who are working in a global society are invited to give talks to equip students with the knowledge and training they will need in their future work as global leaders.
6. In keeping with the graduate school's focus on overseas education such as the Wandervogel Study and field work, a speaker from the Otaru Quarantine Station (Ministry of Health, Labour and Welfare) was invited in 2018 academic year for a faculty development session on infectious diseases to be aware of when traveling overseas and preventive measures that can be taken.
7. An Educational Instruction Committee comprising an instructor and two assistant instructors is formed for each student shortly after the course begins (mid-April). The faculty makes use of the benefits of this multi-instructor approach, building a flexible instruction framework that approaches the subject matter from a wide range of perspectives. Care is taken to ensure that each committee comprises faculty from different areas of study.
8. When selecting international students, applications are made online and interviews are conducted by email and Skype to make the process easier for overseas nationals who wish to apply for the course.
9. From the academic year of 2018, a summer course was established with mutual acceptance between Hokkaido University and the National University of Singapore (NUS). One student from the Graduate School of Global Food Resources participated and attending lectures at NUS, a plant factory and oil palm plantation to receive a local education, as well as receiving pre-departure support and attending joint classes in Hokkaido.
10. Two overseas learning satellites are held: Wandervogel Study I (project name: Dairy Farming and Resource Recycling in a Developed Country: Learning from Denmark) and Wandervogel Study II (project name: Tackling Food Resource Issues in a Developing Country: Field Work in Myanmar).

11. The graduate school functioned as a summer institute, teaching three classes: “Diversity in Agriculture”, “Agricultural Resource Economics” and “Special Course in Food Resources: Economic Statistics on Food Resources”.
12. The following events such as lectures for local citizens, public seminars and international symposiums were held.

2017 academic year

- Public talk for Sustainability Week 2017: Learning about Sustainability in Agriculture from Long-standing Farming Methods in Japan and the USA
- Joint seminar between Hokkaido University and the Research Institute for Humanity and Nature: Rediscovering Agriculture: Insights from Fields Around the World
- Special lecture on agriculture and international food resources: A Call for Young People to Become Global Personnel
- Special lecture on agriculture and international food resources: Integrated Management of Water Resources and Reuse of Waste Water
- International Symposium on Biomass Refinery: From Biomass Crops to Chemicals and Fuels

2018 academic year

- International Symposium on Resilience in the Global Food System (hosted by GI-CoRE’s GSF with cooperation from the Graduate School of Global Food Resources)
- A poster presentation session was held for students in the master’s course at the same symposium, with awards given to four students.

➢ **Other initiatives in the establishment of the Graduate School, such as unique curriculum**

The Graduate School of Global Food Resources holds field work courses called 'Wandervogel Study'. Through these courses, students visit locations inside and outside Japan to gain firsthand knowledge of the realities of issues concerning food resources. This provides educational development as they become aware of food resource issues around the world and autonomously and proactively link these issues to their own areas of interest.

Course Name	Main Year	Number of Credits		Objective/Content	Main Training Site
Wandervogel Study in Global Food Resources I	1	Compulsory	1	Independent study efforts for solving and improving food-resource problems in Developed Countries.	Denmark
Wandervogel Study in Global Food Resources II	1	Compulsory	1	Independent study efforts for solving and improving food-resource problems in Developing Countries.	Myanmar
Wandervogel Study in Global Food Resources III	2	Compulsory elective	1	Independent study efforts for solving and improving various food-resource problems in various parts of the world.	Multiple (various overseas locations)
Wandervogel Study in Global Food Resources IV	2	Compulsory elective	1	Recognize the challenges within agricultural groups/local governments, and independently study efforts for solving and improving food-resource problems within Japan.	Multiple (various domestic locations)
Wandervogel Research Internship in Global Food Resources V	2	Compulsory elective	[1]*	Deepen expertise and conduct master's thesis research/research on designated topics at sites outside of school such as governments, research institutions, and corporations at home and abroad.	Multiple (various overseas / domestic locations)

* Courses where the number of credits is in [ ] are taken through multiple class titles, and they may be taken as any one of those courses.

All 51 subjects (12 compulsory courses, 17 compulsory electives, and 22 electives) are taught in English. As all of the courses at the Graduate School of Global Food Resources are taught in English, all students are able to complete their courses entirely in English.

2.3 Future Developments

Here, we will discuss the future of the Graduate School of Global Food Resources from three perspectives: 1. admissions, 2. faculty structure, and 3. curriculum and career development.

2.3.1 Admissions

There has been a steady number of applicants for the Master's course in both general and special selection over the three years since the program's start. In addition to Japanese students, a certain number of international students are enrolled, and this is expected to increase. We have gone a little beyond the capacity in total (15 students per year), but the Ministry of Education, Culture, Sports, Science and Technology (MEXT) policy requires strict management of admissions capacities at universities. This means that no matter the number of applicants, we are unable to accept more than a certain number of students. On the other hand, however, this implementing a strict entrance exam enables us to admit only students of a particular caliber.

Currently, enrollment in doctoral courses is decreasing in Japanese universities, so fulfilling enrollment capacities has become a concern for many graduate schools. For our doctoral course that started in April 2019, we successfully had six student enrollments, which fulfils the capacity.

However, we must put consistent efforts to convey the appeal of both the Graduate School of Global Food Resources and Hokkaido University to promote higher achieving.

2.3.2 Faculty structure

The Graduate School of Global Food Resources had 21 full-time faculty members when it was established in April 2017. Over the past two years, circumstances such as retirement and transfer to other universities have led to the loss of three full-time faculty members, and they have not yet been replaced. Now there are 18 full-time faculty members as of April 2019.

Budgets of national universities, especially the Management Expenses Grants from the central government continue to be reduced at all the national universities across the country, which also leads to the tightening of faculty expenses. Hokkaido University plans to reduce faculty expenses by 7.5% during our 3rd Med-term Target Period (the six years from 2016 to 2021). As a result, there have been cases where handling of personnel has not been smooth. This has led to a situation where the faculty has no leeway in any department, so there is no room for cooperation between the Graduate School of Global Food Resources and other departments.

Despite these circumstances, we must secure a certain number of faculty members to ensure that the educational philosophy and goals set forth by the Graduate School are achieved. We must also continue to establish links with the institutes outside the university to bring in faculty from those institutes through cross-appointment.

GI-CoRE is an initiative unique to Hokkaido University through which faculty from overseas universities and institutes can be assigned to the HU through cross-appointment. Using this sole system, the GSF need to invite faculty from overseas, diversifying the educational program of our

Graduate School. It will be necessary to promote research and educational exchange with other countries and develop the education provided by the Graduate School of Global Food Resources.

2.3.3 Curriculum and career development

Education in the Graduate School of Global Food Resources is characterized by an emphasis on hands-on, practical education in both national and international settings with a broad perspective that encompasses the humanities and sciences, with all classes conducted in English. Students are accepted from a wide variety of backgrounds beyond the agricultural sciences. The course utilizes a broad curriculum that covers 51 subjects to achieve a distinctive education. Wandervogel Study is one of the most distinctive parts of our curriculum. These subjects are taught by a variety of faculty, including those invited from overseas. We intend to continue, maintain and enforce diversity in our curriculum. At the same time, the curriculum must be continuously evaluated and improved. Also, we need to encourage students to engage in active learning, practical training, discussion and group work must be promoted in the place of conventional passive learning in lecture format.

The students' English proficiency improves considerably by the end of the course. However, we have not yet ascertained the level of this improvement objectively. We need to introduce appropriate objective indicators of English proficiency shortly.

We asked the first graduates of the Master's course for a survey which was implemented at the time of their graduation. The result of this survey indicated a high level of satisfaction: more than 4 points out of 5 on average. Prospects for their careers were also excellent. In order to continue to achieve high levels of student satisfaction and educational achievement, we need to continue to improve our curriculum, develop an appealing syllabus and develop even better educational methods.

For Doctor's course student as well as our young faculty, it is necessary to increase the number of international joint studies by developing further relationships between foreign universities and institutes. With such collaborations, we could offer numerous opportunities for graduate students and young researchers to experience innovative research at sophisticated leading laboratories, with education and instruction provided by internationally leading researchers. Through these, they will have the chance to gain a global perspective and know-how. This direct experience will stimulate the young researchers and students to develop their career, and such youthful researchers and student will lead the GSF and the Graduate School in the dynamism of active research and study in the future.

3. Administrative Framework

3.1 GSF Management System

The Global Institution for Collaborative Research and Education (GI-CoRE) was established in April 2014 as a faculty organization with the aim of developing international collaborative research and education. Taking full advantage of the distinctive characteristics and strengths of Hokkaido University, GI-CoRE is a unique department unlike any others before it. It functions as an independent educational and research organization under the direct supervision of the president of the university. The newly adopted GI-CoRE framework facilitates international collaborative research and education smoothly and systematically with leading research members invited from overseas, rather than relying on international exchange promoted individually by researchers. Under the President's powerful leadership, Hokkaido University reformed its management system and established the framework of GI-CoRE promptly to implement an unprecedented method for accepting overseas researchers.

Under the concept of GI-CoRE, the Global Station for Food, Land and Water Resources (GSF) was launched in April 2015 as the third global station of the project. Mr. Nobuhito Hobo, the former Ambassador Extraordinary and Plenipotentiary of Japan to Sri Lanka, Dr. Gretchen Kalonji, the former Assistant Director-General for the Natural Sciences, UNESCO, and Dr. Jean-Robert Pitte, the former president of Université Paris-Sorbonne, Paris IV, were assigned as strategic advisers.

In the first and second year, GSF faculty members who joined GSF from various fields such as agriculture, fisheries, engineering, health science, anthropology, environmental science, economics and education were divided into three units; Production, Environment, and Governance. From the third year onward, the three units were consolidated into one overseas unit to enhance the station's interdisciplinary approach that goes beyond the borders between its units in research and education.

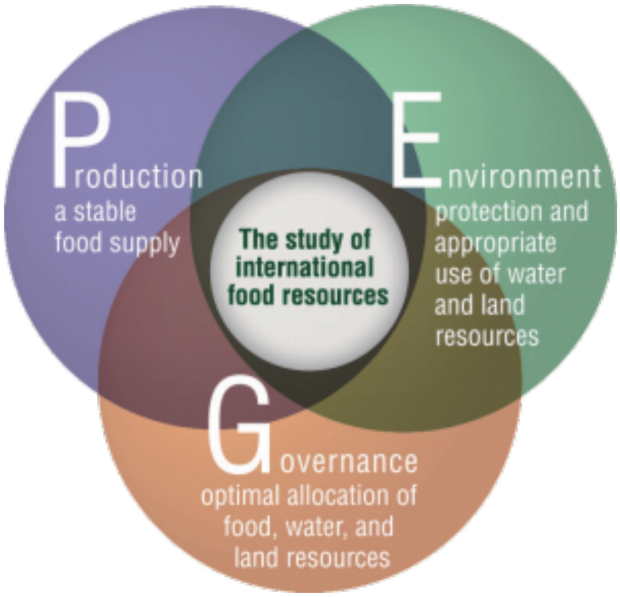


Figure 8. Structure of GI-CoRE GSF (2015 and 2016)

The members have held regular meetings and actively discussed important matters such as 1) transfers of faculty members, 2) research and educational activities of the global stations, and 3) budget management. As such, these activities are being driven successfully by a faculty-led management system.

3.2 Establishment and Improvement of Acceptance System

Under the governance of the President, GI-CoRE has established the necessary system to accept overseas researchers and improved the environment in which GI-CoRE tasks are carried out, in order to invite the world's top researchers from external universities and institutions and allow them to collaborate with the fine teaching staff in the related disciplines at Hokkaido University. Below are details on this.

1. In order to achieve a more flexible arrangement in the hiring of personnel, GI-CoRE introduced a cross-appointment system with overseas universities and institutions before the system was implemented for the whole university. The cross-appointment system enables top-class researchers from overseas and domestic institutions to be appointed at Hokkaido University while holding an employee status at their original institutions. It enables researchers to temporarily transfer to another organization while simultaneously belonging to the original organization where they are employed.
2. The implementation of the cross-appointment system has produced more flexible personnel and salary systems for the overseas faculty members. An annual salary system has been selected, the employment age restriction has been relaxed and a new title of Distinguished Professor has been established to acknowledge particularly important achievements in faculty members' fields of study.
3. GI-CoRE has set up a flexible system to handle travel expenses and accommodation rentals for overseas researchers who conduct education and research activities at Hokkaido University.
4. To utilize existing research resources in the university, GI-CoRE has also applied the cross-appointment system to participating researchers from Hokkaido University who conduct international collaborative research and education. The researchers hold positions both in their original departments and in GI-CoRE.
5. Upon conducting advanced international collaborative research and education, GI-CoRE has reviewed the point-based personnel system and applied flexible personnel distribution even in researcher positions.
6. GI-CoRE overseas faculty members are exempt from general administrative tasks such as faculty meetings and work for entrance examinations so that they can concentrate on their research and education for GI-CoRE.

The above-mentioned cross-appointment system, annual salary system for regular teaching staff and other relevant systems have been started as pilot systems for other departments within the university. In addition to these systems, GI-CoRE has provided rich research environments and extensive educational experiences to young researchers and brought them the benefits of the fusion of different research fields and interdisciplinary collaboration with diversified departments as they cooperate in the project.

Through this virtuous cycle, the pilot systems at GI-CoRE have been gradually expanded to the whole university and have started to reinforce the university's administrative functions.

GI-CoRE utilizes established networks and outcomes achieved through collaborative research with institutions and organizations to further strengthen research projects that give the university an edge over other research universities and implement 'global postgraduate-level education by organic fusion of different fields' at graduate schools in related fields. To promote these, GI-CoRE will use management expenses grants from the Japanese government, and aims to obtain various funds such as competitive funds as grants-in-aid for scientific research and donation.

3.3 Administrative System

In order to support research and educational activities in the global station, administrative staff are required to strengthen their capabilities to handle international affairs. With this in mind, Hokkaido University has set up a specialist administrative office for GI-CoRE and assigned staff members who were able to offer substantial assistance in English to create a bilingual (Japanese and English) environment where professors who have come from overseas are able to put all their focus on teaching and research. The administrative staff at the GSF Station comprises one specialist and two clerical assistants. These staff members are stationed at the building where the Graduate School of Global Food Resources is located, and provide support for daily research activities conducted there.

3.4 Future Prospects

Here, we describe the future organizational challenges of GSF and the Graduate School of Global Food Resources.

3.4.1 Internalization and fixation of GS into the related sector within Hokkaido University

Under the direct governance of GI-CoRE, each GS has been operated using a special budget called MEXT's Promotion Budget for Function Enhancement. Basically, this budget is to be incorporated as a core expense in the university's ordinary budget after being taken for a period of five years.

At the end of GS's five-year first phase, the university executive department asked to start considering that each GS be internalized and fixed in the relevant sector, instead of keeping each GS under the direct affiliate of GI-CoRE.

In response to this, GSF has begun to discuss its internalization and fixation into the Research Faculty of Agriculture, which is the most closely related sector for GSF. In preparation for GSF being incorporated as part of the Research Faculty of Agriculture commencing from the fiscal year 2020, we are now examining the organizational concepts, faculty positions and treatment, budgeting, and administrative systems of future GSF.

Despite the mother body of GSF will be changed from GI-CoRE to the Research Faculty of Agriculture, GSF should maintain its properties of a highly independent research-based organization through the collaborative research activities between the cross-appointed overseas researchers and the Hokkaido University faculties. Furthermore, the fruit of GSF's research activities has to be extended to the educational reinforcement for both graduate schools of the Global Food Resources and the Agriculture.

One of the consequences of the internalization of GSs is the reduction of its budget. Upon the internalization, the budget will be incorporated as the university's ordinary budget. Therefore, it will be continuously funded, but the amount will be expected to be reduced to approximately 65% of the former amount. Thus, it is predicted that GSF will be under tough financial situation after internalization. To overcome the effect, it is necessary to further promote research and educational activities through the selection and integration of the core competence of GSF. Further efforts are also needed for obtaining external research funding.

3.4.2 Improvement of educational system

MEXT's Central Council for Education published a report called *Grand Design for Higher Education toward 2040* in November 2018. (An English summary can be found here: http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2018/12/17/1411360_7_2.pdf)

Among this, the following two points are raised as the image of the required human resources and the form that higher education should aim for.

1) People capable of surviving the age of unpredictability: Acquire universal knowledge and understanding as well as versatile skills both in humanities and sciences. Qualify to actively support society along with the changes of the times and improve the society with capability of thinking logically
2) Shift to learners-oriented education: Visualize the learning outcomes of individual learners, ensure diversity and flexibility in systems to enable learners to continue learning as well as mobility of learners

To achieve these objectives, the council is indicating the following education and research framework requirements. 1) diverse students, 2) diverse faculties, 3) diverse and flexible

educational programs, 4) flexible governance to accept diversity, and 5) enhancement of university's diverse strengths.

The Graduate School of Global Food Resources has adopted many of these recommended elements prior to the announcement of this report. Notably, the history and reputation of Hokkaido University dating back to the early days of the Sapporo Agricultural College, basic philosophies of Hokkaido University, and the scale and diversity of this comprehensive university are the backbone of the education provided by the Graduate School of Global Food Resources and forming the strength of this school.

On the other hand, there are areas for improvement in the educational program of the Graduate School of Global Food Resources. For example, our education tends to be heavily influenced by each faculty member’s research field, methods, experience and research acquirements. In some ways, this is unavoidable because each of our faculty members has a highly specialist background as a researcher. It also provides students with an otherwise rare opportunity to meet highly specialized professionals who can share their experience, knowledge and insights. However, as the provider of educational programs, we need to look at things through the students’ eyes – what do they really want to learn? What skills do they need to master? We must constantly examine our educational systems and have to keep working to improve them.

Appendices

Appendix I. Description of Research Projects

Project I: Sensing technologies for detection of biomarkers in animals and microbes

This research is carried out and promoted by three research groups in Hokkaido, the USA, and Australia as illustrated as Figure A1. Graduate students in each group are assigned on this study, and researchers from five domestic companies cooperate in prototyping sensor elements and systems. In addition, experiments are conducted at farms belonging to Hokkaido University and two major overseas universities that are strong in the agricultural fields, i.e., the University of Sydney and the Iowa State University. The following four components are involved in this project.

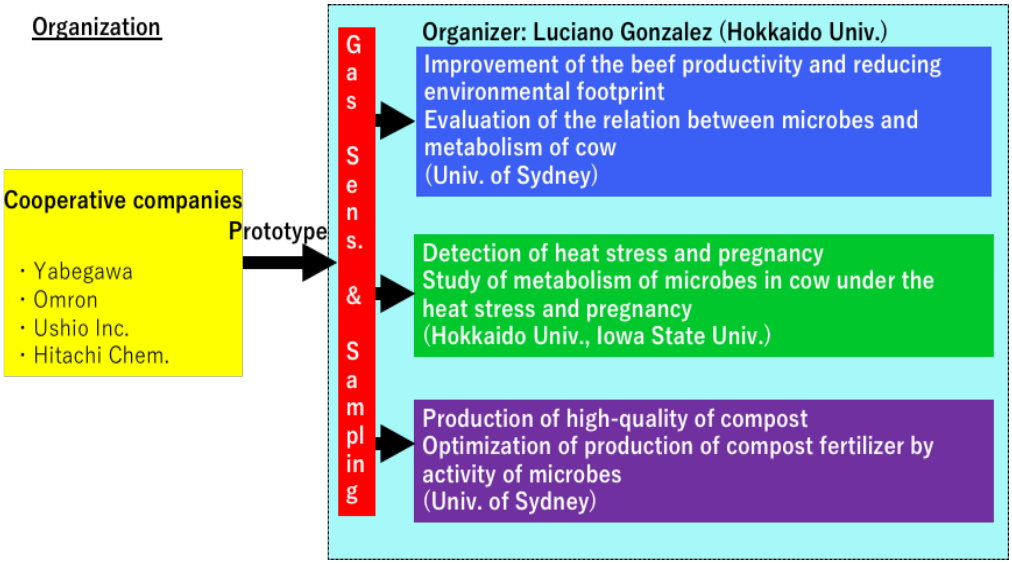


Figure A1. Organization of the project on sensing technologies for detection of biomarkers in animals and microbes.

I-A. Diagnosis of bovine heat stress and pregnancy (collaboration with Prof. Lance Baumgard, the Iowa State University)

The purpose of this study is to improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

In this research, basic sensors such as an N_2O, NO and CO_2 gas sensor, a CH_4 gas sensor, an H_2 gas sensor, a temperature sensor, and a humidity sensor are built in a breath gas monitoring system. Additionally, gas sensors to measure O_2, alcohols, acetone, hydrogen peroxide, ammonia, sulfide, and NO will be assembled for heat stroke or pregnancy diagnosis.

In the study on heat stroke diagnosis, Prof. Baumgard will investigate the effectiveness of substances used to counter heat stroke by comparing metabolic state with intestinal tissue and gastric surface structures in cows with a breath gas monitoring system.

In the study on pregnancy diagnosis, Masashi Takahashi and Toshikazu Kawaguchi will compare the signal substances related to pregnancy in bovine blood and gas products in cows' breath. The study will be conducted using a new pregnancy diagnosis technique.

I-B. Improvement of productivity and reduction of environmental footprint in beef production (collaboration with Prof. Luciano Gonzalez, the University of Sydney)

The purpose of this study is to improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

I-C. High-quality compost manufacturing technology (collaboration with Prof. Michael Kertesz, the University of Sydney)

The purpose of this study is to improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

I-D. Prevention of decomposition of vegetables after harvest (collaboration with Prof. Brian Jones, the University of Sydney)

Vegetables produce ethylene gas through metabolic reactions after harvest, and it is known that ethylene gas causes decomposition of vegetables in storage boxes. Photo-catalysts have become a focus for decomposition of ethylene gas in recent years. Here, we propose a use of a newly synthesized photo-catalyst to prevent decomposition of vegetables.

Project I-A: Diagnosis of bovine heat stress and pregnancy

Purpose

To improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

Research

Previous research in the medical field has demonstrated the importance of breath sensing to detect metabolic and other health disorders. When viruses and bacteria cause inflammation, substances from their metabolism are released in the patient's breath. Therefore, it is predicted that inflammation of the digestive system of cattle also produces detectable substances.

Heat stress is increasing due to recent rises in temperature, and there is concern about bovine production and milk quality in future. A member of our research team, Prof. Lance Baumgard,

found that the walls of the rumen and small intestine have a surface structure covered with folds. As the temperature rises, these adhere to each other and inhibit the absorption of sugars and amino acids. Adhesion of folds in the second or third compartment of the gastrointestinal tract may also greatly affect the activity of bacteria living there. In addition, it is considered likely that an increase in body temperature due to an increase in ambient temperature or heat stroke will also affect the activity of microorganisms inside and outside the body of cattle. The formation of nitrogen oxide gases may also be caused by inflammation of tissues due to adhesion, meaning that heat stress could be predicted with a system to monitor these compounds.

Similarly, various signal substances are produced during pregnancy. One research article reported that the concentration of nitrogen oxide gas gradually increases throughout pregnancy. It is also known that pregnancy can result in metabolic problems such as pregnancy toxemia, which is caused by an accumulation of ketone compounds in blood that are also increased in exhaled breath. Among the digestive organs, the stomach is particularly susceptible to stress, and its response can be detected with an H_2 gas sensor.

In this research, basic sensors such as an N_2O, NO and CO_2 gas sensor, a CH_4 gas sensor, an H_2 gas sensor, a temperature sensor, and a humidity sensor are built in a breath gas monitoring system. Additionally, gas sensors to measure O_2, alcohols, acetone, hydrogen peroxide, ammonia, sulfide, and NO will be assembled for heat stroke or pregnancy diagnosis.

In the study on heat stroke diagnosis, Prof. Baumgard will investigate the effectiveness of substances used to counter heat stroke by comparing metabolic state with intestinal tissue and gastric surface structures in cows with a breath gas monitoring system.

In the study on pregnancy diagnosis, Masashi Takahashi and Toshikazu Kawaguchi will compare the signal substances related to pregnancy in bovine blood and gas products in cows' breath. The study will be conducted using a new pregnancy diagnosis technique.

Results

This project is to be carried out from 2019 to 2022 with funding by Grants-in-Aid for Scientific Research, Japan. Some companies have expressed advance interest in this collaborative project. In 2015 and 2017, we met with members of the business section of Ushio Co. at their office to discuss the collaboration project. Ushio Co. asked Yabegawa Electric Co. to build a sensing system for the diagnosis of bovine heat stress. Yabegawa Electric Co. made a prototype of a breath gas sensor system late in 2017, and the breath sensor has continuously been updated since.

For a preliminary experiment of the concept, semiconductor gas sensors were constructed for the purpose of monitoring bovine expiratory volatile compounds (Figure A2). A CO_2 gas sensor, a CH_4 gas sensor, an H_2 gas sensor, a temperature sensor, and a humidity sensor were installed in a 10 cm housing. Data transfer module equips the DAC interface (digital signal: $\pm$1.0 V) and it send data to a database at two-second intervals via a Wi-Fi (2.4 GHz) module over the internet. Data is also stored on a Micro SD card in case the data transfer fails. The breath is suctioned with a flexible tube

placed near the nose using a micro fan mounted in the housing and is then sent to the sensors. In the test on a cow on a farm, a flow rate of 10 cm^3 / s and a tube diameter of 4 mm was used. It was concluded that the sampling system is capable of obtaining a sensor response corresponding to exhalation with almost no delay when used on cows on farms. For each gas component, this system was able to measure in the concentration range of bovine breath with CO_2 concentration (40,000 ppm), CH_4 concentration (1,000 ppm), and H_2 concentration (100 ppm).

In this study, we are investigating the monitoring of metabolism-related substances for evaluation of the activity of bacteria and microorganisms in the rumen (such as methanogenic activity). O_2, alcohol, acetone, hydrogen peroxide, ammonia, sulfide, and nitrogen compounds such as N_2O and NO will also be monitored in this study. Additionally, a GPS and motion sensor for swing motion will be assembled to track the behavior of grazing animals during periods such as the grazing and rumination period and link this data to the emissions of different volatile compounds.

A preliminary experiment indicated that communication using Wi-Fi is unsuitable for a vast ranch because the range of the radio waves is limited to 50 m. Wi-Fi modules also consume a large amount of electricity, posing the challenge that they can only be operated for about 24 hours even with a 10,000 mAh mobile battery. We will therefore study the development of data transfer technology using a 920 MHz power-saving radio. A power-saving radio consumes 1/4 or less of that consumed by a Wi-Fi module, making it possible to perform data communication as far as 15 km away (without obstructions) in vast pastures.

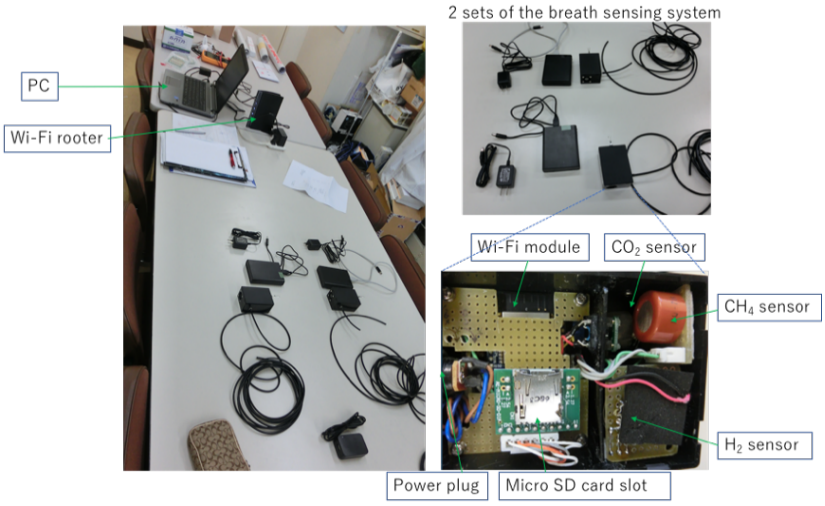


Figure A2. Prototyped breath gas sensor system

Project I-B: Improvement of beef productivity and reduction of environmental footprint in beef production

Purpose

To improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

Research

Beef quality is evaluated from physical characteristics (water retention, shear strength, muscle fiber, collagen), fat quality (fatty acid content and profile, and fat melting point), fat content, taste components (free amino acids, nucleic acid related substances, and chemical composition), and aroma using analytical instruments. Most often, the quality of beef experienced by the diner is evaluated by sensory factors, such as tenderness, flavor, and appearance (fat distribution and color). The tenderness of meat is thought to be determined by the quality and quantity of connective tissue mainly composed of muscle fibers and collagen. In addition, the pH of meat does not decrease sufficiently as a result of maturation due to stress prior to slaughter, which increases toughness. The meat quality is influenced not only by breed but also by the conditions under which the cow was raised including nutrition, stress experienced prior to slaughter, and processing. Luciano Gonzalez worked on the effects of genetics, nutrition, stress and disease on meat quality of beef cattle.

We are currently conducting an experiment to evaluate the metabolic activity of microorganisms in bovine rumen by measuring the concentration of CO_2, CH_4, and H_2 in the breath of cattle using a prototype breath sensing system (Figure A2). The objective is to measure these volatile compounds in a cost-effective and practical way on a large scale. This will allow monitoring and management of nutrition, health and greenhouse emissions from ruminant production. Luciano Gonzalez is currently involved in several projects aiming to reduce methane emissions from ruminant production in Australia by improving nutrition, animal management and breeding. His work has made it possible to breed animals with improved nutritional and metabolic profiles, which have lower methane emissions, in the last few years.

Results

Prior to receiving Grants-in-Aids for Scientific Research, the collaboration was funded by a company that plans to commercialize the system.

Hitachi Chem. Co., the University of Sydney, and Hokkaido University signed the contract of this collaboration project in 2018. This contract describes the collaboration regarding the development of the agricultural system with new materials including sensors developed by Hitachi Chem. Co.

In this project, we used a prototyped breath gas sensor system developed by Yabegawa Electric Co. in late 2017. The breath sensor has been continuously updated since then.

The concentrations of CO_2, CH_4, and H_2 in the breath of cattle are continuously monitored using the prototype breath sensing system in the farm of the Camden Campus of the University of Sydney. In 2018 and 2019, Prof. Kawaguchi visited the farm of Camden Campus to obtain preliminary results and identify challenges involved in breath sensing.

Sensorgrams of breath gases were constantly obtained in intervals of one second. The signal was slightly smaller than the expected value. Prof. Luciano Gonzalez purchased a commercial breath gas sampler and analyzer and compared the results with those obtained using the breath gas sensing system.

At present, the effect of wind is a challenge in gas sampling. When a strong wind blows, gas concentration is decreased, meaning that sampled gases are diluted with air. The gas sampling speed needs to be increased to avoid the effect of wind.

Yabegawa Electric Co. and Prof. Kawaguchi are therefore in the process of developing an ultrasonic gas sampling system. We have plans to prepare two research articles about the breath gas sensing system based on the results from the University of Sydney.

In the next project, an AI livestock production system is being studied. Labor costs in Australia are extremely high, and the average monthly salary of technician working on a farm is equivalent to 1.5 million yen. Australia therefore has a well-developed AI livestock production system. To date, Prof. Luciano Gonzalez has studied the relation between metabolism and the quality of meat, evaluating fat with an IR sensor. The gas sensing system for the metabolism of dairy cows will help to improve the quality of meat in aged cows.

Meanwhile, Hokkaido wants to promote the mass production of livestock on a large scale, and AI livestock production technology is very useful for this goal. Some companies are interested in this technology and are offering to provide a foundation for collaborative research on this topic. Collaboration with companies in Hokkaido is still under discussion.

Project I-C: High-quality compost manufacturing technology

Purpose

To improve the quality of compost fertilizers and livestock production through the use of advanced sensors and monitoring systems able to measure substances produced by the metabolism of microorganisms living in bovine bodies and compost.

Research

Michael Kertesz studies compost fertilizer comprising a mixture of wheat straw, poultry manure, and calcium sulfate for the cultivation of various mushrooms. CH_4, CO_2, CO, and butyric acid are known to be formed as a gas phase component by fermentation under aerobic conditions, while NH_3, N_2O, and N_2 are generated by nitrification and denitrification reactions. However, the temperature of the compost rises over time (Figure A3, A4). This high-temperature phase is maintained by blowing air into the compost to maintain an aerobic atmosphere. Odorous volatile substances such as 2-methyl isoborneol and geosmin can be produced. Many mesophilic aerobic bacteria are not killed even in the high-temperature phase, instead turning into a dormant form, often spores. The high-temperature phase is followed by a curing phase at a lower temperature, and the activity of these mesophilic organisms starts again. So far, we have used the PCR method to identify bacteria and microorganisms and discuss the theory of quantity, but we found that it is more important to monitor activity than the number of bacteria and microorganisms for the reasons described above. Therefore, we aim to optimize compost manufacturing technology using the same device as the breath monitoring system that evaluates the activity of bacteria and microorganisms in the bovine body.

However, it was also noticed that the surface of a compost pile has a greatly different temperature and humidity compared to the inside. It is necessary to evaluate the activity of bacteria and microorganisms at different depths in the compost. In this study, we will develop a structure to collect gas from eight points and inject gases into the gas sensor system with a newly developed multipoint autosampler. Preliminary experiment results show that a micro fan with a pressure of 250 Ps does not have sufficient pressure to perform gas sampling in a compost pile. An ultrasonic pump that can achieve a 2000 Ps output at a small size will therefore be developed to sample gas. In past studies involving gas analysis of compost fertilizer, the gases were sampled from the surface of the pile or the headspace after the compost was put in a container. Direct measurement is a totally new concept, and the design of the inlet for sampling gas is a challenge that needs to be addressed using our preliminary result data.

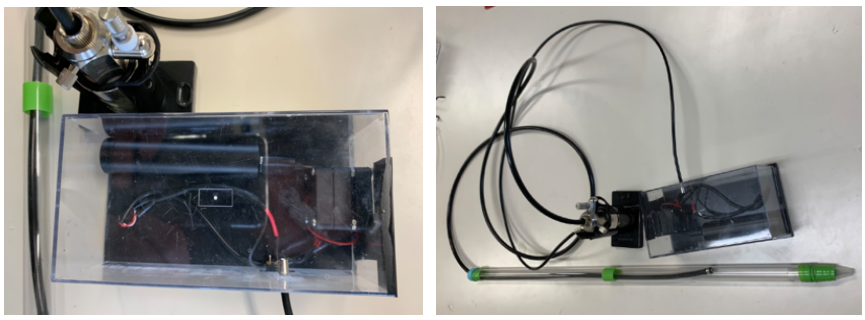


Figure A3. Gas sampling system for compost fertilizer

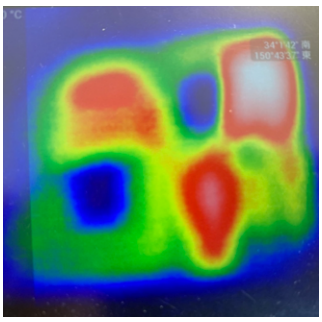


Figure A4. Thermal image of compost

Results

Prof. Kawaguchi visited a compost yard with Prof. Michael Kertesz in Sydney. The Australian compost company gave us the opportunity to examine the sensing system in their compost yards. Figure A3 shows our gas sampling system for compost fertilizer. Prof. Kashiwagi helped to design the stick sampler to collect gas from soil. Triple fans are assembled in a sealed box.

Gas was collected from the holes at the tip of the stick by a vacuuming process using the fans and the temperature and sampling speed of the fan exhaust were measured It was found that the sampling speed of 3.5 ms^{-1} was not sufficient to collect the gas from soil: above 15 ms^{-1} was needed.

A thermal image was obtained using a thermal camera (IR camera). The surface temperature of the compost was found to be 38 ˚C, close to the atmospheric temperature. The inner temperature, however, was 50-60 ˚C due to the metabolism and fermentation of compost. Aerobic conditions were controlled by blowing air from the floor. Therefore, the thermal image (Figure A4) shows spots with low and high temperature alternately.

The Australian compost company is very interested in the results and has proposed a collaborative project with the University of Sydney and Hokkaido University. At their request, a new thermal imaging and soil moisture sensing system has been developed (Figure A5), and will be demonstrated in September 2019.

This technology is used in AI agriculture in Hokkaido. The Iwamizawa City government has expressed particular interest in this technology for the purpose of producing custom-made compost. International collaboration is expected.

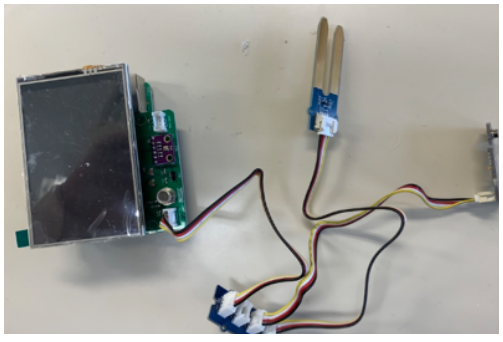


Figure A5. Newly developed thermal imaging and soil moisture sensing system

Project I-D: Prevention of decomposition of vegetables after harvest

Purpose

Vegetables produce ethylene gas through metabolic reactions after harvest, and it is known that ethylene gas causes decomposition of vegetables in storage boxes. Photo-catalysts have become a focus for decomposition of ethylene gas in recent years. Here, we propose a use of a newly synthesized photo-catalyst to prevent decomposition of vegetables.

Research

Food loss is one of challenges that must be addressed to achieve zero hunger according to the Sustainable Development Goals. This is caused by improper storage of food. For example, in developing countries where appropriate storage is not established, food is abundant after harvest but scarce later. As you can imagine, vegetables and fruit soon decompose at the high temperatures of many of these countries. Vegetables decompose through metabolism, as their cells are still alive after harvest. Of course, bacteria and yeast are also active in the vegetables. Vegetables and fruits are generally stored at 4 ˚C to decrease metabolic activity, but power outages often occur in developing countries, causing the vegetables to decompose. Meanwhile, global food trading is increasing, and foods spend a long time in transit to their export destinations. As time passes, the vegetables decompose despite remaining chilled under controlled temperatures, indicating that decomposition is caused by the metabolism of the living cells in the vegetables. The vegetables themselves consume the nutrients in their flesh and produce ethylene gas through the metabolism process. Ethylene gas attacks the plasma membrane of the cells of the vegetables, turning them dark brown and black. Nowadays, there is a focus on photo-catalysts to decompose ethylene. Hitachi Co. sells a refrigerator modified with a photo-catalyst for food storage. However, the present photo-catalyst needs UV light (light with a wavelength below 250 nm).

In this collaborative project, a photo-catalyst that can work under normal indoor lighting has been proposed for use in food storage. In 2012, Prof. Kawaguchi developed a method to synthesize a photo-catalyst with a “self-assembling” method. Hokkaido University obtained two patents for achievement. This collaboration will employ this photo-catalyst to solve this issue.

Results

We chose titanium dioxide as a photo-catalyst for the food storage. Titanium dioxide forms several crystalline structures such as anatase, rutile, and amorphous. First, their photo-catalytic activities were compared. Figure A6 demonstrates the decomposition of methylene blue under normal indoor lighting. TiO_2 was suspended in methylene blue aqueous solution, and it was noticed that the color of the synthesized TiO_2 in the test tube turned clear.

In Figure A7, a UV-Vis spectrum depicts the absorption peak of this photo-catalyst. The peak was observed at 370 nm, the same wavelength of one of the emission peaks of a fluorescent lamp

(generally used in offices). This result directly indicates that a general-purpose lamp will activate this photo-catalyst and facilitate decomposition of ethylene gas.

Modification of the surface of food package was attempted. The microscopic image (Figure A7) illustrates the particle-like modification that took place.

We plan to have a student at Hokkaido University examine a vegetable storage test using packaging modified with the photo-catalyst developed in the University of Sydney from August to November 2019.

The largest packaging company in Sydney is very interested in this collaboration project, and funding is currently under discussion with the company.

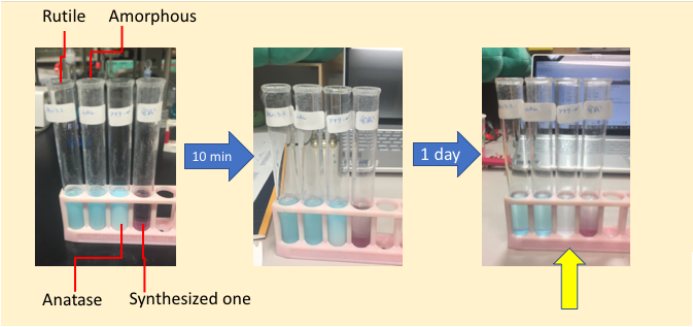
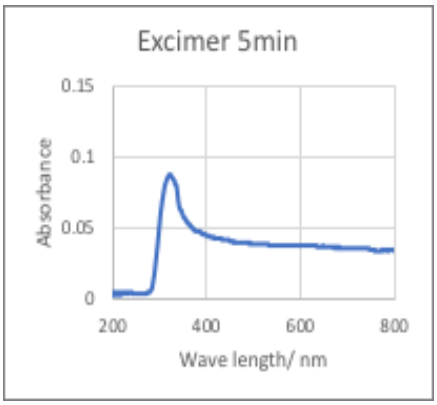


Figure A6. Demonstration of decomposition of methylene blue (color dye) by TiO_2 under room-light.



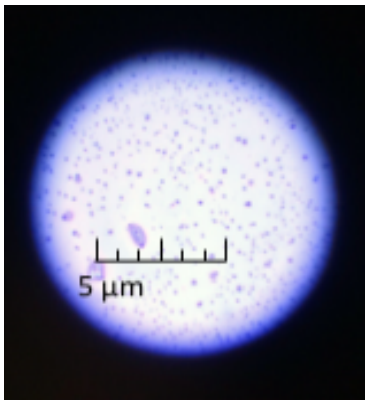


Figure A7. UV-Vis spectrum of the synthesized photo catalyst and microscopic image of a package modified with the photo catalyst

Project II: Nitrogen cycles and microbes in the environment

Carried out by a team of internationally recognized scientists, this project seeks to investigate nitrogen cycles and microbes. Profs. Timothy Clough (Lincoln University, New Zealand) and Michael Kertesz (University of Sydney, Australia) joined GI-CoRE GSF, and have been conducting collaborative research with Associate Prof. Yoshitaka Uchida (GI-CoRE GSF, and Research Faculty of Agriculture, Hokkaido University). The team investigates the microbial mechanisms of nitrogen transformation, particularly in soils and livestock waste. Excess nitrogen is becoming an issue in agricultural systems, particularly livestock systems such as the dairy and beef industries. Human beings often uptake nitrogen (in forms such as protein and vitamins) through animal-based diets, but modern agricultural systems (intensive farming) use an excessive amount of nitrogen to produce high-quality animal-based diets.

Dr. Kertesz has been studying not only the nitrogen cycle but also sulfur and phosphorus cycles in the environment. Additionally, his research focuses on specific environments such as plant root zones (rhizospheres) and mushroom compost. He has investigated the contribution of fungal species in these nutrient cycles. In contrast, Dr. Clough specializes in nitrogen gas emissions from soils. He is skilled in using stable isotopes (e.g. ^{15}N) to investigate the sources and pathways of nitrogen transformation. Dr. Uchida focuses on the activities of soil microbes using molecular approaches. He is interested in functional genes related to nitrogen cycles and is able to investigate diversity in microbes holding a specific functional gene. By collaborating, these scientists are able to investigate the black boxes within the nitrogen cycle. Some research topics are listed below.

Drs. Kertesz and Uchida are currently investigating microbial dynamics in animal manure, particularly during composting processes. These processes are necessary to control the availability of nutrients, to reduce its odor and to alter its physical conditions to suit the purpose of the compost. However, composting processes require a significant amount of money and time (for purposes such

as the addition of supplementary nitrogen and carbon, along with mixing). Thus, we aim to investigate shifts in microbial community structures within livestock waste during the composting processes with variable conditions. This international collaboration identified that manure processing systems vary significantly between countries. For example, in Hokkaido, dairy farm waste is often intensively managed: waste from different farms is centralized at a certain location (such as biogas plants), and the waste is redistributed to surrounding farms. This type of animal waste management system is very rare in Australia, where each farm has its own waste treatment systems (such as ponds) and nutrients are returned on each farm. Additionally, Hokkaido dairy farmers are more interested in the use of manure compost as a physical conditioner for soils, whereas Australian dairy farmers utilize the same materials mainly to reduce the input of chemical fertilizers. Thus, the team will investigate the patterns of microbial community structure changes and their relationship with compost quality, using various types of manure (cow and chicken), nitrogen (urea) and carbon additives (straw, sawdust, wood chips) under different temperature and moisture conditions. Bacterial and fungal communities, as well as their functional genes, are targeted in this study. At the end of this study, key microbes that are important to improve cost and labor efficiency during composting are identified for the different purposes of the compost.

Drs. Clough and Uchida are researching the mechanisms of biological nitrous oxide (N_2O) emissions. Emissions of N_2O are a very important issue because the gas is strongly related to ozone layer depletion as well as global warming. The team is targeting the emissions from surface-damaged soils, using a dual isotope approach (use of ^{15}N and ^{18}O) and molecular methods (analyses of soil DNA and RNA). In dairy farming systems, soil surfaces can sustain damage (such as photo damage) due to animals trampling the pasture surface. Dr. Clough is based in New Zealand and has been studying the effect of animal tramping (soil compaction) on environmental risks related to the nitrogen cycle for many years (including *Soil Biol Biochem* 2008 by Uchida, Clough et al.), since animal grazing is very common in New Zealand. In Hokkaido, grazing is not common, but some dairy farmers have begun imitating New Zealand systems with intensive grazing because of its cost performance. Guidance is needed for Japanese farmers attempting the grazing system, because of the environmental risks. Environmental factors specific to Hokkaido soils (such as soil freezing) must be investigated before applying New Zealand-based guidelines regarding livestock and environmental management concerning grazing (Uchida and Clough, *Grassland Sci* 2015). The surface-damaged areas represent hotspots for nitrogen-related environmental risks, including N_2O emissions. Under these conditions, multiple N_2O-producing microbial pathways can play an important role, and these pathways can be evaluated using isotope approaches.

Project III: Collaborative effort on utilization of enzyme-assisted kelp for production of biofuels and health benefits

Purpose

Advanced genome-science methods will be used to identify enzymes capable of efficient and rapid hydrolysis of all polysaccharides present in abundant, renewable, and farmable Japanese brown kelp species. Monomer sugars provided by this work will be available as substrates for microbial fermentation into a myriad of biofuels and bioproducts useful to humankind. Additionally, the products of this work have great potential benefits as bioactive polysaccharides with properties beneficial for human health such as antioxidant and anti-inflammatory properties.

There are tremendous opportunities and ever-increasing demands to produce energy and obtain valuable bioproducts in clean and sustainable ways from renewable plant biomass. There are many types of plant biomass around the world that are suitable for conversion into fuels and bioproducts including corn stover, miscanthus, sugar cane bagasse, poplar wood, and brown kelp (Peralta-Yahya and Keasling, Biotechnol. J., 2010). Each region of the world has some type of biomass that should be considered.

Our current collaborative work focuses on brown kelp as an abundant, potentially farmable biomass. Japan has the 6th largest territorial waters in its exclusive economic zone (4,470,000 km^2). These waters contain substantial amounts of brown kelp, which potentially represents a local, renewable substrate for biorefinery operations. In practical terms, a kelp biorefinery would liberate sugars for use as beneficial products by themselves or as substrates for microbial fermentation into a myriad of biofuels and bioproducts useful to humankind.

Kelp contains three types of non-crystalline polysaccharides (Figure A8): laminarin, alginate, and fucoidan. Laminarin (~20%) is a β-1,3-linked glucan with β-1,6 branch points and occasional reducing ends capped by mannitol. Alginate (~30%) is a mixed linkage polysaccharide consisting of variable tracts of β-(1,4)-D-mannuronate and β-(1,4)-L-guluronate. Regions of consecutive mannuronate are called M-blocks, while regions of consecutive guluronate are called G-blocks; alternating regions are called MG-blocks. Most brown kelp species also contain 0.5-20% of sulfated polysaccharide called fucoidan (a diverse β-1,2 and/or -1,3-linked glucan), whose chemical

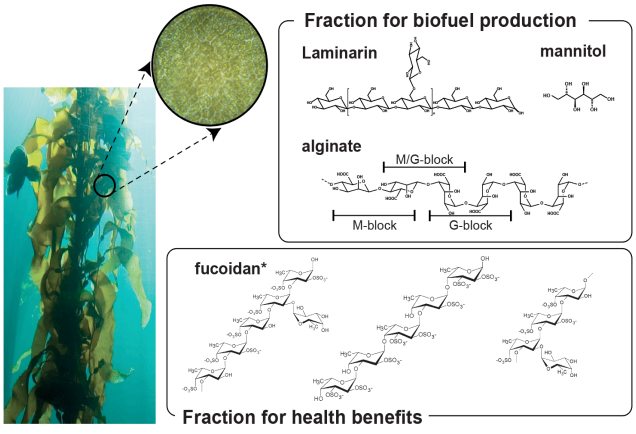


Figure A8. Structures of the major polysaccharides found in brown kelp, an abundant, potentially farmable biomass found in Japanese coastal waters. *Fucoidan structures are representatives from three order of brown algae.

composition and structure varies depending on the kelp species. Recently, fucoidan has been considered to be a potentially beneficial bioactive polysaccharide that could function as an antioxidant or anti-inflammatory agent, or provide other beneficial properties for human health.

Unlike terrestrial biomass, kelp does not contain lignin and has a high quantity of free, readily fermented mannitol (up to 30% in some species [Iwamoto et al., Mar. Biotechnol., 2005]). This makes kelp an excellent and realistic biomass for studies on enzymatic hydrolysis to obtain monomers or beneficial oligosaccharides by the simplest possible combination of enzymes without harsh chemical extraction steps.

Study

We obtained valuable preliminary results by studying *Saccharina latissimima*, a brown kelp species that is abundant along the California coast of the USA and Norway but does not contain fucoidan (Scullin et al., Biores. Technol., 2015). This work showed our skills in biochemical analysis and structural biology, which will now be applied in the new and innovative work proposed here. In this work, we focus on *Sargassum horneri* (known as akamoku in Japan), an abundant brown kelp in Japanese waters that provides an excellent, renewable source for laminarin, alginate and fucoidan, three targets for biorefinery use to make biofuels and biochemicals as well as bioproducts with health benefits (Figure A8).

The scientific significance of this work is that we will develop enzymatic methods to convert all kelp polysaccharides into monomers or other desirable soluble fractions, which has not been achieved with any brown algae before. This will be achieved using our expertise in genome-enabled biochemistry, including discovery of enzymes by a combination of bioinformatics, gene synthesis, protein production, enzyme characterization, and protein engineering; determination of the chemical composition of brown kelp and the time course of its enzymatic conversion; and then metabolic engineering of model bacteria to maximize the potential of brown kelp as a renewable biomass for biofuel and bioproducts.

The originality of this work arises from our recognition that brown kelp is an excellent, industrially realistic biomass for studies to improve efficiency and yield of enzymatic hydrolysis using the simplest combination of enzymes possible, and without harsh chemical extraction steps. Since we know the structures of all of the major polysaccharides present, our research will yield phylogeny-based discovery of enzymes with properties best matched for synergistic reaction. By studying different combinations of the enzymes that are identified, we expect to be able to systematically deconstruct a wide range of brown kelp found in Japan into valuable oligosaccharides and monomer sugars.

One important outcome of our research will be that simple, pure sugars produced from kelp by this research will become available for conversion to biofuels and other bioproducts in biorefinery operations, which will help to reduce the huge world-wide dependence on fossil fuels.

Results

Using *S. latissima*, we have obtained 80% glucose and 20% oligosaccharides from laminarin and extensive conversion of alginate to soluble oligosaccharides when 1 µg equivalents of both GH55 laminarinase (Bianchetti and Takasuka et al., J. Biol. Chem., 2015) and PL18 alginate lyase (in preparation) were reacted in 1.0 mL of 50 mM phosphate, pH 6.0, containing 10 mg *S. latissima*, for 15 minutes. This is our starting point to achieve complete hydrolysis of both laminarin and alginate (Figure A9) in a model brown kelp to form monomer sugars. Progress toward our first research goal can be evaluated in relation to this benchmark.

Our first goal is to identify enzymes (and reaction conditions) with the total mass loading of 5 mg/g of biomass or less that is needed to convert the remaining 20% of laminarin oligosaccharides to glucose and to selectively convert alginate oligosaccharides to monomers of mannuronate and guluronate. To achieve this, we will identify enzymes that hydrolyze laminaribiose (β-1,3-linkage), gentiobiose (β-1,6-linkage), and glucosyl-mannitol (linkage unknown at this point), as well as enzymes to hydrolyze M-, G-, and M/G-blocks in alginate oligosaccharides. We will look for initial candidates for each of these activities in existing CAZyme families. The anomeric bond arrangement in glucosyl-mannitol will be determined using NMR, with our enzyme studies focused on hydrolyzing it into glucose and mannitol. For alginate oligosaccharide hydrolysis, we will start with the exo-alginate lyase family (PL17; www.cazy.org) and use our established gene discovery and characterization approaches to prepare and test candidate enzymes.

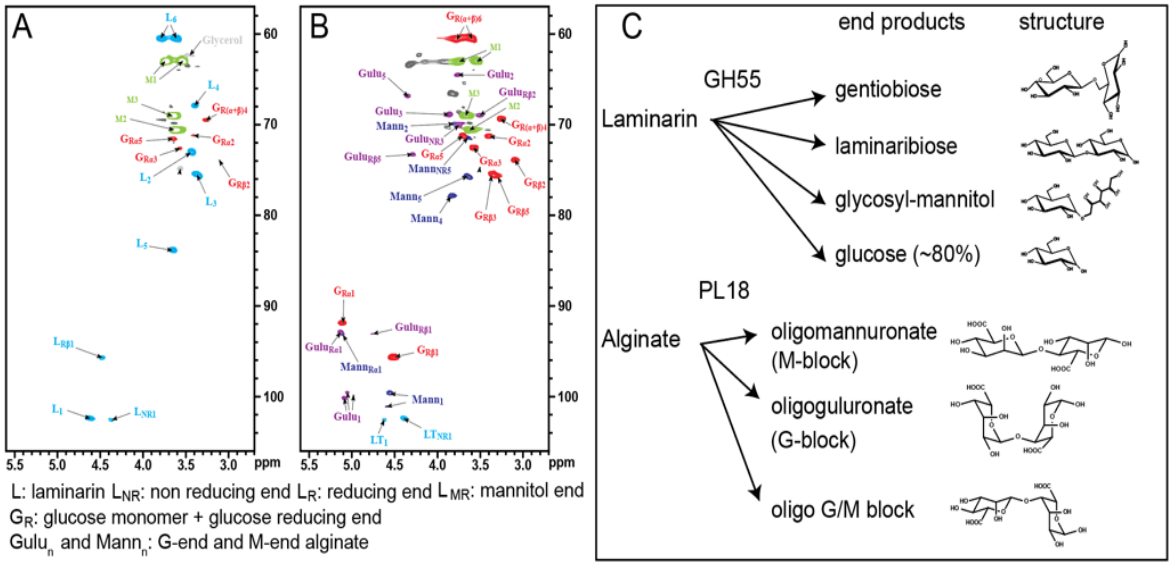


Figure A9. Kelp hydrolysis by two enzymes, GH55 and PL18, analyzed by 2D HSQC NMR. Laminarin and mannitol were found in the absence of two enzymes (A), and end products were analyzed (B). Summary of the products identified from this analysis is shown in (C).

Our second goal will be to gain a greater understanding of the structure and reactivity of fucoidans kelp. As the enzymes needed to complete hydrolysis of laminarin and alginates become available as a result of the work described above, we will use them to obtain intact fucoidans from *S. horneri* under mild conditions. We will provide these materials to our collaborator, Dr. Hideyuki Kurihara from the School of Fisheries, Hokkaido University, who will test their properties relative to fucoidans obtained from other, harsher chemical methods. These purified fucoidans will also be an excellent substrate for identification of enzymes that can hydrolyze bonds found in them (e.g., β-1,2, -1,3 and -1,4 hydrolases, sulfatases).

Our third goal is to produce engineered forms of each enzyme so that they can be recovered from kelp hydrolysis solutions for reuse and thus improve process efficiency in a biorefinery setting. We will use gene synthesis approaches to make fusions to known affinity tags (such as His or FLAG, at either an N- or C-terminus) and test whether the modified enzymes can be recovered from kelp hydrolysates at the sugar concentrations and ionic strength obtained from our enzyme digestions. We will also determine the specific activity of enzymes after successive cycles of reaction and recovery to define long-term stability.

Finally, we will use genome editing technology to install all of the enzymes necessary for kelp hydrolysis into the genome of a model bacterium such as Escherichia coli and yeast (Atsumi et al., Nature, 2008, Yoshikuni et al., Nature, 2006, Santos and Yoshikuni, Nat. protocol, 2014).

Funding source

This work has been partially funded by the JSPS KAKENHI Fund for the Promotion of Joint International Research (15KK0269 to T.T.) and Grant-in-Aid for Scientific Research B (18H02011 to S.A.)

Project IV: Mechanisms of fungicide resistance in pathosystems and host-pathogen interactions in grasses

Plant diseases cause serious damages to the yield and quality of crops. Chemical control such as fungicide should be reduced in term of environmental issues. Sustainable agriculture requires appropriate plant disease control in crops. Grasses were used in our research as the research of both scientists (Profs. Yamada and Jung) targeted grasses for turf, forage and bioenergy. The primary focus of our joint research and the extensive career goal are to develop the optimal disease and fungicide resistance management strategies for pathosystems by translating our understanding of pathogen ecology, mechanisms of fungicide resistance (field and molecular diagnostic tools and new drug discovery), and breeding and genetics of host resistance. Research falls into two areas of study, which can be summarized as 1) mechanisms of fungicide resistance in grass pathosystems using molecular and genomic approaches and 2) host-pathogen interactions in grass systems.

We obtained some available information on the control of dollar spot disease caused by *Sclerotinia homoeocarpa*, one of the most common and economically important diseases in cool-season turf grass species in both the United States and Japan. Below are descriptions of joint research activities between Hokkaido University and the University of Massachusetts so far.

1) Resistance of *Sclerotinia homoeocarpa* field isolates to succinate dehydrogenase inhibitor fungicides

Sclerotinia homoeocarpa isolates were collected from golf courses in Japan and the United States (2016–2017). The Japanese isolates were collected during a monitoring study and the U.S. isolates were collected in response to field failure. Five active ingredients of succinate dehydrogenase inhibitors (SDHI) (boscalid, fluopyram, fluxapyroxad, isofetamid, and penthiopyrad) were examined using in vitro sensitivity assays to determine cross-resistance. Sequence analysis revealed a point mutation leading to an amino acid substitution (H267Y) and a silent mutation (CTT to CTC) at codon 181 in the *Sdh*B subunit gene. Isolates with the B-H267Y (n = 10) mutation were resistant to boscalid and penthiopyrad and had increased sensitivity to fluopyram. 181C>T isolates (n = 2) with the *Sdh*B silent mutation were resistant to boscalid, isofetamid, and penthiopyrad. Sequence analysis revealed three mutations leading to an amino acid substitution (G91R, n = 5; G150R, n = 1; G159W, n = 1) in the *Sdh*C subunit gene. Isolates harboring the *Sdh*C (G91R or G150R) mutations were resistant to boscalid, fluxapyroxad, isofetamid, and penthiopyrad (Figure A10). A genetic transformation system was used to generate

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SdhB        (n=15) 251 EERKAALDNS MSLYRCHTIL NCSRTCPKGL NPGLAIAEIK 280
SdhB(H267Y)(n=10) 251 EERKAALDNS MSLYRCYTIL NCSRTCPKGL NPGLAIAEIK 280
                      ********** ****** *** ********** **********
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Figure A10. Alignment of partially deduced amino acid sequences of *Sdh*B from the 25 field isolates used in this study. “n” indicates number of isolates. SdhB (H267Y) refers to substitution at amino acid position 267 (shaded letter) in the *Sdh*B gene in ten isolates from Japan and correlates with resistance to boscalid and penthiopyrad.

mutants from a SDHI-sensitive isolate to confirm that the B-H267Y and C-G91R mutations were direct determinants of SDHI resistance and associated with in vitro sensitivity assay results.

Popko JT, Sang H, Lee J, Yamada T, Hoshino Y, Jung G. Resistance of *Sclerotinia homoeocarpa* field isolates to succinate dehydrogenase inhibitor fungicides. Plant Disease, 102, 2625–2631 (2018)

2) Nucleic adaptability of heterokaryons to fungicides in the multinucleate fungus *Sclerotinia homoeocarpa*

Sclerotinia homoeocarpa is the causal organism of dollar spot in turf grasses. It is a multinucleate fungus with a history of resistance to multiple fungicide classes. Heterokaryosis gives rise to the coexistence of genetically distinct nuclei within a cell, which contributes to genotypic and phenotypic plasticity in multinucleate fungi. We demonstrate that field isolates that are resistant to either a demethylation inhibitor or methyl benzimidazole carbamate fungicide can form heterokaryons with resistance to each fungicide and adaptability to serial combinations of different fungicide concentrations. Field isolates and putative heterokaryons were assayed on fungicide-amended media for *in vitro* sensitivity. Shifts in fungicide sensitivity and microsatellite genotypes indicated that heterokaryons could adapt to changes in fungicide pressure. The presence of both nuclei in heterokaryons was confirmed by detection of a single nucleotide polymorphism in the β-tubulin gene, the presence of microsatellite alleles of both field isolates, and live-cell imaging of two different fluorescently tagged nuclei using laser scanning confocal microscopy. Nucleic adaptability of heterokaryons to fungicides was strongly supported by the visualization of changes in fluorescently labeled nuclei according to fungicide pressure. Results from this study suggest that heterokaryosis is a mechanism by which the pathogen adapts to multiple fungicide pressures in the field.

Kessler D, Sang H, Bousquet A, Hulvey JP, Garcia D, Rhee S, Hoshino Y, Yamada T, Jung G. Nucleic adaptability of heterokaryons to fungicides in a multinucleate fungus, *Sclerotinia homoeocarpa*, Fungal Genetics and Biology, 115, 64–77 (2018)

Project V: Fisheries management measures for multi-species, multi-method fisheries in Asia

Purpose

Establishment of sustainable capture fisheries is an emergent issue all over the world, with 90 percent of the world's fish population already more than fully exploited and 30 percent classified as overexploited. Conventional fishery management theories and measures are developed in Western countries in temperate zones, based on the characteristics of fisheries in temperate zone. As such, these theories and measures assume single-species, single- gear fisheries, namely that most of the catch from a fishing gear occupies one dominant species, and that the types of fishing gears targeting a species are limited. In Asian countries, however, especially in tropical areas, the same gear is used to catch large numbers of species in one operation, and there are many different gears used to catch the same species. In this situation, it is sometimes very difficult to obtain separate catch statistics for a specific species, which makes stock assessment very difficult. Additionally, if a specific species is depleted and requires conservation measures, such measures are quite difficult to implement because suppression of fishing efforts with a specific fishing gear leads to depression of catches and income not only for the species requiring conservation but also for other commercial species.

In this situation, it is necessary to understand the details of the multi-species, multi gear fisheries that are used. For example, to explore possibilities for single species management, the seasonality or geographical distribution of the species needs to be carefully analyzed, and possible measures for such situations should be considered.

Evaluation of ecosystem integrity is also important in situations like these because all of the species are sympatric, requiring consideration of interspecific relationships. Pauly et al. (1998 Science) warned of the possibility of fishing down the food web. Since fisheries tend to catch species at higher trophic levels, fisheries activities may cause a decrease in the average trophic level of the species in the ecosystem.

Since catch statistics, biological measurement data, and field observation opportunities are available in the upper Gulf of Thailand with special cooperation from the Department of Fisheries in the Royal Thailand Government, ecosystem integrity and sustainability of fisheries will be evaluated in this project. Analysis indicates that possible fisheries management measures for multi-species, multi-gear fisheries can be proposed.

This attempt could be an impetus to establish not only innovative yet still implementable fisheries management for tropical fisheries, but also realistic multi-species fisheries management in temperate fishing grounds such as Japan.

Study

1. Data collection: Logbooks and biological measurement data have been collected from Department of Fisheries. Catch amount, species composition, fishing grounds, fishing efforts for important species, and fishing gears can be selected from these data sources.
2. Interview survey: To collect local knowledge, an interview-based survey of stakeholders in major fishing gear operators (port owners, boat owners and skippers) will be conducted. Details on the species compositions in the fishing grounds will be collected in this survey.
3. Sampling: Fish specimens will be collected to obtain fish specimens for an estimation of trophic level by stable isotope analysis. Particular focus will be placed on minor fish species in the trash fish.
4. Fishing ground analysis: From the data obtained from stages 1 and 2, special and temporal distribution and aggregation of the fishing grounds for important species will be specified.
5. Stable isotope analysis for trophic level estimation: The trophic level of minor species will be estimated using stable isotope analysis of the sample obtained in stage 3. Trophic levels of the measured species will be referred from relevant texts.
6. Design of fisheries management measures for multi-species, multi-gear fisheries: Fisheries management measures will be designed based on the analysis in stage 4including marine protected areas, seasonal closures, real-time closures, mesh-size enlargement, fishing effort reduction, and catch quotas with move-on rules. Various parameters for the measures (such as size of closed areas, duration of closure, and closed season) can be selected for further effect evaluation.
7. Evaluation of effects of fisheries management measures: The effect of the fisheries management measures and the sensitivity of the parameters can be evaluated using a combination of conventional operating models, management strategy evaluations, and fish movement simulations. The effects on the average trophic level can be evaluated by using multi-species population dynamics modelling.
8. Evaluation of fishing down the food web: Possibilities for the phenomenon of fishing down the food web in the current fisheries will be evaluated based on the results of stage 7. Effective fisheries management measures for conserving ecosystem integrity will also be recommended.
9. Evaluation of size composition: Possibilities for the phenomenon of downsizing in the current fishery will be evaluated based on the results of stage 7.
10. Recommendation of fisheries management measures for multi-species, multi-gear fisheries: Possible fisheries management measures for multi-species, multi-gear fisheries will be recommended based on the results of stages 7, 8, and 9.

Results

1. Assessment and data collection of multi-species fisheries: The precision of biological measurements, species identification, and logbook collection have been confirmed based on several visits to ports located in the upper Gulf of Thailand.
2. Simulation of a fisheries management measure: This focuses on the Short Mackerel (*Rastrelliger brachysoma*), a species measured in the upper Gulf of Thailand and the one of the most commercially important species. Season closure for this species is currently in effect. A simulation study was conducted based on catch statistics disclosed for this species. Taking into account multi-species fisheries, the effect is evaluated not only in terms of the conservation of the target species but also in terms of minimizing the effects of reduction in catches of other fish species. Procedures have been developed to find optimized fisheries management parameters.
3. Budgeting: An application has been submitted for a grant for the project supported by Japanese government (Grant-in-Aid for Scientific Research :Kakenhi), but it has not been awarded at this point. And updated research proposal will be applied.

Appendix II. Research Achievement and List of Publications (FY 2015-2019)

As of May 2019

1. International collaborative papers (peer reviewed)	Featured in International journals: 21
2. Other publications	Featured in International journals: 131 Books published: 10
3. Verbal presentations	Keynote speeches: 15 Invited lectures: 24 (International 9, Japanese 15) Other presentations: 74 (International 37, Japanese 37)
4. Patent applications	Registered patents: 1 (Overseas 1, Japan 0) Pending patents: 2 (Overseas 1, Japan 1)
5. Awards received	15
6. External grants	4
7. Scientific outreach	6

1. International collaborative papers (peer reviewed)

International collaborative papers co-authored with overseas affiliated universities.

@ Papers with GI-CoRE researchers of HU.
i) Papers where "GI-CoRE" is stated as an affiliated institution.
ii) Papers which mention "Hokkaido University" in the acknowledgements.

1. Glasgow E.M., Vander Meulen K.A., **Takasuka T.E**., Bianchetti C.M., Bergeman L.F., Deutsch S., **Fox B.G.** (2019) Extent and origins of functional diversity in a subfamily of glycoside hydrolases. *Journal of Molecular Biology*, 431, 1217-1233. @

2. Harlyan L., Wu D., Kinashi R., **Kaewnern M., Matsuishi T.** (2019) Validation of a feedback harvest control rule in data-limited conditions for managing multispecies fisheries. *Canadian Journal of Fisheries and Aquatic Sciences*, 76(10), 1885-1893. @ i)

3. Huang J., Yu Z., Groom J., Cheng J.F., Tarver A., **Yoshikuni Y.**, Chistoserdova L. (2019) Rare earth element alcohol dehydrogenases widely occur among globally distributed, numerically abundant and environmentally important microbes. *ISME J*, 13, 2005-2017.

4. Khuu T.P.D., **Saito Y.**, Tojo N., Nguyen P.D., Nguyen T.N.H., **Matsuishi T.** (2019) Are consumers willing to pay more for traceability? Evidence from an auction experiment of Vietnamese pork. *International Journal of Food and Agricultural Economics*, 7, 127-140. i)

5. Khuu T.P.D., **Saito Y.**, Nguyen T.N.H., Tong Y. D., **Matsuishi T.** (2019) Pressure-State-Response of traceability implementation in seafood-exporting countries: Evidence from Vietnamese shrimp products. *Aquaculture International*, 27, 1209-1229. i)

6. Kabiraz D. C., Morita K., Sakamoto K., **Takahashi M.**, **Kawaguchi T.** (2018) Highly sensitive detection of clenbuterol in urine sample by using surface plasmon resonance immunosensor. *Talanta***,** 186, 521-526.

7. **Kawaguchi T.**, Kabiraz D.C., Morita K., **Takahashi M.** (2018) Surface plasmon resonance immunosensor using secondary immunoreaction. *Online Chemical Sensors*, 34, A, 34-36.

8. Kessler D., Sang H., Bousquet A., Hulvey J.P., Garcia D., Rhee S., Hoshino Y., **Yamada T.**, **Jung G.** (2018) Nucleic adaptability of heterokaryons to fungicides in a multinucleate fungus, *Sclerotinia homoeocarpa*. *Fungal Genetics and Biology*, 115, 64-77. @

9. Popko J.T., Sang H., Lee J., **Yamada T.**, Hoshino Y., **Jung G.** (2018) Resistance of *Sclerotinia homoeocarpa* field isolates to succinate dehydrogenase inhibitor fungicides. *Plant Disease*, 102, 2625-2631. @

10. Schauberger B., Ben-Ari T., Makowski D., **Kato T.**, Kato H., Ciais P. (2018) Yield trends, variability and stagnation analysis of major crops in France over more than a century. *Scientific Reports*, 8, article number 16865.

11. Suzuki T., Sakumoto R., Hayashi KG., Ogiso T., Kunii H., Shirozu T., Kim S.W., Bai H., Kawahara M., Kimura K., **Takahashi M.** (2018) Involvement of IFNT in the induction of apoptotic, pyroptotic and autophagic cell death-related signaling pathways in bovine uterine endometrium during early pregnancy. *Journal of Reproduction and Development*, 64, 495-502.

12. Talukder M.A.S., Balboula A.Z., Shirozu T., Kim S.W., Kunii H., Suzuki T., Ito T., Kimura K., **Takahashi M.** (2018) Activation of lysosomal cathepsins in pregnant bovine leukocytes. *Reproduction*, 155, 515-528.

13. Kabiraz D.C., Morita K., **Kawaguchi T.** (2017) Kinetic study of secondary immunoreaction in indirect competitive inhibition immunoassay. *Online Chemical Sensors*, 33, A, 125-127.

14. Kabiraz D. C., Morita K., **Kawaguchi T.**, **Takahashi M.** (2017) SPR biosensing for detection of beta agonist in urine of cow. *Online Chemical Sensors*, 33, B, 66-68.

15. Kabiraz D. C., Morita K., Sakamoto K., **Kawaguchi T.** (2017) Mechanism of surface plasmon resonance sensing by indirect competitive inhibition immunoassay using Au nanoparticle labeled antibody. *Talanta***,** 172, 1-7.

16. Zhuykov S., **Kawaguchi T.** Hai Z., Albari M.K., Heynderickx P.M. **(**2017) Interfacial engineering of two-dimensional nano-structured materials by atomic layer deposition. *Applied Surface Science***,** 392, 231-243.

17. Book A.J., Lewin G.R., McDonald B.R., **Takasuka T.E.**, Wendt-Pienkowski E., Doering D.T., Suh S., Raffa K.F., **Fox B.G.**, Currie C.R. (2016) Evolution of high cellulolytic activity in symbiotic *Streptomyces* through selection of expanded gene content and coordinated gene expression. *PLoS Biology*, 14, e1002475. @

18. Bianchetti C.M., **Takasuka T.E.**, Deutsch S., Udell H.S., Yik E.J., Bergeman L.F., **Fox B.G.** (2015) Active site and laminarin binding in glycoside hydrolase family 55. *Journal of Biological Chemistry*, 290, 11819-11832. @

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2.2 Books published

1. **Kawamura S**. et al., "Lexicon of Postharvest Engineering", Asakura Publishing Co. Ltd., 2019. [Japanese]
2. **Kobayashi K.** et al., "The "Sixth industry" vertical integration of food, agriculture and rural", Nobunkyo, 2018. [Japanese]
3. **Matsuishi T.**, "Shutsudo! Iruka Kujira 110", Kaibundo, Tokyo, 2018. [Japanese]
4. **Nabeshima T**., "Dynamics of African Peasants: Historical Acculturation of Rural Community under the International Politics", Akashi Shoten, 264p, 2018. [Japanese]
5. **Nabeshima T.**, "State Regime and Legal System", in The Japan Society for International Development (ed.), Encyclopedia of International Development, Maruzen, 210-211, 2018. [Japanese]
6. **Kobayashi K.** edit, "Outlook of agricultural cooperatives from practice of Hokkaido: Beyond the JA Reform", Tsukuba Shobo, 2017. [Japanese]
7. **Funamizu N.**, Zavala M.A.L., "Composting toilet for sustainable water management", *in* Green technologies for sustainable water management, edited by Ngo H.H., Guo W., Surampalli R.Y., Zhang T.C., published online: July 01, 2016, American Society of Civil Engineers, 903-954, 2016.
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9. **Kato T.**, "Carbon cycle", Chapter 1.2., Frontiers of Agricultural Science, Research Faculty of Agriculture, Hokkaido University (Ed.), 6-9, 2015. [Japanese]
10. **Nabeshima T.**, "Integrated Water Resources Management and World Water Policy", in **Funamizu N.** (ed.), Sanitation Education Program. E-learning movie uploaded in YouTube, 2015.

3. Verbal presentations

3.1 Keynote speeches

1. **Clough T.J.**: Denitrification: what do we know and where to from here?. *Tracing denitrification*, Mar. 12-14, 2019, Giessen, Germany. [International]
2. **Sone T.**: Challenges for viticulture and wine production in Hokkaido, International Conference on Biosciences & Medical Engineering, Bali, Indonesia, Apr 11, 2019. [International]
3. **Takahashi M.**: Quality evaluation of oocytes and embryos for improving the bovine production, 54th seminar of Hokkaido branch of the society for analytical chemistry, Sapporo, Jan 12, 2019. [Domestic]
4. **Kobayashi K.**: Function of JA for sustainable agriculture in rural areas -How agricultural cooperatives could establish positive relation with advanced farms for rural development-, Annual Meeting of the Agricultural Economics Society of Japan, Hokkaido University, March 2018. [Domestic]

5. **Mokthar G**: Future Water treatment and Sanitation systems, 3rd International Conference on Innovative Engineering Materials (ICIEM), Sousse, Tunisia, May 2-5, 2018. [International]

6. **Mokthar G**: Water reclamation and resources recovery promising technology for a resilient society, International Symposium on Resilience in the Global Food System, Sapporo, Japan, Oct 3-4, 2018. [International]

7. **Yamada T.**: Breeding approach on forage species to establish bio-economy society, The 4th International Grassland Agro-ecosystems Conference, Lanzhou University, Lanzhou, China, Sep 26,2018, [International]

8. **Yamada T.**: Forage production and utilization in Hokkaido, Japan, The 7th Japan-China-Korea Grassland Conference, Hokkaido University, Sapporo, Japan, July 8, 2018. [International]

9. **Kato T.**: Data assimilation in Ecology, 2nd Riken workshop on data assimilation, RIKEN, Kobe, Japan, Sep 26, 2017. [Domestic]

10. **Kato T.**: Ecosystem carbon cycle and chlorophyll fluorescence, Training course of AsiaFlux Workshop 2017, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China, Aug 17, 2017. [International]

11. **Kobayashi K.**: Agricultural cooperatives for shaping future of agriculture in Hokkaido, Annual meeting of Agricultural Economics Society of Hokkaido, Hokkaido University, Oct 2017. [Domestic]

12. **Mokthar G**: Advances in Water treatment and Sanitation, Tunisia-Japan Symposium on Science, Society and Technology, Gammart, Tunisia, Nov 24-26, 2017. [International]

13. **Takahashi M.**: Evaluation and regulation of intracellular cysteine protease to improve the quality and quantity of bovine in vitro embryo production, The 4th International Conference of Beef Cattle Improvement and Industrialization in China, Northwest A&F University, Yanglin China, Nov 30, 2017. [International]

14. **Kato T.**: Data assimilation in Ecology, 1st Riken workshop on data assimilation, RIKEN, Kobe, Japan, Sep 17, 2015. [Domestic]

3.2 Invited lectures

1. **Clough T.J.**: N_2O emissions from grazing lands. *Climate change, reactive nitrogen, food security and sustainable agriculture, OECD workshop*, Apr. 15-16, 2019, Garmisch-Partenkirchen, Germany. [International]

2. **Kato T.**: Diagnostic on photosynthetic activity by solar-induced fluorescence. *Research Center for High-technology Greenhouse Plant Production Advanced Technology Seminar*, School of Agriculture, Ehime University, Matsuyama, Jan. 30, 2019. [Domestic]

3. **Kato T.**, Kobayashi H., Sakai Y., Noda H., Nasahara K.N., Akitsu T., Ono K., Muraoka H.: Estimation of ecosystem-level photosynthesis by solar-induced fluorescence measurement. *[OS-A] Challenge for further development of land ecosystem monitoring approach by close-remote-sensing, The Society of Agricultural Meteorology of Japan*, Shizuoka University, Shizuoka, Mar. 4, 2019. [Domestic]

4. **Kawamura S.**: Progress of Agricultural Products in Hokkaido: Accomplishments and Issues. 59th Forum of Frozen Food Technology, Sapporo, Japan, Feb 1, 2019. [Domestics]

5. **Yamada T.**: Polymorphism of Genes Involved with Regulation of Flowering Time in Miscanthus as C4 Bioenergy Crop. Plant and Animal Genome XXVII, San Diego, CA, USA, Jan 12, 2019. [International]

6. **Kato T.**, et al.: Bottom-up and top-down approach investigations on solar induced fluorescence for estimating the photosynthesis at ecosystem scale by both ground-based measurement and modeling, American Geophysical Union 2018 Fall Meeting, E Walter Congress Center, Washington DC, USA, Dec 10, 2018. [International]

7. **Kawamura S.**: Development of Automatic Rice Quality Inspection System Using Visible and Near-infrared Light. 34th Near-Infrared Spectroscopy Forum, Sapporo, Japan, Nov 21, 2018. [Domestic]

8. **Kawamura S.**: New Postharvest Technology: Improving Rice Grain Quality, 2nd International Conference on Agricultural Postharvest Handling and Processing, Kuta, Indonesia, Aug 29, 2018. [International]

9. **Kawamura S.**: Rice Postharvest Technology to Improve Quality and Taste: Rice Grain Elevator and Milling Factory, The 2nd International Symposium on Rice Quality, Palatability and Processing, Tianjin, China, Sep 14, 2018. [International]

10. **Mokthar G.:** Water Reclamation, Resources Recovery and Value Chain Sanitation led Research, Special speech at Marmara University, Turkey, Oct 9, 2018. [International]

11. **Sone T.**: Research and education for wine in Hokkaido University, Innovative Food and Healthcare MASTER symposium, Tokyo, Japan, April 16, 2018. [Domestic]

12. **Takasuka T.:** Novel insect symbionts cellulolytic Streptomyces potentiate plant biomass refinery, International Symposium on Biomass Refinery: From Biomass Crops to Chemicals and Fuels, Sapporo, Japan, Feb 5-6, 2018. [Domestic]

13. **Kato T.**: Drone x Crop “Expectation from Agriculture, Citizen, Economics”, 8th Hokudai Cross road, Hokkaido University Museum, Sapporo, Japan, Jan 19, 2017. [Domestic]

14. **Mokthar G**: Paradigm Shift in Water Treatment and Sanitation, Water Researches and Technologies Center Borj-Cedria Technopark (CERTE) at Carthage University, Tunis, Tunisia, Nov 27, 2017. [International]

15. **Mokthar G**: 21st century Water and sanitation Spring, Special speech at Higher Institute of Biotechnology, Sfax University, Sfax, Tunisia, Nov 20, 2017. [International]

16. **Sone T.**: Chemistry and Microbiology of Wine, winter seminar for Hokkaido Branch of Japanese Society for Analytical Chemistry, Nanporo, Japan, Jan 8, 2017. [Domestic]

17. **Sone T.**: For the promotion of viticulture and wine industry in Hokkaido, Symposium for Japanese society for horticulture, Ebetsu, Japan, Sep 3, 2017. [Domestic]

18. **Sone T.:** Microbiological perspective of wines and vines in Hokkaido, Enology and viticulture symposium 2017 in Tokachi, Obihiro, Japan, Feb 3, 2017. [Domestic]

19. **Takasuka T.**, Ellinger J.J., Nagy S.K.: Omics and genome-enabled technology to understand phylogenetic-based enzyme functions, Joint Conference of the Societies for Environmental Microbiology, Sendai, Japan, Aug 29-31, 2017. [Domestic]

20. **Kato T.**: Observation on ecosystem-level photosynthetic function by solar-induced fluorescence, 63rd Ecological society of Japan, Sendai Convention Center, Sendai, Japan, Mar 21, 2016. [Domestic]

21. **Sone T.**: Microbiological approach for the development of wine industry in Hokkaido, Innovative Food and Healthcare MASTER symposium, Hokkaido University, Sapporo, Japan, Aug 20, 2016. [Domestic]

22. **Sone T.**: What we can do for the improvement of productivity under global warming: rice and wines, 2nd International Forum on Global Food Resources, Hokkaido University, Sapporo, Japan, Oct 5, 2016. [Domestic]

23. **Yamada T.**: Molecular breeding of perennial biomass crops, The 9th International Symposium on Molecular Breeding of Forage and Turf, Lanzhou University, Lanzhou, China, Aug 16, 2016. [International]

24. **Takasuka T.**, Bianchetti C.M., Deng K., Bergeman L., Deutsch S., Northen T., Fox, B.G.: Phylogenetic-guided biochemical annotation for glycoside hydrolase families, The 15th Annual Meeting of Protein Science Society of Japan, Tokushima, Japan, Jun 24-26, 2015. [Domestic]

3.3 Other presentations

1. Begum P., Li S., Morozumi T., Johmen M., **Sone T., Kawaguchi T.**: Electrochemical sensing for analysis of wine. *86th Conference of Electrochemical Society of Japan*, Mar. 28, 2019. [Domestic]

2. Buareal K., **Kato T.**, Ono K.: Solar–induced chlorophyll fluorescence for detecting ecosystem photosynthetic activity by high–resolution spectrum measurement in a paddy field in Japan. *Japan Geoscience Union Meeting 2019*, May 28, 2019, Makuhari Messe, Chiba. [Domestic]

3. **Kato T.**, Mizuno K.: Environmental controls on anomalous variation in solar–induced fluorescence during the last 10 years. *Japan Geoscience Union Meeting 2019*, May 28, 2019, Makuhari Messe, Chiba. [Domestic]

4. **Kato T.**, Watanabe D.: Effect of climate change on Japanese rice production during last 133 years. *The 66th Annual Meeting of the Ecological Society of Japan*, Mar. 18, 2019, Kobe International Convention Hall, Kobe. [Domestic]

5. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Continuous water quality monitoring utilizing plate-type four-electrode electrochemical chip. Kyoto, Japan, Mar 27-29, 2019. [Domestic]

6. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Monitoring of different kinds of heavy metal ions. The 86th The Electrochemical Society of Japan Spring Meeting, Kyoto, Japan, Mar 27-29, 2019. [Domestic]

7. Tagawa M., Ito R., **Mokhtar G., Kawaguchi T.**, Johmen M.: Phosphorus recovery from food factory wastewater by electrolytic treatment. *The 53rd Annual Conference of Japan Society on Water Environment*, Mar. 7-9, 2019, Yamanashi. [Domestic]

8. Tsubokawa Y., Ito R., **Mokhtar G., Kawaguchi T.**, Johmen M.: Filtration performance of graphite membrane. *The 53rd Annual Conference of Japan Society on Water Environment*, Mar. 7-9, 2019, Yamanashi. [Domestic]

9. Wang S., **Mokhtar G.,** Ito R., **Funamizu N.**, Johmen M., **Kawaguchi T.**: Water quality monitoring by utilizing planar type electrochemical chip. *The 65th chemical sensor research symposium*, Mar. 27-29, 2019, Kyoto. [Domestic]

10. Wang S., **Mokhtar G.**, **Funamizu N.**, Johmen M., **Kawaguchi T.**: Water quality monitoring By utilizing planar typed electrochemical chip. *86th Conference of Electrochemical Society of Japan*, Mar. 27, 2019, Kyoto University, Kyoto. [Domestic]

11. Yang L., **Mokhtar G.,** Ito R., **Funamizu N.**, Johmen M., **Kawaguchi T.**: Detection of heavy metals using electro-chemical sensor chip. *The 65th chemical sensor research symposium*, Mar. 27-29, 2019, Kyoto. [Domestic]

12. Yang L., **Mokhtar G.**, Ito R., **Funamizu N.**, Johmen M., **Kawaguchi T.**: Detection of heavy metals by using electrochemical sensor chip. *86th Conference of Electrochemical Society of Japan*, Mar. 27, 2019, Kyoto University, Kyoto. [Domestic]

13. **Kato T.**: Detection of ecosystem-level photosynthesis by Solar-Induced Chlorophyll Fluorescence in rice paddy field. International Symposium on Biomass Refinery: From Biomass Crops to Chemicals and Fuels, Sapporo, Japan, Feb 5, 2018. [International]

14. **Kato T.**, et al.: Constructing the simulation model to estimate the SIF using remote sensing data. American Geophysical Union 2018 Fall Meeting, Washington DC, USA, Dec 12, 2018. [International]

15. **Kato T.**, et al.: Effect of a simulated typhoon disturbance on forest and carbon dynamics in a cool-temperate forest in Hokkaido by SEIB-DGVM. American Geophysical Union 2018 Fall Meeting, Washington DC, USA, Dec 12, 2018. [International]

16. **Kato T.**, et al.: Effect of typhoon intensity and frequency on forest dynamics and material cycle using the Spatially Explicit Individual-Based Dynamics Global Vegetation Model (SEIB-DGVM). JpGU 2018 Assembly, Chiba, Japan, May 24, 2018. [Domestic]

17. **Kato T.**, et al.: The simulation model of energy partition in leaf scale to estimate GPP from SIF, JpGU 2018 Assembly, Chiba, Japan, May 24, 2018[Domestic]

18. **Kato T.**, Mizuno K.: Relationship in anomalous changes in solar-induced chlorophyll fluorescence to the environmental factors for last 10 years. JpGU 2018 Assembly, Chiba, Japan, May 24, 2018. [Domestic]

19. **Kawamura S.**, et al.: Development of technology for determining rice amylose content using Near-Infrared Spectroscopy. The 8th International Symposium on Machinery and Mechatronics for Agriculture and Biosystems Engineering (ISMAB), Jeju, Korea, May 29, 2018. [International]

20. **Kawamura S.**, et al.: Effect of rice cultivars on accuracy for determining amylose content using near-infrared spectroscopy. The 6th Asian NIR Symposium (ANS2018), Kunming, China, Jun 23, 2018. [International]

21. **Kawamura, S**., et al.: Non-destructive online real-time milk quality determination in a milking robot using near-infrared spectroscopic sensing system. International Institute for Tropical Agriculture (IITA), 12th CIGR (International Commission of Agricultural and Biosystems Engineering) Section VI (Postharvest Technology & Bioprocess Engineering) International Symposium, Ibadan, Nigeria, Oct 23, 2018. [International]

22. **Kawamura S.**, et al.: Practical application of near-infrared spectroscopy for determining rice amylose content at grain elevator. International Institute for Tropical Agriculture (IITA), 12th CIGR (International Commission of Agricultural and Biosystems Engineering) Section VI (Postharvest Technology & Bioprocess Engineering) International Symposium, Ibadan, Nigeria, Oct 23, 2018. [International]

23. **Mokthar G., Funamizu N.**, et al.: Ammonia Diffusion through a semipermeable membrane during Forward Osmosis Process, 6th International Dry toilet conference, Tampere, Finland, Aug 22-24, 2018 [International]

24. **Mokthar G., Funamizu N.**, et al.: Development of PEG coated MNPs as novel Draw solution. 3rd International Conference on Innovative Engineering Materials (ICIEM), Sousse, Tunisia, May 2-5, 2018. [International]

25. **Mokthar G., Funamizu N.**, et al.: Foulant analysis of FO membrane used for urine concentration, 6th Dry Toilet Conference, Tampere, Finland, Aug 22-24, 2018. [International]

26. **Mokthar G., Funamizu N.**, et al.: Soil fertilization with human urine and salinization risks, The IWA Regional Conference on Water Reuse and Salinity Management (IWARESA), Murcia, Spain, Jun 11-15, 2018. [International]

27. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Disinfection technology of environmental water by photocatalytic reaction using titanium oxide. 26th Sanitary Engineering Symposium, Sapporo, Japan, Nov 8-9, 2018. [Domestic]

28. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Electrochemical detection of heavy metals in environmental water. 26th Sanitary Engineering Symposium, Sapporo, Japan, Nov 8-9, 2018. [Domestic]

29. **Mokthar G.**, **Funamizu N., Kawaguchi T.**, et al.: Evaluation of Alginate Modified Graphite Composite Electrode. Symposium of Electrochemical Society of Japan, Katsushika, Japan, Mar 9, 2018. [Domestic]

30. **Mokthar G.**, **Funamizu N., Kawaguchi T.**, et al.: Evaluation of heavy metal adsorption performance using composite electrode of alginic acid and graphene. Winter Study Conference of Chemical Association Hokkaido branch, Sapporo, Japan, Jan 16, 2018. [Domestic]

31. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Heavy metal removal technique using α-amylose. 26th Sanitary Engineering Symposium, Sapporo, Japan, Nov 8-9, 2018. [Domestic]

32. **Mohktar G.**, **Funamizu N., Kawaguchi T.**, et al.: Heavy metal removal using amylose graphene composite electrode. The Electrochemical Society of Japan fall meeting, Kanazawa, Japan, Sep 25-26, 2018. [Domestic]

33. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Maintenance free pH monitoring system, 26th Sanitary Engineering Symposium, Sapporo, Japan, Nov 8-9, 2018. [Domestic]

34. **Nabeshima T.**: African civil society in contradiction to the nation state. the Round Table “Issues of Political Science in Development: The Focus of Governance and Development Politics II”, The Japan Society for International Development, University of the Sacred Heart, Tokyo, Japan, June 2, 2018. [Domestic]

35. **Nabeshima T.**: Let’s try to think what we can do in the field of developing countries!, Lectures to high school students of Seishi High School, Sapporo, Japan, May 23, 2018. [Domestic]

36. **Nabeshima T.**: Observation from social science about SATREPS Project in Burkina Faso. Forum “Current State and Challenges of Sanitation Research in Sub-Saharan Africa” of Japan Association for African Studies, Hokkaido University, Sapporo, Japan, May 27, 2018. [Domestic]

37. **Sone T.**, et al.: Analysis of fungal flora in vineyard soils in Hokkaido. Annual meeting for American Society for Enology and Viticulture Japan Chapter, Kyoto, Japan, Nov 17, 2018. [Domestic]

38. **Sone T**., et al.: Research on microbial endophytes isolated from wine grapes in Hokkaido. Annual meeting for American Society for Enology and Viticulture Japan Chapter, Kyoto, Japan, Nov 17, 2018. [Domestic]

39. **Takahashi M.**, et al.: Effect of IFNτ on lysosomal functions in bovine leukocytes during early pregnancy, 124th Annual meeting of Japanese Society of Animal Science, Tokyo, Japan, Mar 28, 2018. [Domestic]

40. **Takahashi M.**, et al.: Elucidation of lysosomal cathepsin in bovine blood leukocytes during early pregnancy. 1st International Conference on Challenges for Future Agriculture, Mymensingh, Bangladesh, Jan 27, 2018. [International]

41. **Kato T.**, et al.,: Analysis of the relationship between the GPP and SIF from remote sensing data using theoretical model. JpGU 2018 Assembly, Chiba, Japan, May 25, 2017. [Domestic]

42. **Kato T.**, et al.: Directional partitioning of vertical Solar-Induced Fluorescence emissions for estimating ecosystem photosynthesis in a deciduous broad-leaf forest in Japan. Joint conference of AsiaFlux Workshop 2017 and the 15th Anniversary Celebration of ChinaFLUX, Beijing, China, Aug 18, 2017. [International]

43. **Kato T.**, et al.: Effect of typhoon disturbance on the forest dynamics and material cycles estimated by SEIB-DGVM based on scenario simulation. Japanese Society of Agricultural Meteorology Hokkaido Branch, Sapporo, Japan, Dec 6, 2017. [Domestic]

44. **Kato T.**, et al.: Estimation of GPP with SIF based on flux tower measurement data using a theoretical model. Potsdam Greenhouse Gas Workshop from Photosystems to Ecosystems, Potsdam Institute for Climatology, Potsdam, Germany, Oct 25, 2017. [International]

45. **Kato T.**, et al.: Ground network of SIF based on eddy flux and spectral measurement tower in Japan. Potsdam Greenhouse Gas Workshop from Photosystems to Ecosystems, Potsdam Institute for Climatology, Potsdam, Germany, Oct 25, 2017. [International]

46. **Kato T.**, et al.: Predicting the protein of winter wheat using hyper-spectral images, International Symposium on Agricultural Meteorology, Aomori, Japan, Mar 18, 2017. [International]

47. **Kato T**., et al.: Simulation of the forest dynamics and material cycle after typhoon disturbance using the Spatially Explicit Individual-Based Dynamics Global Vegetation Model (SEIB-DGVM). JpGU 2018 Assembly, Makuhari, Chiba, Japan, May 25, 2017. [Domestic]

48. **Mokthar G.**, **Funamizu N.**, et al.: Assessment of different irrigational practices on managing the nitrogen loss into the groundwater using HYDRUS 1D software: Gaza Strip as a case study -Palestine. First Euro-Mediterranean Conference for Environmental Integration, Tunisia, Nov 22-25, 2017. [International]

49. **Mokthar G.**, **Funamizu N**. et al.: Design of a forward osmosis unit for urine concentration and nutrient recovery, The 6th Maghreb Conference on Desalination and Water Treatment (CMTDE), Hammamet, Tunisia, Dec 17-20, 2017. [International]

50. **Mokthar G.**, **Funamizu N.**, et al.: Engineering of size-controlled magnetic nanoparticles for use as draw solution in forward osmosis Process. The 6th Maghreb Conference on Desalination and Water Treatment, Hammamet, Tunisia, Dec 17-20, 2017. [International]

51. **Mokthar G.**, **Funamizu N.**, et al.: Novel Draw solution for urine concentration by FO process. Tunisia-Japan Symposium on Science, Society and Technology, Gammart, Tunisia, Nov 24-26, 2017. [International]

52. **Mokthar G.**, **Funamizu N.**, et al.: Organic matter recovery from wastewater using brine from reverse osmosis as draw solution. The 6th Maghreb Conference on Desalination and Water Treatment, Hammamet, Tunisia, Dec 17-20, 2017. [International]

53. **Mokthar G.**, **Funamizu N.**, et al.: Synthesis of magnetic nanoparticles for urine concentration applications using forward osmosis process. Water and Environment Technology Conference, Sapporo, Japan, July 22-23, 2017. [International]

54. **Mokthar G.**, **Funamizu N.**, **Kawaguchi T.**, et al.: Environmental water remediation using electrochemical method. 25th Sanitary engineering symposium, Sapporo, Japan, Nov 10, 2017. [Domestic]

55. **Mokthar G**, **Funamizu N.**, **Kawaguchi T.**, et al.: Production process of hypochlorite by two-way electrocatalyst. Winter Conference of the Hokkaido Branch of the Chemical Society of Japan, Sapporo, Japan, Jan 17, 2017. [Domestic]

56. **Mokthar G.**, **Kawaguchi t.**, **Funamizu N.**, et al.: Morphological, chemical and Electrochemical carbon based and novel metal electrode characterization for use in water electrochemical disinfection. First Euro-Mediterranean Conference for Environmental Integration, Sousse, Tunisia, Nov 22-25, 2017. [International]

57. **Nabeshima T.**: Comparative study of peasants' organization between Indonesia and African countries: learning from Clifford Geertz's theory. Agriculture Involution, International Symposium on Green Technology for Value Chains 2016, Tangerang, Indonesia, Jakarta, Indonesia, Oct 23, 2017. [International]

58. **Takahashi M.**, et al.: Novel genes expressed by embryo-derived interferon tau in bovine external reproductive organs. 123th Annual meeting of Japanese Society of Animal Science, Nagano, Japan, Sep 6, 2017. [Domestic]

59. **Takamure I.**, et al.: Genetic analysis of the mutant, 535, which has zebra chlorosis, tillering dwarf and gametophyte genes in rice. 16th International Symposium on Rice Functional Genomics, Suwon, Korea, Sep 25-28, 2017. [International]

60. **Kato T.**, et al.: An Integrative Observing and Modeling Approach for the Physiological Understanding of Sun-Induced Chlorophyll Fluorescence in Japan. American Geophysical Union 2016 Fall Meeting, Moscone Center, San Francisco, USA, Dec 16, 2016. [International]

61. **Kato T.**: Detection of ecosystem-level photosynthesis by Sun-Induced Chlorophyll Fluorescence in rice paddy field. International Conference on Agricultural Biodiversity and Sustainability 2016, Hokkaido University, Sapporo, Japan, Aug 22, 2016. [International]

62. **Kato T.**, et al.: Detection of upward and downward Solar-induced chlorophyll fluorescence emissions at the forest floor in a cool-temperate deciduous broadleaf forest in Japan. American Geophysical Union 2016 Fall Meeting, Moscone Center, San Francisco, USA, Dec 16, 2016. [International]

63. **Kato T.**, et al.: Ground-based network of Long-term measurement of Sun-Induced Chlorophyll Fluorescence, 12th International Workshop on Greenhouse Gas Measurements from Space, Kyoto University, Kyoto, Japan, Jun 8, 2016. [International]

64. **Kato T.**, et al.: Seasonal changes in the photosynthetic capacity and chlorophyll fluorescence in canopy leaves of Quercus crispula in a cool-temperate forest. American Geophysical Union 2016 Fall Meeting, Moscone Center, San Francisco, USA, Dec 16, 2016. [International]

65. **Kato T.**: Sun-induced fluorescence measurement for realtime detecting of ecosystem-scale photosynthesis in crop field. 2nd International Forum on Global Food Resources: New Models for Research, Education and Human Resource Development, Hokkaido University, Sapporo, Japan, Oct 6, 2016. [International]

66. **Mokthar G., Funamizu N.**: Bacterial Endotoxin in Reclaimed Wastewater. 2nd International Forum on Global Food Resources: New Models for Research, Education and Human Resource Development, Hokkaido University, Sapporo, Japan, Oct 5, 2016. [International]

67. **Mokthar G.**, **Funamizu N., Kawaguchi T.**, et al.: Development of sterilization technique using electrochemical technique. The 24th Symposium on Sanitary Engineering, Hokkaido University, Sapporo, Japan, Nov 15, 2016. [Domestic]

68. **Takako Nabeshima**: Historical Acculturation of Rural Community: Why does a political scientist deal with African peasants? 2nd International Forum on Global Food Resources: New Models for Research, Education and Human Resource Development, Hokkaido University, Sapporo, Japan, Oct 5, 2016. [International]

69. **Nabeshima T.**: Decision Making of Green Policy in African State and Rural Community, International Symposium on Green Technology for Value Chains 2016, Tangerang, Indonesia, Oct 4, 2016. [International]

70. **Nabeshima T.**: Dual Decision Making between State Administration and Rural Community: Political History of Conflict and Integration over Water and Sanitation. 53th Conference of Japan Association for African Studies, Nippon University, Fujisawa, Japan, Jun 4, 2016. (in Japanese) [Domestic]

71. **Kato T.**, et al.: Estimation of gross primary production and light use efficiency by the tower-based sun-induced fluorescence measurement in the Japanese evergreen coniferous forest. 2015 American Geophysical Union Fall Meeting, Moscone Center, San Francisco, USA, Dec 17, 2015. [International]

72. **Kato T**., et al.: Sun-induced chlorophyll fluorescence reveals strong representation of photosynthesis at ecosystem level in rice paddy field in Japan. 2015 American Geophysical Union Fall Meeting, Moscone Center, San Francisco, USA, Dec 15, 2015. [International]

73. **Nabeshima T.**: How can we confront the mistakable history of African countries? Lectures in Hamanasu Probus Club of Sapporo East Rotary Club, Sapporo, Japan, Nov 17, 2015. [Domestic]

74. **Nabeshima T.**: Issue and reformation of Integrated Water Resource Management for the African peasants. 5th Zambia Water Forum and Exhibition, Lusaka, Zambia, Nov 3, 2015. [International]

4. Patent applications

1. Tokkyo (Patent): 2017-16839. Method for pregnancy detection in ruminant animals. Hokkaido University, **Masashi Takahashi,** HIroki Kunii, Tsukino Ito, Manabu Kawahara, Hanako Bai, Toshiyuki Suzuki.

2. Tokugan (Patent Application): 2015-167581. Chlorophyll fluorescence measuring device. Aug 27, 2015. National University Corporation Hokkaido University, **Tomomichi Kato**.

3. Kokusai Tokkyo (Patent Cooperation Treaty): PCT/JP2016/073845. Chlorophyll fluorescence measuring device. Aug 15, 2016. National University Corporation Hokkaido University, **Tomomichi Kato**.

5. Awards

1. **Kawaguchi T.**: Certificate of Excellence in Reviewing (Elsevier), Feb 23, 2019.

2. **Kawamura S.**: Improvement of Eating Quality of Hokkaido Grown Rice by Postharvest Technology, The Heisei 30th Award of Science and Technology by Hokkaido Governor, Feb 14, 2019.

3. **Funamizu N.**: Most Outstanding Contributor to Hokkaido (International cooperation), Aug 4, 2018.

4. **Kawaguchi T.**: Analytical Chemistry Award, Japan Society for Analytical Chemistry, Jan 17, 2018.

5. **Kawaguchi T.**: Certificate of Outstanding Contribution, Elsevier Proteins and Proteomics, Apr 20, 2018.

6. **Kawamura S.**: Studies on Postharvest Technology of Rice, Award for Distinguished Research Achievement by Japanese Society of Agricultural, Biological and Environmental Engineering and Scientists, Sep 19, 2018.

7. Kimura T., Takahashi T., Masumo H., Saito K., **Sone T.**: Outstanding oral presentation award, Annual meeting for American Society for Enology and Viticulture Japan Chapter, Kyoto, Japan, Nov 17, 2018.

8. **Kobayashi K.**: JA Research Award, Central Union of Agricultural Cooperatives, Dec 2018.

9. **Mokthar G.**: Appreciation Award, 3rd International Conference on Innovative Engineering Materials, Sousse, Tunisia, May 2-5, 2018.

10. **Mokthar G.**: Springer Best Paper Award, 3rd International Conference on Innovative Engineering Materials, Sousse, Tunisia, May 2-5, 2018.

11. **Kato T.**: Development of Realtime monitoring camera on solar-induced fluorescence for photosynthetic function in field, Konica Minolta Imaging Science Encouragement Award, Feb 2017.

12. **Mokthar G.**: Best Poster Award, The 6th Maghreb Conference on Desalination and Water Treatment (CMTDE), Hammamet, Tunisia, Dec 17-20, 2017.

13. **Mokthar G.**, Yajima K., **Kawaguchi T**., Ito R., **Funamizu N**.: Best paper award, First Euro-Mediterranean Conference for Environmental Integration, Sousse, Tunisia, Nov 22-25, 2017.

14. **Kawaguchi T.**: Certificate of Outstanding Contribution, Elsevier Talanta, Nov 22, 2016.

15. **Kawaguchi T.**: Minister of Education, Culture, Sports, Science and Technology Award, Commendation for Invention, Oct 13, 2016.

6. External grants

1. Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), “Development of consolidated bioprocessing of macro algae biomass to produce bioproducts”, 2018-2022, **Atsumi S.** (PI), **Takasuka T.** (co-PI), Hori C. (co-PI).

2. Japan Racing Association, grands for promotion of livestock industries, “Reseeding to grasslands in the eastern Hokkaido”, 2018-2020, **Yamada T.** (PI).

3. Department of Energy (DOE) USA, Plant Feedstock Genomics for Bioenergy, funded grant by E.J. Sack (PI), “Introgression of novel disease resistance genes from *Miscanthus* into energycane”, 2017-2020, **Yamada T.** (co-PI).

4. Japan Society for the Promotion of Science, Grants-in-aid for Scientific Research (B), “Development of drought tolerant energy crops based on field survey in the North American drought zone”, 2017-2019, **Yamada T.** (PI).

7. Scientific outreach

1. International Symposium on Biomass Refinery: From Biomass Crops to Chemicals and Fuels. Feb 5-6, 2018. Venue: Suzuki Akira Hall, Frontier Research in Applied Science Building, Hokkaido University.

2. International Symposium on Resilience in the Global Food System. Oct 3-4, 2018. Venue: Suzuki Akira Hall, Frontier Research in Applied Science Building, Hokkaido University.

3. Joint seminar between Hokkaido University and the Research Institute for Humanity and Nature: Rediscovering Agriculture: Insights from fields around the world. Aug 4, 2017. Venue: Room F319, Food Resources Research Building, Hokkaido University.

4. Public talk for Sustainability Week 2017: Learning about Sustainability in Agriculture from Long-standing Farming Methods in Japan and the USA. Aug 8, 2017. Venue: Small Lecture Hall, Hokkaido University Conference Hall.

5. Special lecture on agriculture and global food resources: A Call for Young People to Become Global Personnel. Jun 27, 2017. Venue: Room 111, Institute for International Collaboration Building, Hokkaido University.

6. Special lecture on agriculture and global food resources: Integrated Management of Water Resources and Reuse of Wastewater. Nov 7, 2017. Venue: Grand Lecture Hall, Faculty of Agriculture, Hokkaido University.

Appendix III. Research Achievement and List of Publications (FY 2019)

As of March 2020

1. International collaborative papers (peer reviewed)	Featured in International journals: 48
2. Other publications	Featured in International journals: 16 Books published: 1
3. Verbal presentations	Keynote speeches: 9 Invited lectures: 1 (International 1, Japanese 0) Other presentations: 23 (International 10, Japanese 13)
4. Patent applications	Registered patents: 0 (Overseas 0, Japan 0) Pending patents: 1 (Overseas 0, Japan 1)
5. Awards received	4
6. External grants	3
7. Scientific outreach	0

1. International collaborative papers (peer reviewed)

International collaborative papers co-authored with overseas affiliated universities.

International collaborative papers co-authored with overseas affiliated universities.
@ Papers with GI-CoRE researchers of HU.
i) Papers where "GI-CoRE" is stated as an affiliated institution.
ii) Papers which mention "Hokkaido University" in the acknowledgements.

1. Cao M., Fatma Z., Song X., Hsieh P.H., Tran V.G., Lyon W.L., Sayadi M., Shao Z., **Yoshikuni Y.**, Zhao H. (2020) A genetic toolbox for metabolic engineering of *Issatchenkia orientalis*. *Metabolic Engineering*, 59, 87-97.

2. Doud D.F.R., Bowers R.M., Schulz F., De Raad M., Deng K., Tarver A., Glasgow E., Vander Meulen K., **Fox B.**, Deutsch S., **Yoshikuni Y.**, Northen T., Hedlund B.P., Singer S.W., Ivanova N., Woyke T. (2020) Function-driven single-cell genomics uncovers cellulose-degrading bacteria from the rare biosphere. *ISME J.*, 14, 659-675.

3. Estifanos T.K., Polyakov M., **Pandit R.**, Hailu A., Burton M. (2020) Managing conflicts between local land use and the protection of the Ethiopian wolf: Residents' preferences for conservation program design features. *Ecological Economics*, 169, 106511.

4. Estifanos T.K., Polyakov M., **Pandit R.**, Hailu A., Burton M. (2020) The impact of protected areas on the rural households' incomes in Ethiopia. *Land Use Policy*, 91, 104349.

5. Gardiner C.A., **Clough T.J.**, Cameron K.C., Di H.J., Edwards G.R. (2020) Ruminant urine patch nitrification and N_2O flux: effects of urine aucubin rate in a laboratory trial. *New Zealand Journal of Agricultural Research*, 63(1), 65-72.

6. Hori C., Song R., Matsumoto K., Matsumoto R., Minkoff B.B., Oita S., Hara H., **Takasuka T.E.** (2020) Proteomic characterization of lignocellulolytic enzymes secreted by the insect-associated fungus, *Daldinia decipiens* oita, isolated from the forest in northern Japan. *Applied and Environmental Microbiology*, 86(8), e02350-19. i)

7. Ke J., **Yoshikuni Y.** (2020) Multi-chassis engineering for heterologous production of microbial natural products. *Current Opinion in Biotechnology*, 62, 88-97. @ i)

8. Kuroda M,Miki N, **Matsuishi T.F.** (2020) Clicks sound frequency characteristics determinants of small toothed whales — recent advances in anatomical information *Biological Reviews* in press doi.org/10.1111/mam.12212 i)

9. Li J., Balboula A.Z., Aboelenain M., Fujii T., Moriyasu S., Bai H., Kawahara M., **Takahashi M.** (2020) Effect of autophagy induction and cathepsin B inhibition on developmental competence of poor quality bovine oocytes. *Journal of Reproduction and Development*, 66(1), 83-91.

10. Li J., Maeji M., Balboula A.Z., Aboelenain M., Fujii T., Moriyasu S., Bai H., Kawahara M., **Takahashi M.** (2020) Dynamic status of lysosomal cathepsin in bovine oocytes and preimplantation embryos. *Journal of Reproduction and Developmen*t, 66(1), 9-17.

11. Rakatama A., **Pandit R**. (2020) Reviewing social forestry schemes in Indonesia: Opportunities and challenges. *Forest Policy and Economics*, 111, 102052.

12. Rakatama, A., **Pandit, R**., Iftekhar, S., Ma, C. (2020). Policy forum: Improving the acceptability of REDD+ projects among local households in Indonesia. *Forest Policy and Economics*, 116. doi:10.1016/j.forpol.2020.102172

13. Chamindu Deepagoda T., Jayarathne J., **Clough T.J.**, Thomas S., Elberling B. (2019) Soil-gas diffusivity and soil-moisture effects on N_2O emissions from intact pasture soils. *Soil Science Society of America Journal*, 83, 1032-1043.

14. Chamindu D.T.K.K., **Clough T.J.**, Thomas S.M., Balaine N., Elberling B. (2019) Density effects on soil-water characteristics, soil-gas diffusivity, and emissions of N_2O and N_2 from a re-packed pasture soil. *Soil Science Society of America Journal*, 83, 118-125.

15. Chen Y.Y., Huang W., Wang W.H., Juang J.Y., **Kato T.**, Luyssaert S. (2019) Reconstructing Taiwan's land cover changes between 1904 and 2015 from historical maps and satellite images. *Scientific Reports*, 9, article number 3643.

16. Ciganda V.S., López-Aizpún M., Repullo M.A., Wu D., Terra J.A., Elustondo D., **Clough T.**, Cardenas L.M. (2019) Soil nitrous oxide emissions from grassland: Potential inhibitor effect of hippuric acid. *Journal of Plant Nutrition and Soil Science*, 182, 40-47.

17. Clark L.V., Dwiyanti M.S., Anzoua K.G., Brummer J.E., Ghimire B.K., Głowacka K., Hall M., Heo K., Jin X., Lipka A.E., Peng J., **Yamada T.**, Yoo J.H., Yu C.Y., Zhao H., Long S.P., Sacks E.J. (2019) Biomass yield in a genetically diverse *Miscanthus sinensis* germplasm panel evaluated at five locations revealed individuals with exceptional potential. *Global Change Biology Bioenergy*, 11(10), 1125-1145.

18. Clark L.V., Dwiyanti M.S., Anzoua K.G., Brummer J.E., Ghimire B.K., Głowacka K., Hall M., Heo K., Jin X., Lipka A.E., Peng J., **Yamada T.**, Yoo J.H., Yu C.Y., Zhao H., Long S.P., Sacks E.J. (2019) Genome-wide association and genomic prediction for biomass yield in a genetically diverse Miscanthus sinensis germplasm panel phenotyped at five locations in Asia and North America. *Global Change Biology Bioenergy*, 11(8), 988-1007.

19. Clifton-Brown J., Harfouche A., Casler M.D., Jones H.D., Macalpine W.J., Murphy-Bokern D., Smart L.B., Adler A., Ashman C., Awty-Carroll D., Bastien C., Bopper S., Botnari V., Brancourt- Hulmel M., Chen Z., Clark L.V., Cosentino S., Dalton S., Davey C., Dolstra O., Donnison I., Flavel R., Greef J., Hanley S., Hastings A., Hertzberg M., Hsu T-W., Huang L.S., Iurato A., Jensen E., Jin X., Jørgensen U., Kiesel A., Kim D-S., Liu J., McCalmont J.P., McMahon B.G., Mos M., Robson P., Sacks E.J., Sandu A., Scalici G., Schwarz K., Scordia D., Shafiei R., Shield I., Slavov G., Stanton B.J., Swaminathan K., Taylor G., Torres A.F., Trindade L.M., Tschaplinski T., Tuskan J., **Yamada T.**, Yu C.Y., Zalesny Jr R.F., Zong J., Lewandowski I. (2019) Breeding progress and preparedness for mass-scale deployment of perennial lignocellulosic biomass crops switchgrass, miscanthus, willow and poplar. *Global Change Biology Bioenergy*, 11(1), 118–151.

20. Dong H., Clark L., Lipka A., Brummer J., Głowacka K., Hall M., Heo K., Jin X., Peng J., **Yamada T.**, Ghimire B., Yoo J.H., Yu C.Y., Zhao H., Long S., Sacks E. (2019) Winter hardiness of *Miscanthus* (III): Genome-wide association and genomic prediction for overwintering ability in *Miscanthus sinensis*. *Global Change Biology Bioenergy,* 11(8), 930-955.

21. Estifanos T.K., Polyakov M., **Pandit R.**, Hailu A., Burton M. (2019) What are tourists willing to pay for securing the survival of a flagship species? The case of protection of the Ethiopian wolf. *Tourism Economics*, https://doi.org/10.1177/1354816619880430

22. Fitrani M., Wudtisin I., **Kaewnern M.**, Susanto R.H. (2019) Pond soil characteristic in reclaimed tidal lowlands and its correlation with the water quality for aquaculture. *IOP Conf. Series: Earth and Environmental Science*, 236, 012021.

23. Harlyan L.I., Wu D., Kinashi R., **Kaewnern M.**, **Matsuishi T.** (2019) Validation of a feedback harvest control rule in data-limited conditions for managing multispecies fisheries. *Canadian Journal of Fisheries and Aquatic Science*s, 76(10), 1885-1893. @) i)

24. Is-haak J., **Kaewnern M.,** Yoonpundh R., Taparhudee W. (2019) Oxygen consumption rates of hybrid Red Tilapia at different sizes during challenge to water velocity. *Journal of Fisheries and Environment*, 43(2), 57-65.

25. Kar S., Zhang N., Nakashima T., Villanueva-Morales A., Stewart J.R., Sacks E.J., Terajima Y., **Yamada T.** (2019) *Saccharum* × *Miscanthus* intergeneric hybrids (miscanes) exhibit greater chilling tolerance of C_4 photosynthesis and postchilling recovery than sugarcane (*Saccharum* spp. hybrids). *Global Change Biology Bioenergy*, 11 (11), 1318-1333.

26. Kar S., Weng T-Y., Nakashima T., Villanueva-Morales A., Stewart J.R., Sacks E.J., Terajima Y., **Yamada T.** (2019) Field performance of Saccharum × Miscanthus intergeneric hybrids (Miscanes) under cool climatic

conditions of northern Japan. *BioEnergy Research*, 13, 132-146.

27. **Kawaguchi T.**, **Takahashi M.**, **Gonzalez L.A.** (2019) Prospect of Gas Biosensor. *Austin J Biosens. Bioelectron,* 2019; 5(1), 1033. @ i)

28. Langley S., Eng T., Wan K.H., Herbert R.A., Klein A.P., **Yoshikuni Y.**, Tringe S.G., Brown J.B., Celniker S.E., Mortimer J.C., Mukhopadhyay A. (2019) Complete genome sequence of *Agrobacterium* sp. strain 33MFTa1.1, isolated from *Thlaspi arvense* roots. *Microbiology Resource Announcements*, 8, e00432-19.

29. Li S., **Kawaguchi T.**, **Takahashi M.**, **Gonzalez L.A.** (2019) Kinetic Analysis of Biosensor, *Austin J. Biosens Bioelectron*. 2019; 5(1): 1035. @ i)

30. Liu T., Qin S., Pang Y., Yao J., Zhao X., **Clough T.**, Wrage-Mönnig N., Zhou S. (2019) Rice root Fe plaque enhances paddy soil N_2O emissions via Fe(II) oxidation-coupled denitrification. *Soil Biology and Biochemistry*, 139, 107610.

31. Lopez Z.M.A., Gonzalez P.O.I., Ruelas H.C., Mena C.D., **Mokthar G.** (2019) Use of cyclic voltammetry to describe the electrochemical behavior of a dual-chamber microbial fuel cell. *Energies,* 12(18): 3532. i)

32. Olatoye O.M., Clark L.V., Wang J., Yang X., **Yamada T.**, Sacks E.J., Lipka A.E. (2019) Evaluation of genomic selection and marker assisted selection in *Miscanthus* and energycane. *Molecular Breeding*, 39, 171.

33. **Pandit R.**, Parrotta J.A., Chaudhary A.K., Karlen D.L., Vieira D.L.M., Anker Y., Ntshotsho P. (2019) A framework to evaluate land degradation and restoration responses for improved planning and decision-making. *Ecosystems and People*, 16(1), 1-18.

34. Parvin B., **Kawaguchi T.**, **Gonzalez L.A.** (2019) Development of gas monitoring system for cow, *Online Chemical Sensors,* 35, B, 46-48. @ i)

35. Peaucelle M., Bacour C., Ciais P., Vuichard N., Kuppel S., Peñuelas J., Marchesini B.L., Blanken P.D., Buchmann N., Chen J., Delpierre N., Desai A.R., Dufrene E., Gianelle D., Gimeno-Colera C., Gruening C., Helfter C., Hörtnagl L., Ibrom A., Joffre R., **Kato T.**, Kolb T.E., Law B., Lindroth A., Mammarella I., Merbold L., Minerbi S., Montagnani L., Šigut L., Sutton M., Varlagin A., Vesala T., Wohlfahrt G., Wolf S., Yakir D., Viovy N. (2019) Covariations between plant functional traits emerge from constraining parameterization of a terrestrial biosphere model. *Global Ecology and Biogeography*, 28, 1351-1365. i)

36. Qin S., Yu L., Yang Z., Li M., **Clough T.**, Wrage-Mönnig N., Hu C., Liu B., Chen S., Zhou S. (2019) Electrodes donate electrons for nitrate reduction in a soil matrix via DNRA and denitrification. *Environmental Science and Technology*, 53(4), 2002-2012.

37. Rayner S., **Clough T.J.**, Baisden T., Moir J. (2019) Can ruminant urine-N rate and plants affect nitrate leaching and its isotopic composition?. *New Zealand Journal of Agricultural Research*, 63(1), 87-105.

38. Rex D., **Clough T.J.**, Richards K.G., Condron L.M., de Klein C.A.M., Morales S.E., Lanigan G.J. (2019) Impact of nitrogen compounds on fungal and bacterial contributions to codenitrification in a pasture soil. *Scientific Reports*, 9, article number 13371.

39. Rissmann C.W.F., Pearson L.K., Beyer M., Couldrey M.A., Lindsay J.L., Martin A.P., Baisden W.T., **Clough T.J.**, Horton T.W., Webster-Brown J.G. (2019) A hydrochemically guided landscape classification system for modelling spatial variation in multiple water quality indices: Process-attribute mapping. *Science of the Total Environment*, 672, 815-833.

40. Schwartz C., Cheng J.F., Evans R., Schwartz C.A., Wagner J.M., Anglin S., Beitz A., Pan W., Lonardi S., Blenner M., Alper H.S., **Yoshikuni Y.**, Wheeldon I. (2019) Validating genome-wide CRISPR-Cas9 function improves screening in the oleaginous yeast *Yarrowia lipolytica*. *Metabolic Engineering*, 55, 102-110.

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44. Thomas S.M., Fraser P.M., Hu W., **Clough T.J.**, van der Klei G., Wilson S., Tregurtha R., Baird D. (2019) Tillage, compaction and wetting effects on NO_3, N_2O and N_2 losses. *Soil Research*, 57 (6), 670-688.

45. Vujinović T., **Clough T.J.**, Curtin D., Meenken E.D., Lehto N.J., Beare M.H. (2019) Quantity and biodegradability of dissolved organic matter released from sequentially leached soils, as influenced by the extent of soil drying prior to rewetting. *Soil Research*, 57 (4), 374-386.

46. Wang G., Zhao Z., Ke J., Engel Y., Shi Y.M., Robinson D., Bingol K., Zhang Z., Bowen B., Louie K., Wang B., Evans R., Miyamoto Y., Cheng K., Kosina S., De Raad M., Silva L., Luhrs A., Lubbe A., Hoyt D.W., Francavilla C., Otani H., Deutsch S., Washton N.M., Rubin E.M., Mouncey N.J., Visel A., Northen T., Cheng J.F., Bode H.B., **Yoshikuni Y.** (2019) CRAGE enables rapid activation of biosynthetic gene clusters in undomesticated bacteria. *Nature Microbiology*, 4, 2498-2510.

47. Yamada K.T., Kitamura S., Abe S., Tajima Y., Matsuda A., Mead J.G., **Matsuishi T.F.** (2019) Description of a new species of beaked whale (*Berardius*) found in the North Pacific. *Scientific Reports,* 9, article number 12723. i)

48. Yuan H., Zhang Z., Li M., **Clough T.**, Wrage-Mönnig N., Qin S., Ge T., Liao H., Zhou S. (2019) Biochar's role as an electron shuttle for mediating soil N_2O emissions. *Soil Biology and Biochemistry*, 133, 94-96.

2. Other publications

2.1 Featured in International journals

i) Papers where "GI-CoRE" is stated as an affiliated institution.
ii) Papers which mention "Hokkaido University" in the acknowledgements.

1. Akiyama H., Yamamoto A., **Uchida Y.**, Takada-Hoshino Y., Tago K., Wang Y., Hayatsu M. (2020) Effect of low C/N crop residue input on N_2O, NO, and CH_4 fluxes from Andosol and Fluvisol fields. *Science of The Total Environment,* 713, 136677.

2. Matsui N., Matsuda A., **Matsuishi T.F.** (2020) Diet of Harbour Porpoises (*Phocoena phocoena*) around Hokkaido, Japan. *Aquatic Mammals*, 46(2), 183-190. i)

3. **Mokhtar G.,** Endo T., Ito R., **Funamizu N.** (2020) Polyethylene Glycol coated magnetic nano-particles based draw solution for forward osmosis. *Sanitation Value Chain*, 4, 27-37.

4. Muchanga R.A., **Uchida Y**., Hirata T., Hatano R., Araki H. (2020) Dynamics of N derived from 15N-labeled rye in soil-tomato system as influenced by cover crop residue management. *The Horticulture Journal*, 89, 394-402.

5. Muchanga R.A., Hirata T., **Uchida Y.**, Hatano R., Araki H. (2020) Soil carbon and nitrogen and tomato yield response to cover crop management. *Agronomy Journal*, 112, 1636-1648.

6. Ohishi K., Amano M., Nakamatsu K., Miyazaki N., Tajima Y., Yamada T.K., Matsuda A., Ochiai M., **Matsuishi T.F.**, Taru H., Iwao H., Maruyama T. (2020) Serologic survey of *Brucella* infection in cetaceans inhabiting along the coast of Japan. *Journal of Veterinary Medical Science*, 82(1) 43-46. i)

7. Yokochi M., Sekimoto K., **Inoue T.** (2020) Subsidence of rice paddy and upland crop fields in Shinotsu Peatland,

Hokkaido, Japan. *PIAHS*, 382, 231–235.

8. Akizawa H., Yanagawa Y., Nagano M., Bai H., **Takahashi M.**, Kawahara M. (2019) Significance of *CCN2* expression in bovine preimplantation development. *Animal science journal*, 90, 49-54. ii)

9. Anabuki T., Ito Y., Ohashi K., **Takasuka T.E.**, Matsuura H., Takahashi K. (2019) Identification of recombinant AtPYL2, an abscisic acid receptor, in *E. coli* using a substrate-derived bioactive small molecule, a biotin linker with alkyne and amino groups, and a protein cross-linker. *Bioorganic and Medical Chemistry Letters*, 29(21), 126634.

10. Bai H., Shabur T.M.A., Kunii H., Itoh T., Kawahara M., **Takahashi M.** (2019) Evaluation of the immune status of peripheral blood monocytes from dairy cows during the periparturition period. *Journal of Reproduction and Development*, 65(4), 313-318.

11. Hamamoto T., **Uchida Y.** (2019) The role of different earthworm species (*Metaphire Hilgendorfi* and *Eisenia Fetida*) on CO_2 emissions and microbial biomass during barley decomposition. *Sustainability*, 11(23), 6544.

12. Koide Y., Sakaguchi S., Uchiyama T., Ota Y., Tezuka A., Nagano A.J., Ishiguro S., **Takamure I.**, Kishima Y. (2019) Genetic properties responsible for the transgressive segregation of days to heading in rice. *G3: Genes, Genomes, Genetics*, 9(5), 1655-1662.

13. Maezawa T., **Matsuishi T.,** Ito K., Kaji S., Tsunokawa M., Kawahara J.I. (2019) The effects of visual impediment on the approaching behavior of harbor porpoise, *Phocoena phocoena*. *Mammal Study*, 44(3) 205-213. i)

14. Shiina K., Komatsu M., Yokoi E., Bai H., **Takahashi M.**, Kawahara M. (2019) Overgrowth of mice generated from postovulatory-aged oocyte spindles. *FASEB BioAdvances*, 1, 393-403.

15. **Uchida Y.**, Moriizumi M., Shimotsuma M. (2019) Effects of rice husk biochar and soil moisture on the accumulation of organic and inorganic nitrogen and nitrous oxide emissions during the decomposition of hairy vetch (*Vicia villosa*) mulch. *Soil Science and Plant Nutrition*, 65, 409-418.

16. Wu L., **Kato T.**, Sato H., Hirano T., Yazaki T. (2019) Sensitivity analysis of the typhoon disturbance effect on forest dynamics and carbon balance in the future in a cool-temperate forest in northern Japan by using SEIB-DGVM. *Forest Ecology and Management*, 451, 117529. i)

2.2 Books published

1. Ke J., **Yoshikuni Y.** (2019) Pathway and gene discovery from natural hosts and organisms. In: Santos C., Ajikumar P. (eds) *Microbial Metabolic Engineering. Methods in Molecular Biology*, vol 1927, 1-9.

3. Verbal presentations

3.1 Keynote speeches

1. Chavalittumrong P., **Kaewnern M.**, **Matsuishi T.F.**: Designing the Survey for Consumer's Willingness to Pay for Blue Swimming Crab Digital Traceability in Thailand. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

2. **Kato T.**: Estimation of ecosystem-level photosynthesis by solar-induced fluorescence measurement - Observing CO_2 uptake from space-. *Hokkaido Society of Agricultural Meteorology Annual Meeting*, Sapporo, Dec. 4, 2019. [Domestic]

3. **Matsuishi T.F.**, Matsuda A., Kuroda M., Matsui N., Abe S., Nakagun S., Kobayashi M., Kitamura S., Yamada T.K., Tajima Y., Mead J.G.: A new species of a Beaked Whale (*Berardius*) and role of a stranding network for the

discovery. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

4. **Mokhtar G.**: New Insights into sustainable water management in regions of water scarcity. *2nd EMCEI conference*, Sousse, Tunisia, Oct. 10-13, 2019. (Plenary speaker) [International]

5. **Mokhtar G.**, Wang S., Ito R., Johmen M., Ushijima K., Kawaguchi T., **Funamizu N.**: Novel sensor chip for IoT/M2M and LTE/3G network based water quality monitoring for off-grid water systems. *2nd EMCEI conference*, Sousse, Tunisia, Oct. 10-13, 2019. [International]

6. **Takahashi M.**: A new approach for early pregnancy detection in cattle. *Seminar in University of Missouri, Division of Animal Sciences*, Nov. 14, 2019. [International]

7. **Takahashi M.**: Interferon-stimulated genes: A novel pregnancy specific biomarker in bovine. *Seminar in Can Tho University*, Can Tho, Viet Nam, Oct. 16, 2019. [International]

8. **Takahashi M.**: Interferon-stimulated genes: Heat stress and animal productivity. *Seminar in Can Tho University*, Can Tho, Viet Nam, Oct. 16, 2019. [International]

9. **Yamada T.**: Genetic variability of *Miscanthus* and miscane (*Saccharum* × *Miscanthus*) intergeneric hybrids. *International symposium on grassland ecology and sustainable management*, Northeast Normal University, China, Aug. 23, 2019. [International]

3.2 Invited lectures

1. **Clough T.J.**: Soil derived agricultural greenhouse gases: production and mitigation. *The consultancy meeting for designing a coordinated research project (CRP) proposal on "Developing Climate Smart Agricultural practices for mitigation of greenhouse gases"*, International Atomic Energy Agency, Jul. 22-26, 2019, Vienna, Austria. [International]

3.3 Other presentations

1. Asano N., Kunii H., Koyama K., Kubo T., Hamaguchi Y., Ogawa H., Kobayashi H., Bai H., Kawahara H., **Takahashi M**.: Pregnancy-specific expression of IFIT1 in the bovine cervical mucosal membrane. International joint Symposium Pathein University & Hokkaido University. Sept 26-27, 2019. Pathein. Myanmar. [International]

2. Buareal K., **Kato T.**, Ono K.: Ground-based measurement of solar-induced chlorophyll fluorescence with high-resolution spectrum in paddy field ecosystem, Japan. *15th International Workshop on Greenhouse Gas Measurements from Space*, Jun. 5, 2019, Hokkaido University, Sapporo. [Domestic]

3. Begum P., **Kawaguchi T.**, **Gonzalez L.A.**: Development of Breath Gas Monitoring System for Cow87th Conference of Electrochemical Society of Japan Sep. 5, 2019 [Domestic]

4. Buareal K., **Kato T.**, Morozumi T., Ono K.: Ground based measurement of solar-induced chlorophyll fluorescence dynamics in rice paddy field ecosystem. *Asiaflux 2019 -20th Anniversary-*, Oct. 3, 2019, Takayama Earth Wisdom Center, Takayama, Gifu. [Domestic]

5. Khuu T.P.D., Nguyen T.N.H., **Saito Y.**, **Matsuishi T.F.**: Are Farmers Willing to Implement for Traceability? Evidence from Double-Bound Choices Experiment of Vietnamese Shrimp. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

6. Maezawa T., **Matsuishi T.F.**, Ito K., Kaji S., Tsunokawa M., Kawahara J.: The effects of visual impediment on the approaching behavior of harbor porpoise, *Phocoena phocoena*. *The 83rd Annual Convention of the Japanese Psychological Association*, Ritsumeikan University, Osaka, Sep. 11, 2019. [Domestic]

7. **Matsuishi T.F.**, Matsuda A., Kuroda M., Matsui N., Nakagun S., Kobayashi M.: Stranding records along the coast of Hokkaido in 2018. *The 30th Commemorative Convention of Cetology Study Group of Japan*, National Museum of Nature and Science, Tokyo, Jun. 9, 2019. [Domestic]

8. Miyazaki A., Sasaki M., Kuroda M., **Matsuishi T.F.**, Tajima Y., Yamada T., Nakagun S., Suzuki C., Tsuzuki N., Kitamura N.: Morphological analysis of the melon of Hubbs's beaked whale (*Mesoplodon carlhubbsi*). *The Mammal Society of Japan*, Chuo University, Tokyo, Sep. 15, 2019. [Domestic]

9. **Mokhtar G.**, Ito R., Matsuda T.: Fouling control during concentration of urine by forward osmosis process -effect of cleaning processes on permeability-, *10th IWA International symposium on waste management in Agro-industries AGRO 2019*, Jun. 18-21, 2019, Rhodes, Greece. [International]

10. Morozumi T., **Kato T.**, Tsujimoto K., Buareal K., Sakai Y., Kobayashi H., Nasahara K.N., Akitsu T., Murayama S., Noda H., Muraoka H.: The temporal variation of solar induced fluorescence detected by the canopy spectroscopy in cool-temperate broad leaf deciduous forest in central Japan. *Asiaflux 2019 -20th Anniversary-*, Oct. 4, 2019, Takayama Earth Wisdom Center, Takayama, Gifu. [Domestic]

11. **Mokhtar G.**, Guo J., Tagawa M., Ito R., **Kawaguchi T.**: Phosphate recovery from starch factory wastewater using porous aluminum. *1st ICSEWEN conference*, Dec 02-05, 2019, Doha, Qatar. [International]

12. **Mokhtar G.**, **Inoue T.**: Pioneering global leaders for tackling global water food energy and environment issues. *1st ICSEWEN conference*, Dec 02-05, 2019, Doha, Qatar. [International]

13. Morozumi T., **Kato T.**, Tsujimoto K., Buareal K., Sakai Y., Kobayashi H., Nasahara K.N., Akitsu T., Murayama S., Noda H., Muraoka H.: Development of methodology for measuring solar-induced fluorescence in cool-temperate forest in central Japan. *Hokkaido Society of Agricultural Meteorology Annual Meeting*, Dec. 4, 2019, Sapporo, Japan. [Domestic]

14. Munehara M., **Matsuishi T.F.**: Effectiveness of real-time closure for mobile species in multi- species fisheries. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

15. **Nabeshima T.**: How to make a plan of rural development in Africa: What is a problem? and who is a stakeholder? (Original French title: « Qui entre en jeu dans la communauté rurale en Afrique?: le problématique et le plan du développement »). *Seminar for French Speaking African trainees of JICA*, Sep. 30, 2019, Hokkaido University, Sapporo. [Domestic]

16. Parvin B., **Kawaguchi T.**, **Luciano G.**: Development of breath gas monitoring system for cow. *87th Conference of Electrochemical Society of Japan*, Sep. 5, 2019. [Domestic]

17. Pattarapongpan S., **Matsuishi T.F.**: The yield per recruit analysis of dwarf whipray, *Brevitrygon heterura*, in Gulf of Thailand and adjacent waters. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

18. Shoji N., **Mokhtar G.**, Sasaki H., **Kawaguchi T.**, Kanauchi M., Sone T.: Development of soy protein fermented foods based on yeast discovery and manufacturing management sensing for a healthy society. *2nd COI conference*, Sep. 19-20, 2019, Tokyo. [Domestic]

19. Shoji N., **Mokthar G.,** Sasaki H., **Kawaguchi T.**, Sone T., Kanauchi M.: The development of cheese-like, new soybean fermented foods using yeast for a healthy society. *2nd COI conference*, Sep. 19-20, 2019, Tokyo. [Domestic]

20. Tagawa M., Ito R., **Mokhtar G.**: Fertilizer production from fertilizer juices. *27th Sanitary Engineering Symposium*, Oct. 31-Nov. 1, 2019, Sousse, Tunisia. [International]

21. **Takahashi M.**: Heat stress impact on livestock reproduction. *International Joint Symposium "Challenges for the Education Development on Agriculture and Food Resources in Tropical Asia"*, Sep. 26-27, 2019, Pathein University, Pathein, Myanmar. [International]

22. Takano K., Sornkliang J., **Matsuishi T.F.**: Assessments of fisheries management in small-scale fisheries - Evidence from Blue-Swimming Crab fisheries in Kep, Cambodia. *2019 ASEAN-FEN 9th International Fisheries Symposium*, Seri Pacific Hotel, Kuala Lumpur, Malaysia, Nov. 18, 2019. [International]

23. Wulan, **Kato T.**, Hayashi M: Mapping the forest aboveground biomass in Japan by SAR-based machine learning model. *Asiaflux 2019 -20th Anniversary-*, Oct. 3, 2019, Takayama Earth Wisdom Center, Takayama, Gifu. [Domestic]

4.Patent applications

1. **Mokhtar G.**, Patent Number 2019-186196, Electrochemical sensor for multi-parameter water quality monitoring (Japan patents, Patent application in progress)

5.Awards

1. **Mokhtar G.**, Interdisciplinary Award, 2nd COI 2019, Tokyo, Japan

2. **Mokhtar G.**, Outstanding Keynote speech award, 2nd EMCEI 2019, Sousse, Tunisia

3. **Mokhtar G.**, Outstanding reviewer support award, 2nd EMCEI 2019, Sousse, Tunisia

4. **Nabeshima T.**: Hokkaido University President's Award for Excellence in Research and Education for AY2019, Feb 7, 2020.

6.External grants

1. **Kaewnern M.**, The academic services project entitled "Curriculum Development for training of Thai's fishing vessel crews", funded by Department of European Affairs, Ministry of Foreign Affairs, Thailand.

2. **Kaewnern M.**, The research project entitled "Survey on local wisdoms in marine natural resources" under the research plan "Establishment of knowledge and utilization of bioresources in the marine ecosystems around Andaman coastal research station for development in Ranong Province and adjacent areas", funded by National Research Council of Thailand.

3. **Mokhtar G.**, COI-JST grant, collaborative Research project with Miyagi University.

References

Global Institution for Collaborative Research and Education (GI-CoRE) Final Evaluation for the Global Station for Food, Land and Water Resources projects

1. Aims

The Global Institution for Collaborative Research and Education (GI-CoRE) shall implement an external evaluation of the research, education and organizational framework of the Global Station for Food, Land and Water Resources projects which started on April 1, 2015. As the projects have welcomed the final (fifth) year of the implementation period upon the Fiscal Year 2019, the feedback of this evaluation shall be used to improve the Global Station project in the future.

2. Evaluation Structure

A "Hokkaido University Global Institution for Collaborative Research and Education External Evaluation Committee" shall be established in Food, Land and Water Resources Global Station in accordance with the External Evaluation Implementation Guidelines for the Hokkaido University Global Institution for Collaborative Research and Education Global Station (Document 2). All evaluations and reports shall be undertaken in English.

□ Global Station for Food, Land and Water Resources External Evaluation Committee

Candidates from Food, Land and Water Resources GS: 2 foreign members, 1 Japanese member

*When the evaluation is complete, the GI-CoRE Steering Committee shall receive a report from the Committee chair.

3. Evaluation Method

□The External Evaluation Committee shall check the contents of the Research Progress Report (Document 3) sent in advance from HU before implementing the on-site investigation and shall evaluate the evaluation items prescribed in Document 4.

□A 5-level evaluation ratings (S to D) and comments shall be obtained for each "Evaluation Item".

Evaluation Ratings	Evaluation Explanation
S	Achieved outcomes have surpassed the original plan (Outstanding)
A	Good progress has been maintained and expected outcomes have been achieved (Excellent)
B	Most expected outcomes have been achieved with some slight delays (Good)
C	Although certain outcomes were achieved, overall results were insufficient. (Satisfactory)
D	No expected outcomes were achieved. (Unsatisfactory)

4. Required Expenses

Travel expenses and honoraria shall be provided to the Evaluation Committee Members (in accordance with HU regulations). Other expenses required for the External Evaluation (as travel expenses, honoraria, evaluation report printing expenses, etc.) shall be funded by the budget (non-personnel cost) of the Global Station.

5. Publishing of Evaluation Results

Evaluation of this project shall be broadly announced, with the results both published on the relevant HU websites and published as booklets which are sent to external organizations such as the Japanese Ministry of Education, Culture, Sports, Science and Technology.

GI-CoRE Global Station External Evaluation Schedule

Year and Month	Agenda
Fiscal Year 2018 (2018)	
June to November	**Proposal of Evaluation Items and Evaluation Structure (Draft Fixed)**
November	**Selection/Arrangement of the Evaluation Committee Members** *Criteria: 2 foreign and 1 Japanese members (candidates who can conduct evaluation in English) *Confirmation of affiliation, main achievements, contact details, etc.
March	**GI-CoRE Steering Committee #19** >> Fixing overviews of evaluation items, evaluation structure, schedule, etc. >> Fixing the Evaluation Committee Members >> Official appointment request (by letters from the GI-CoRE Director) >> Fixing evaluation forms >> Starting to create the GI-CoRE Research Progress Report (in English)
Fiscal Year 2019 (2019)	
April	**Commencement of the Appointment as the Evaluation Committee Members**
May to June	**Preparation of Research Progress Report and On-site Investigation**
July	**Completion of the Research Progress Report (in English)** >> Forwarding the report to the Evaluation Committee Members for their document screening
End July	**July 24th (Wed.) to July 25th (Thu.)** On-site Investigation (by the External Evaluation Committee)/ Symposium
October	**Submission of Report of the Final Evaluation** >> Evaluation Committee Members shall forward their reports of the final evaluation, based on the document screening and on-site investigation
October to December	**GI-CoRE Steering Committee #22** >> Report of the Final Evaluation by the Chair of the External Evaluation Committee of GSF on behalf of the three Committee Members *Arrangement in progress to request the External Evaluation Committee Chair
March	**Expiration of the GSF project under the GI-CoRE System**
Fiscal Year 2020 (2020)	
April	**Internalization of the GSF project into the affiliated faculty**
July	**Publication of the Final Evaluation Reports (in English)**

Hokkaido University
Global Institution for Collaborative Research and Education (GI-CoRE)
External Evaluation Implementation Guidelines for the Global Stations

December 15, 2015

Establishment of the Global Institution for Collaborative Research and Education Steering Committee

1. Purpose

These implementation guidelines shall provide the necessary matters for the implementation of evaluation of the Global Station by non-University affiliated persons (hereinafter the “GS External Evaluation”) of the Hokkaido University Global Institution for Collaborative Research and Education (GI-CoRE).

2. Committee

(1) The "Hokkaido University Global Institution for Collaborative Research and Education External Evaluation Committee (hereinafter the "Committee")" shall be established by GI-CoRE in order to perform the matters prescribed in each of the following items.

(i) Implementation of GS External Evaluation

(ii) Matters related to the creation and publishing of the report pertaining to the GS External Evaluation

(2) A Committee shall be established for each Global Station that is target for external evaluation.

3. Composition

(1) The Committee shall be composed of third parties other than constituent members of Hokkaido University, and designated by the Director of GI-CoRE from persons prescribed in each of the following items.

(i) Person designated by the Director of GI-CoRE who is an expert both within and outside Japan in the research field of the Global Station to be externally evaluated

(ii) Persons whom the Director of GI-CoRE deems necessary

(2) The Committee members prescribed in the preceding paragraph shall be commissioned by the Director of GI-CoRE after approval by the GI-CoRE Steering Committee.

4. Term of Office

(1) The term of office for Committee Members shall be 1 year. However, if a Committee Member vacancy occurs, the term of office of the successor shall be the remaining term of the predecessor.

(2) Committee Members may be reappointed.

5. Committee Chair

(1) A Committee Chair shall be appointed and selected through mutual election by the Committee members.

(2) The Committee Chair shall call a Committee meeting as required, and shall chair the said meeting.

6. Proceedings

(1) A Committee meeting may not be held unless a majority of the members are present.

(2) Committee meeting proceedings shall be decided by a majority of the attending members. In case of a tie, the Committee Chair shall decide the issue.

7. Implementation of GS External Evaluation

(1) The Committee shall implement the GS External Evaluation as prescribed in the following Article.

(2) The Committee may hear the opinions of persons concerned and implement firsthand investigations related to the implementation of the GS External Evaluation.

8. Evaluation Items

The Committee shall evaluate the items prescribed by GI-CoRE in each of the following items.

(1) Items related to research

(2) Items related to education

(3) Items related to the structure of the research and education center

(4) Other items deemed necessary by the Committee

9. Creation and Publishing of the Report

The Committee shall collate the evaluation results prescribed in the preceding paragraph and publish the results in a report.

10. Response to Evaluation Results

The Director of GI-CoRE shall promptly work to implement improvements in view of the report prescribed in the previous paragraph for items in which improvements are deemed necessary.

11. General Affairs

General affairs for the Committee shall be processed by the Division of International Relations, International Affairs Department.

12. Miscellaneous Provisions

Necessary matters concerning GS External Evaluation other than those prescribed within these implementation guidelines shall be prescribed separately by the GI-CoRE Steering Committee.

Supplementary Provisions

These guidelines shall come in force on 12 December 2017.

REGULATIONS FOR THE HOKKAIDO UNIVERSITY GLOBAL INSTITUTION FOR COLLABORATIVE RESEARCH AND EDUCATION

HU Doc. No.151
April 1, 2014

(Purpose)

Article 1 These *Regulations* shall prescribe the organization and administration of the Hokkaido University Global Institution for Collaborative Research and Education (hereinafter referred to as "the Institution for Research and Education"), based upon the *Rules Concerning the Organization of Hokkaido University* (HU Doc. No. 31 of 2004), Article 37(4).

(Objectives)

Article 2 The objectives of the Institution for Research and Education shall be to invite teaching staff from Japan and overseas with world-class education and research results, to promote international collaborative research and international collaborative education (hereinafter referred to as "international collaborative research and education") that capitalizes upon the distinctive characteristics of Hokkaido University (hereinafter referred to as the "University"), and to provide support for international collaborative research being furthered independently by faculties or schools.

(Employees)

Article 3 A Director and other necessary teaching staff shall be placed in the Institution for Research and Education.

(The Director)

Article 4 The President shall be appointed as the Director of the Institution for Research and Education.

2. The Director shall supervise the work of the Institution for Research and Education.

(The assistant director)

Article 5 An assistant director shall be placed in the Institution for Research and Education.

2. A vice president designated by the President shall be appointed as the assistant director.
3. The assistant director shall assist the Director in his or her duties and shall take over those duties in the event of the latter being incapacitated.

(Global stations)

Article 6 The following global stations shall be placed in the Institution for Research and Education to promote international collaborative research and education that capitalizes upon the distinctive characteristics of the University.

(1) The Global Station for Quantum Medical Science and Engineering
(2) The Global Station for Zoonosis Control
(3) The Global Station for Food, Land and Water Resources
(4) The Global Station for Soft Matter
(5) The Global Station for Big Data and Cybersecurity
(6) The Global Station for Arctic Research

2. Full-time teaching staff from the University (including specially appointed academic staff who come under each item of Article 3 of the *Hokkaido University Specially Appointed*

Academic Staff Regulations (HU Doc. No. 35 of 2006). The same applies to Article 7(2) below.) and teaching staff invited from Japan and overseas shall be placed in the Institution for Research and Education.

3. The period for which a global station is established shall be five years. However, this period can be extended within five years if the steering committee provided for in Article 8 deems it necessary.

(Global station leaders)

Article 7 A global station leader shall be placed in each of the global stations referred to in the items of Article 6(1).

2. The global station leader shall be one of the teaching staff of the said global station who has been designated by the Director.
3. The global station leader shall supervise the work of the said global station under the orders of the Director.
4. The term of office of the global station leaders shall be three years or less, and they can be reappointed.

(Steering Committee)

Article 8 A steering committee shall be placed in the Institution for Research and Education to deliberate important matters concerning the said institution.

2. The organization and administration of the steering committee shall be prescribed separately.

(Administration)

Article 9 The administrative work of the Institution for Research and Education shall be processed in the Division of International Planning, the International Affairs Department.

(Miscellaneous provisions)

Article 10 In addition to what is prescribed in these *Regulations*, necessary matters regarding the operation of the Institution for Research and Education shall be prescribed separately by the President after approval by the steering committee.

Supplementary Provisions

These *Regulations* come into force on April 1, 2014.

Supplementary Provisions

These *Regulations* come into force on April 1, 2015.

Supplementary Provisions

These *Regulations* come into force on April 1, 2016.

Supplementary Provisions

These *Regulations* come into force on July 1, 2018.

REGULATIONS FOR THE GLOBAL INSTITUTION FOR COLLABORATIVE RESEARCH AND EDUCATION STEERING COMMITTEE

HU Doc. No. 152
April 1, 2014

(Purpose)

Article 1 These *regulations* shall provide for the necessary matters concerning the organization and administration of the Global Institution for Collaborative Research and Education Steering Committee (hereinafter referred to as "the committee"), based upon Article 8(2) of the *Regulations for the Global Institution for Collaborative Research and Education* (HU Doc. No. 151 of 2014, "*Regulations for the Institution for Education and Research*" in Article 3).

(Topics for Deliberation)

Article 2 The committee shall deliberate on the issues set forth in item (6) through item (10) of Article 2 of the *National University Corporation Hokkaido University Agenda for Hearing with Faculty Council Rules* (HU Doc. No. 42 of 2015, referred to as "*Hearing Rules*" in the following paragraph) and deliver opinions to the President.

2. In addition to the matters specified in the preceding paragraph, the committee shall deliberate the following matters pertaining to the Hokkaido University Global Institution for Collaborative Research and Education (hereinafter referred to as "the Institution for Research and Education" in (5) below).

(1) Matters regarding personnel affairs of the faculty (excluding matters set forth in item (6) through item (10) of Article 2 of the *Hearing Rules*).

(2) Matters regarding the establishment, reform or termination of global stations.

(3) Matters regarding the evaluation of the educational and research activities of global stations.

(4) Matters regarding budgets.

(5) Other important matters pertaining to the administration of the Institution for Research and Education.

(Structure)

Article 3 The committee shall consist of the following members:

(1) The director of the Global Institution for Collaborative Research and Education (referred to as "the director" in Article 5)

(2) The assistant director of the Global Institution for Collaborative Research and Education (referred to as "the assistant director" in Article 5)

(3) One vice president designated by the President (excluding the person mentioned in the previous item)

(4) One dean or director from each of the following categories (a-d), each of whom shall be designated by the President

a) The Graduate School of Letters, the Graduate School of Law, the Faculty of Education, the Research Faculty of Media and Communication, the Faculty of Economics and Business, the Faculty of Public Policy

b) The Graduate School of Information Science and Technology, the Faculty of Fisheries Sciences, the Faculty of Environmental Earth Science, the Faculty of Science, the Research Faculty of Agriculture, the Faculty of Advanced Life Science, the Faculty of Engineering, the Faculty of Veterinary Medicine

c) The Faculty of Pharmaceutical Sciences, the Faculty of Health Sciences, the Faculty of Medicine, the Faculty of Dental Medicine, Hokkaido University Hospital

d) Each affiliated research institute, each research center, the Field Science Center for Northern Biosphere

(5) Each global station leader as prescribed in Article 7 of the *Regulations* for the Institution for Education and Research

(6) Other persons whom the President deems appropriate

2. The President shall appoint the committee members mentioned in the preceding item (6)

(Term of Office)

Article 4 The terms of office of the committee members indicated in paragraph 1(4) and paragraph 1(6) of the previous article shall be two years. However, the term of office of substitute committee members shall be the remaining term of office of the previous committee member.

2. The committee members indicated in the preceding paragraph may be reappointed.

(Committee Chair)

Article 5 The director shall be appointed as the committee chair.

2. The committee chair shall call committee meetings and preside over the said meetings.

3. The assistant director shall take over the director's duties in the event of the latter being incapacitated.

(Proceedings)

Article 6 The committee cannot validly convene unless at least two-thirds of the committee members are present.

2 Committee proceedings, other than those prescribed separately, shall be decided by the majority vote of the attending committee members.

(Attendance of Persons Other Than Committee Members)

Article 7 In cases deemed necessary by the committee, persons other than committee members may be permitted to attend committee meetings, and explanations or opinions of the said persons may be heard.

(Committees on Special Issues)

Article 8 Committees on special issues may be established within the committee when necessary in order to deliberate specialized matters.

(General Affairs)

Article 9 The administrative affairs of the committee shall be processed in the Division of International Planning, the International Affairs Department.

(Miscellaneous Provisions)

Article 10 In addition to what is prescribed in these *regulations*, necessary matters regarding the operation of the committee shall be prescribed by the said committee.

Supplementary Provisions

These *regulations* come into force on April 1, 2014.

Supplementary Provisions (HU Doc. No. 196 of April 1, 2015)

These *regulations* come into force on April 1, 2015.

Supplementary Provisions (HU Doc. No. 191 of October 1, 2016)

These *regulations* come into force on October 1, 2016.

Supplementary Provisions (HU Doc. No. 163 of April 1, 2017)

1. These *regulations* come into force on April 1, 2017.
2. The dean of the Graduate School of Dental Medicine who was specified as a committee member in c) of paragraph 1(4) of Article 3 prior to the revision (hereinafter referred to as "the former committee member" in this paragraph) shall be deemed to have been appointed as a committee member under the revised *regulations* in c) of paragraph 1(4) of Article 3 on the enforcement date of these regulations. The term of office of the said member shall be the remaining term of office of the former committee member on the enforcement date, notwithstanding the revised provisions of Article 4(1).

Supplementary Provisions (HU Doc. No. 182 of June 20, 2017)

These *regulations* come into force on June 20, 2017 and apply retroactively from April 1, 2017.

Supplementary Provisions (HU Doc. No. 98 of July 1, 2018)

These *regulations* come into force on July 1, 2018.

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