

1. 研究活動 (2016年4月～2017年3月)

1.1 研究活動概要

(1) 乾燥地研究センターについて

乾燥地研究センターは国立大学法人鳥取大学の独立部局であると同時に、共同利用・共同研究拠点である。その設置目的は、「乾燥地における砂漠化や干ばつなどの諸問題に対処し、乾燥地における自然-社会系の持続性の維持・向上に資する研究を中核的研究教育拠点として推進し、乾燥地科学分野の研究者の利用に供すること」にある。

文部科学省の研究拠点形成費等補助金事業による21世紀COEプログラム(平成14～18年度)やグローバルCOEプログラム「乾燥地科学拠点の世界展開」(平成19～23年度)により、乾燥地科学分野の研究水準の向上と世界をリードする創造的な人材を育成し、研究・教育の世界的ネットワークも形成した。

本拠点形成の目的は、研究面においては、乾燥地研究センターがその前身を含めてこれまでに蓄積した砂地における植物生産や植生回復に関する知見と技術を、広く世界の乾燥地土壌に適用可能なものへと高度化するとともに、これに社会経済分野や医学分野などの知見や技術を融合させて、世界の砂漠化対処に資する、健康的な人間生活の営みを保障する「新たな乾燥地科学」を構築することにある。一方、教育面においては、大学院生(修士課程、博士課程)、研究生、JICA等からの外国人委託研究員等の教育を担当し、乾燥地の砂漠化対処に関わる国際機関や企業、NGOなどが必要とする研究者や技術者を養成することである。

本拠点の形成は、世界の乾燥地科学の発展、国連砂漠化対処条約に係る我が国の貢献義務の履行及び当該分野の人材育成にとって重要な意義を有する。

平成27年度には、「乾燥地植物資源を活用した天水栽培限界地における作物技術の開発-世界の耕作限界地における持続的開発を目指して-(通称:限界地プロジェクト)」(平成27年度～平成30年度)が文部科学省特別経費事業に採択され、年間降水量300mm台の降雨依存農業地域で、持続的な生産を可能にする農業技術パッケージの開発に挑戦している。

また、乾燥地研究センターの恒川篤史教授を研究代表者とする研究課題『砂漠化対処に向けた次世代型「持続可能な土地管理(SLM)」フレームワークの開発』(平成29年度～平成33年度)が、科学技術振興機構(JST)の国際科学技術共同研究推進事業「地球規模課題対応国際科学技術協力プログラム(SATREPS)」平成28年度新規研究課題に採択された。

平成28年6月、乾燥地研究センターは西オーストラリア大学と新たに学術交流協定を締結した。

同月、乾燥地研究センターの伊藤健彦助教が、モンゴルにおける自然環境保全活動への貢献が高く評価され、モンゴル国自然環境グリーン開発観光省からモンゴル国環境優秀専門家賞を受賞した。

平成28年7月、サウジアラビア国営石油会社サウジアラムコの日本法人、アラムコ・アジア・ジャパン株式会社と鳥取大学は、乾燥地研究センターへの研究支援に関する合意書に署名した。

平成28年8月にケニア・ナイロビで開催された第6回アフリカ開発会議(TICAD VI)「サヘル・アフリカの角砂漠化対処を通じた気候変動に対するレジリエンス強化イニシアティブ」サイドイベントに恒川篤史教授がパネ

1. Research Overview (April 2016–March 2017)

1.1 Outlines of Research Activities

(1) About Arid Land Research Center

The Arid Land Research Center (ALRC) is an independent department of Tottori University and, at the same time, is a Joint Usage/ Research Center. The mission of the ALRC is to conduct research on desertification and to develop sustainable agricultural practices in arid and semi-arid areas. The door is open to all researchers who are engaged in the field of Dryland Science.

Tottori University had undertaken the 21st COE Program “Program for Arid Land Science” for five years from FY 2002 to FY 2006, and Global COE program “Global Center of Excellence for Dryland Science” for five years from FY 2007 to FY 2011, both of which were funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). These MEXT-sponsored programs had helped establish a global network in terms of education and research, while contributing to the enhancement of the level of research in the field of the dryland science and nurturing internationally-active, competent researchers.

The goals of the establishment of the Center are, with regard to research, to advance knowledge and technologies concerning plant production and revegetation of deserts, which the Arid Land Research Center and its predecessor have accumulated, so it can be widely applied to arid land soils around the world. Simultaneously, blending this with knowledge and technologies in the social economics and medical fields etc., to build a new Science of Arid Land that contribute to combat global desertification and ensure people’s healthy daily lives. In the educational field, ALRC’s mission is to nurture researchers and advance technologists to deal with arid lands that are required by international organizations, private companies, NGOs etc. through educating graduate students (Master’s and Doctoral courses), research students, and international researchers from Japan International Cooperation Agency (JICA), etc.

The establishment of the Center is extremely significant in terms of further advancement in the world’s dryland sciences, fulfillment of Japan’s obligation to contribute to the United Nations Convention to Combat Desertification, and human resource development in this field.

ALRC has started a four-year project “Development of Crop Husbandry Technology in Marginal Rainfed Environment Using Dryland Plant Resources - Toward Sustainable Improvement in Global Marginal Regions,” or “Project Marginal Region Agriculture” for short, in FY 2015, funded by MEXT. The challenge of this project is to make an agricultural package that enables sustainable production of food, oil and forage crops in the regions with about 300 mm annual rainfall.

ALRC’s Professor Atsushi Tsunekawa’s project proposal titled “Development of Next-Generation Sustainable Land Management (SLM) Framework to Combat Desertification” was selected as one of the FY2016 Science and Technology Research Partnership for Sustainable Development (SATREPS) programs by Japan Science and Technology Agency (JST). The project will move forward with full-scale implementation from FY 2017 through FY 2021 in collaboration with Bahir Dar University, Ethiopia.

In June 2016, ALRC and the University of Western Australia agreed to exchange a memorandum of understanding to enhance relations between the universities.

In the same month, ALRC’s Assistant Professor Takehiko Ito was awarded the prize of Best Environmental Specialist by Ministry of Environment, Green Development and Truism of Mongolia as his contribution to natural environment conservation activities in Mongolia was highly regarded.

In July 2016, Aramco Asia Japan K.K. and Tottori University signed an agreement to extend support to ALRC’s research activities.

リストとして参画した。

平成28年8月21日から24日に、乾燥地研究センターは海外研究機関を含む6機関と共催で、エジプト・アレキサンドリアにおいて「第12回乾燥地開発国際会議」を開催。鳥取大学からは21名の研究者、学生が参加し、口頭発表やポスター発表を行った。

平成28年9月、乾燥地研究センターの妻鹿良亮特命助教が、日本育種学会第130回講演会において優秀発表賞を受賞した。

平成28年10月3日から10月5日の3日間、スーダン農業研究機構からエルサディグ・スレイマン・モハメド・アリ長官を乾燥地研究センターに招聘し、国際共同研究に係る打合せを行った。

平成28年10月から平成29年1月までの4ヶ月間、元ハルツーム大学（スーダン）学長のアルシェイク・アルシデグ・アハメド・アルムスタファ教授を、乾燥地研究センターの外国人客員教員として招聘した。

また、乾燥地研究センターの岡本昌憲助教と静岡大学の轟教授らを中心とした共同研究グループが、植物の乾燥耐性能を向上させる化合物の開発に成功。平成28年11月14日に国際科学専門誌『Scientific Reports』のオンライン版に掲載された。

さらに、岡本昌憲助教がClarivate Analytics（旧トムソン・ロイターIP&Science）による、論文の引用分析による世界で影響力の高い科学者2016年版（2016 Highly Cited Researcher）に選出された。

平成29年3月、乾燥地研究センターの木村玲二准教授が、風食の発生という観点からの衛星による全球の乾燥地分布マップを完成させた。

また、本センターは、平成28年度国立大学法人等施設整備実施予定事業の補正予算採択を受け、本館の改修が決定し、平成29年9月完成に向け、工事を開始した。

組織・運営体制

本センターは、センター長、副センター長、教授会（教授、准教授等で構成）、運営委員会（外部委員、学内委員、センター専任教授で構成）及び共同研究委員会（外部委員、センター専任教授で構成）、3研究部門、乾燥地植物資源バンク室、及び事務部で組織され、その運営は、教授会と運営委員会によって行われる。なお、鳥取大学技術部は平成24年度より組織が一元化され、1つの部局となったが、これまでと同様、業務依頼及び技術支援による相互連携を図っている。

研究部門は、総合的砂漠化対処部門、環境保全部門、農業生産部門の3研究部門から構成され、専任の教授4名、准教授6名、助教3名、特命助教1名、特任教授2名、国内客員3名、外国人客員3名が配置されている。また、プロジェクト研究員7名、日本学術振興会特別研究員1名が配置された。事務系には職員12名（事務職員5名、事務補佐員7名）、技術系には職員16名（技術職員4名、技術補佐員12名）が配置され、研究・教育の支援事務などを担当している。（人数は平成28年10月1日時点）。

共同研究、教育、刊行物

平成28年度における共同利用研究代表者（大学教員など）は56名、指導学生数は28名（博士課程15名、修士課程8名、学部学生3名、研究生2名、うち留学生18名（中国4名、エチオピア5名、スーダン5名、ナイジェリア2名、エジプト1名、タンザニア1名））である。

In August 2016, ALRC's Professor Atsushi Tsunekawa participated in a side event titled "A new African initiative for combating desertification to strengthen resilience to climate change in the Sahel and Horn of Africa" of the Sixth Tokyo International Conference on African Development (TICAD-VI) held in Nairobi, Kenya as a panelist.

During August 21 through 24, 2016, ALRC co-hosted the Twelfth International Conference on Development of Drylands (ICDD) with six other international organizations in Alexandria, Egypt. 21 researchers and students from Tottori University took part in the conference and gave presentations.

In September 2016, ALRC's Specially Appointed Assistant Professor Ryosuke MEGA received the award for his oral presentation at the 130th Meeting of the Japanese Society of Breeding.

In October 2016, ALRC invited Prof. Elsaddg Suliman Mohamed Ali, Director General of Agricultural Research Corporation (ARC), Sudan, and held meetings on collaborative research.

ALRC invited Prof. Elsiddig Ahmed Elmustafa Elsheikh, a former president of the University of Khartoum, Sudan, as its visiting professor for four months from October 2016 through January 2017.

A research team with ALRC's Tenure-track Assistant Professor Dr. Masanori Okamoto and Professor Dr. Todoroki in Shizuoka University succeeded in developing a novel compound, which can enhance drought tolerance in plants. It was published in an online edition of Scientific Reports on November 14, 2016.

Moreover, Dr. Masanori Okamoto was elected as one of the highly cited researchers in 2016 by Clarivate Analytics, formerly the IP & Science business of Thomson Reuters, in recognition of ranking among the top 1% most cited academic journals in a specific field.

In March 2017, ALRC's Associate Professor Reiji Kimura developed a database called "Global mapping on the distribution of Arid regions based on a dust erodibility from a satellite data" on the ALRC's web site.

In addition, ALRC has begun the renovation of its main building based on the government's supplementary budget for fiscal 2016. The construction is due to be completed in September 2017.

Organization and Management Structure

ALRC consists of the Director, Vice Director, Faculty Meeting, Advisory Committee, Joint Research Committee, Research Division, the Laboratory of Arid Land Plant Resources, and the Administration Department. The Faculty Meeting and the Advisory Committee operate the center. The Technical Departments of Tottori University integrated their organizations in FY2012 to form one department, but as in the past, maintains mutual links based on business requests and technical support.

The Research Division is composed of three divisions: Integrated Desertification Control Division, Environmental Conservation Division, and Agricultural Production Division. As of October 1, 2016, four full-time professors, six associate professors, three assistant professors, one specially appointed assistant professor, two specially appointed professors, three visiting national professors and three visiting international researchers were allocated to these research divisions. In addition, seven project researchers and one JSPS research fellow were added to our research teams. Moreover, 12 office staff (five full-time and seven part-time) and 16 technical staff (four full-time and 12 part-time) supported ALRC's research and education.

Joint Research, Education, Publication

In FY 2016, 56 joint-use research representatives, mainly from national and private universities, were attached to ALRC. In addition, ALRC had a total of 28 students; 15

共同研究に関する研究発表会は毎年開催しており、平成28年度は、12月3日～4日に当センターにおいて開催した。また、センター内外の乾燥地研究者によるセミナーも数多く開催されている。

教育については、平成21年度より修士課程（農学研究科）及び博士課程（連合農学研究科）に「国際乾燥地科学専攻」を新設し、学部－修士－博士の一環教育を整備している。

定期刊行物としては、鳥取大学乾燥地研究センター年報を発足以来毎年刊行し、センターの研究教育活動の紹介を行っている。また、センターの活動を地域で支え、その研究活動と成果を広く情報発信することを通じて地域の発展を図る組織として設立された「とっとり乾地研倶楽部」の支援により、広報誌を年数回発行し、最新の活動状況等を紹介している。

この他、平成28年度には、以下の刊行物を出版した。

- 乾燥地フォトブックシリーズ vol.1 乾燥地の自然と暮らし モンゴル（伊藤健彦・大谷眞二 著、鳥取大学乾燥地研究センター監修、今井出版、平成28年11月出版）

研修施設

平成23年8月には、学外の共同研究者や学生が研究及び研修のために宿泊できる研修施設（ゲストハウス）が完成した。この施設は、ツインルーム2室、シングルルーム4室、研修室1室を備えている。

アウトリーチ活動

乾燥地研究センターでは、国内外や地域の人々にセンターを知ってもらうため、施設見学や体験学習などを積極的に受入れている。また、研究成果を広く社会に還元するため、一般市民や研究者を対象としたシンポジウム、パネル展等のイベントを開催している。

平成28年度の主な活動は以下のとおり。

- 第12回乾燥地開発国際会議（ICDD）を共催で開催：平成28年8月21日～24日、参加者数約120名、エジプト・アレキサンドリア
- 第6回アフリカ開発会議（TICAD VI）サイドイベントにおける研究活動の紹介：平成28年8月27日、ケニア・ナイロビ
- 国立大学共同利用・共同研究拠点協議会「第55回知の拠点セミナー」における黄砂に関する講演：平成28年9月17日、京都大学東京オフィス、参加人数64名
- 放送大学鳥取学習センター主催シンポジウムにおける砂漠緑化に関する講演：平成28年10月8日、鳥取大学農学部
- 一般社団法人ナレッジキャピタル主催「超学校」における出前講義：平成28年11月7日～12月19日（全4回）、グランフロント大阪
- 毎日メディアカフェでセミナー「砂漠の世界によるこそ」を開催：平成28年11月29日、毎日新聞東京本社
- 一般公開：平成28年7月31日、参加人数213名
- きみもなろう！砂漠博士（小学生向け実験イベント）：平成28年7月31日、参加人数16名

Ph.D. students, 8 master's students, 3 undergraduate students, and 2 research students. Of them, 18 students were from overseas; 4 Chinese, 5 Ethiopian, 5 Sudanese, 2 Nigerian, 1 Egyptian, and 1 Tanzanian.

ALRC holds the Joint Research Symposium every year. In FY 2016, we held the symposium on December 3 and 4 at the center. Seminars were often held by internal and external experts.

Concerning education, a course named “Global Arid Land Science” was established in FY2009 for Master's course (Graduate School of Agriculture) and Doctoral course (United Graduate School of Agricultural Sciences). This course offers a consistent educational system through undergraduate, master's and doctoral courses.

Annual report has been published since the establishment of ALRC, which provides information and data about ALRC's research and education activities. In addition, ALRC issues a newsletter several times a year to introduce its latest research activities, supported by the “Tottori Kan-chiken Club” that was established by a local business association.

Moreover, ALRC issued the following publication in FY 2016.

- Photobooks of Drylands vol. 1: Nature and Life in Drylands: Mongolia. pp.100. (T. Ito, S. Otani, Published by IMAISHUPPAN, Yonago, Nov. 2016)

Accommodation Facility

A guest house was built in August 2011, which is available for joint researchers and students who would like to stay in the premises of ALRC for research activities and training. This accommodation facility has two twin rooms, four single rooms and one training room.

Outreach Activities

ALRC has been conducting various public outreach activities such as facility tours and on-site learning program to promote and publicize ALRC activities both inside and outside Japan. In addition, ALRC has been holding many events such as symposiums and panel exhibitions to disseminate research results and achievements to public and outside researchers.

We held the following activities during FY 2016.

- ALRC co-hosted the Twelfth International Conference on Development of Drylands (ICDD): August 21-24, 2016, Alexandria, Egypt
- Participation in a side event of the Sixth Tokyo International Conference on African Development (TICAD-VI): August 27, 2016, Nairobi Kenya
- Giving a lecture on Asian dust at a seminar hosted by Council for Joint Usage and Research Centers of Japanese National Universities: September 17, 2016, Tokyo office of Kyoto University
- Giving a lecture on desert greening at a symposium hosted by the Tottori Study Center of the Open University of Japan: October 8, 2016, Faculty of Agriculture of Tottori University
- Giving a series of lectures at “CHO (surpassing)” School Series hosted by Knowledge Capital Association: from November 7 to December 19, 2016 (four times), Grand Front Osaka
- Holding a Seminar titled “Welcome to the Desert World”: November 29, 2016, 2016, Mainichi Media Café, Tokyo
- Open House Event: July 31, 2016, ALRC
- On-site learning program for elementary students “Let's become a Dr. Desert”: July 31, 2016, ALRC

(2) 研究部門

1) 総合的砂漠化対処部門

恒川 篤史 (保全情報学)

保全情報学分野では、乾燥地における植物生産および生態系変化のモニタリングとモデリングを中心的課題としている。特に水やダストを介しての大気と陸域（植生と土壌）の間の相互作用の解明や、乾燥地における生態系・地域社会の持続可能性を評価する手法の開発に力を入れている。そのため数値モデル・リモートセンシング・GISなどの情報技術とフィールドでの観測、乾燥地研究センターにおける施設実験などを組み合わせながら、以下のような研究を進めている。

1. 生態系プロセスモデルを用いた環境応答の予測
2. リモートセンシング・GISを用いた生物生産力の広域推定
3. 乾燥地における持続可能性の評価手法の開発
4. バイオ燃料植物の生産力と環境影響の評価

本年度は、エチオピアの青ナイル川上流域における土壌侵食について以下の研究成果を得た。新しく考案された方法論的枠組みを用いて、現在および将来の予想条件下における総土壌損失および土砂収率の変動性を分析した。その結果、流域では平均土壌損失率が $27.5 \text{ t ha}^{-1} \text{ yr}^{-1}$ であり、総土壌損失は 473 Mt yr^{-1} 、そのうち少なくとも10%はガリー侵食に由来し、26.7%はエチオピアにとどまる。因子分析の結果、この高い空間的変動性の原因となったのは、農業生態系の変動（平均因子スコア = 1.32）と勾配（1.28）であった。適切な土壌および水の保全対策が流域の77.3%に相当する中程度から重度の侵食（ $\text{N15 t ha}^{-1} \text{ yr}^{-1}$ ）を受け地域で実施されたとすると、流域からの全土壌損失は、約52%軽減されると予測された。

[Haregeweyn N, Tsunekawa A, Poesen J, Tsubo M, Meshesha DT, Fenta AA, Nyssen J, Adgo E. 2017. Comprehensive assessment of soil erosion risk for better land use planning in river basins: Case study of the Upper Blue Nile River. *Science of the Total Environment* 574: 95-108.]

(2) Research Divisions

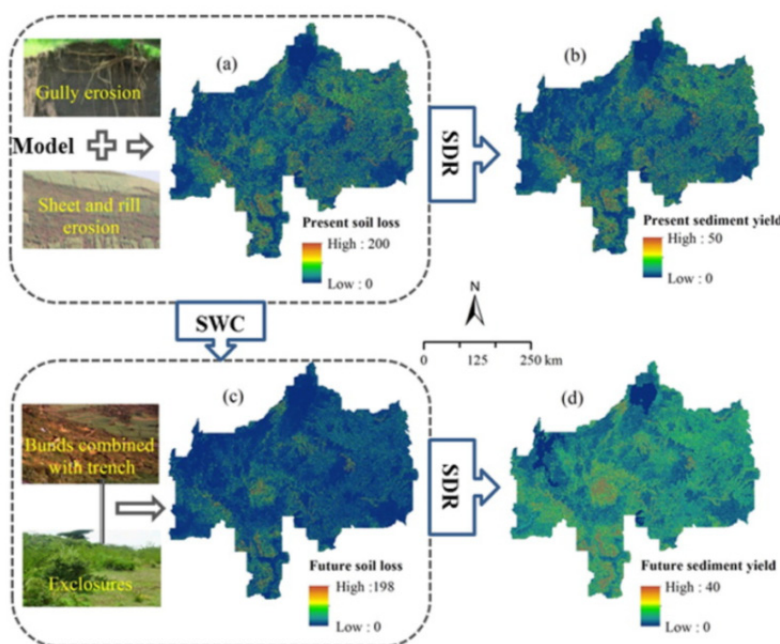
1) Integrated Desertification Control Division

Atsushi Tsunekawa (Prof., Conservation Informatics)

The Conservation Informatics Subdivision conducts research on the monitoring and modeling of the plant production and ecosystem change in the dry lands. Particular efforts are being made to clarify the interaction between the atmosphere and the land surface (vegetation and soil) through water and dust, and to develop methodologies for evaluating the sustainability of ecosystems and local communities in dry lands. The research of the Subdivision is driven by combining the use of information technologies such as numerical modeling, remote sensing and geographic information systems (GIS); field observations; and experiments using ALRC's facilities for the following topics.

1. Prediction of environmental response using a process-based ecosystem model
2. Regional estimation of biological productivity using remote sensing and GIS
3. Development of methodologies for evaluating sustainability in drylands
4. Evaluation of productivity and environmental impacts of biofuel plants

We obtained the following research findings about soil erosion in the Upper Blue Nile River (UBNR) basin of Ethiopia. The results showed that the basin generates an average soil loss rate of $27.5 \text{ t ha}^{-1} \text{ yr}^{-1}$ and a gross soil loss of ca. 473 Mt yr^{-1} , of which, at least 10% comes from gully erosion and 26.7% leaves Ethiopia. In a factor analysis, variation in agroecology (average factor score = 1.32) and slope (1.28) were the two factors most responsible for this high spatial variability. If appropriate soil and water conservation practices targeted ca. 77.3% of the area with moderate to severe erosion ($\text{N15 t ha}^{-1} \text{ yr}^{-1}$), the total soil loss from the basin could be reduced by ca. 52%. Our methodological framework identified the potential risk for soil erosion in large-scale zones, and with a more sophisticated model and input data of higher spatial and temporal resolution, results could be specified locally within these risk zones.



Soil loss and sediment yield ($\text{t ha}^{-1} \text{ yr}^{-1}$) in the UBNR basin: (a) present (2016) soil loss when soil and water conservation (SWC) is negligible, (b) present sediment yield after taking into account the sediment delivery ratio (SDR), (c) future (2025) soil loss after targeted implementation of SWC interventions, and (d) future sediment yield after taking into account the effect of SWC into the SDR. (Haregeweyn et al., 2017)

黒崎 泰典 (ダスト気候学)

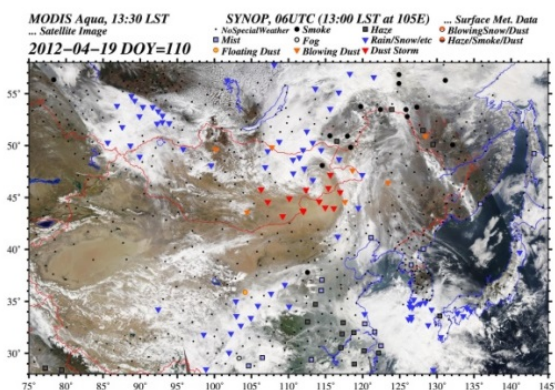
日本では黄砂として知られるダスト粒子(鉱物粒子)は乾燥地や耕作地などにおいて強風によって舞い上がり、より細かい粒子は自由対流圏の風によって長距離輸送される。ゴビ砂漠やタクラマカン砂漠起源のダストはグリーンランド、ハワイ、米国西海岸などにおいてしばしば観測される。ダストは人間生活に大きく影響しているが、発生域と風下域で影響タイプが異なる。発生域では気象災害の側面が強く、人や家畜の死亡・行方不明、建築物損壊などの被害が報告されている。発生域から遠くなるに従い、健康影響、酸性雨中和、海洋生態系への影響、放射過程・雲凝結過程を介した気候への影響といった環境影響の側面が強くなる。ダスト気候学分野では、主に(1)日々のダスト空間分布モニタリング、(2)発生原因解明とその黄砂数値モデルへの応用、(3)日本に飛来するダストの沈着量、発生源解明を課題とし、本年度は主に以下のことを実施した。

課題(1)では、気象台データとMODIS衛星画像を用いた東アジア準リアルタイムダストモニタリングシステムの維持更新を行い、ダスト発生・輸送経路の議論に用いた。

課題(2)では、黄砂プロジェクトにおいて、2012年3月にゴビ砂漠北部のツォクトオボー(モンゴル)に設置した黄砂発生観測システムの維持管理を行った。これまでの観測から、観測地点周辺約10kmスケールでダスト発生域が空間的に偏在していることが分かってきたため、場所による黄砂発生量の違いを定量的に明らかにするための観測を実施した。乾地研共同研究(代表:石塚正秀・香川大)などにおいて、土壌クラストの黄砂発生への影響の重要性を定量化するため、クラスト強度評価のための室内実験を実施した。

課題(3)では、乾地研共同研究(長田和雄・名古屋大)において、PM2.5観測などを乾燥地研究センター屋上で実施した。この観測において、課題(1)で作成した衛星画像を観測日特定に活用した。課題1~3を繋げるため、乾地研共同研究(代表:関山剛・気象研究所)において数値モデルを用いた黄砂発生・輸送の研究を推進している。

これらは、日本学術振興会科学研究費(課題番号15H05115、25220201)、鳥取大学国際乾燥地研究機構経費、乾燥地研究センター共同研究において実施した。



Dust distribution on April 19, 2012. This image was produced by the near-real time east Asia dust monitoring system.

Yasunori Kurosaki (Assoc. Prof., Dust Climatology)

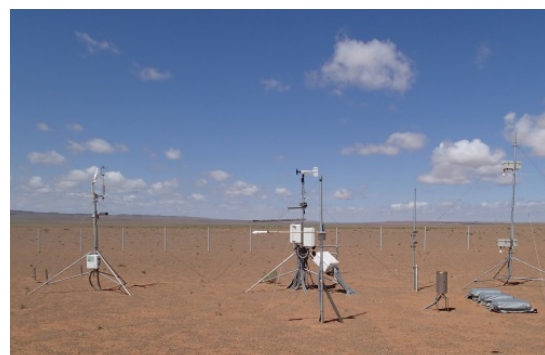
Mineral dust particles are blown up by a strong wind in arid land, agricultural area, etc., and they are transported over a long distance by wind in free troposphere. We often observe dust particles emitted from the Gobi and the Taklimakan travels to Greenland, Hawaii, the North America, etc. Dust largely affects human lives, but types of the effect are different by place. In source areas, it works as a disaster which leads death and disappearance, damages on architectural facility, etc. In downwind areas, it works as a factor of health impact such as respiratory disease and as a factor of environment change such as neutralization of acid rain, marine ecosystem change, climate change, etc. The dust climatology subdivision has majorly three subjects, which are (1) monitoring of dust distribution, (2) elucidation of dust emission mechanisms and an application of them on numerical dust models, and (3) elucidation of the amount of deposited dust in Japan and its source regions. Major works done in the fiscal year are described as below.

On the subject (1), maintenance of the near-real time East Asia dust monitoring system using MODIS satellite images and meteorological observatory data was carried out. The images were utilized for discussion of emission places and transportation routes of dust with research colleagues.

On the subject (2), maintenance of dust emission observation system, which was set up at Tsogt-Ovoo Mongolia located in a northern part of the Gobi Desert under Project Asian Dust on March 2012, was carried out. In addition to the ordinal observation using the system, another observation was also carried out to quantitatively clarify a spatial difference in dust emission. Laboratory experiments were carried out to evaluate an importance of soil crust on aeolian erodibility under ALRC joint research (PI: Prof. Ishizuka, Kagawa Univ.) etc.

On the subject (3), observations of PM2.5 etc. were carried out on the roof of ALRC building under ALRC joint research (PI: Prof. Osada, Nagoya Univ.). To connect subjects 1-3, a research using numerical dust model was carried out under ALRC joint research (PI: Dr. Sekiyama, Meteorological Research Institute).

These works were supported by JSPS KAKENHI (Grant Numbers 15H05115 and 25220201), by International Platform for Dryland Research and Education (IPDRE), and by ALRC joint researches.



Dust emission observation system set up in Tsogt-Ovoo Mongolia located in a northern part of the Gobi Desert.

小林 伸行 (社会経済学)

畜産:

乾燥地の開発においては、自然環境の保全、住民の生計向上と生活改善とのバランスのとれた総合的・持続的な開発が重要であるとの認識に立ち、畜産による土地利用とこれによる自然環境とのバランスある発展につき、各地・国の状況に応じた適応可能な策の提示を目指す。これに関し、中国・蘭州大学との共同研究を2015年から行なっている。

中国では、牛肉消費量の急増に対する飼料給与量の抑制のため、飼料の効率的な利用体系の構築が求められる。同国内用牛生産の重点地域である甘粛省では舎飼い飼養が推奨されるが、草地利用型の畜産が行なわれてきた同省で舎飼い飼養管理は普及途上にある。このため、同省で一般的に栽培され、タンパク質含量や耐旱性の高さから肉用牛飼料としての有用性が高いと考えられるアルファルファ乾草 (AH) で濃厚飼料 (C) を代替した際の増体およびエネルギー・窒素出納成績に及ぼす影響を調査した。

これまでに以下の結果を得た。

1. AHによるCの代替で、乾物摂取量は減少せずに体内への蓄積Nが増加する。しかし、その過剰の代替は、飼料・エネルギー効率の低下と増体減少をもたらす、メタン排出量を有意に増加させる。
2. 一方、一定程度のAH給与では、増体成績やメタン排出量に大きな影響を及ぼさない。飼料コストも考慮すると、AHの混合による飼養には妥当性がある。
3. 飼料設計においては、粗飼料・濃厚飼料の比率を34~47%とすることで、最大1.5kg/日程度の増体を期待する。この際、他種牛より高い維持エネルギー量を考慮して給与量を調整する。

国際協力:

乾燥地技術の適用現場の多くが途上国にあることから、その普及のため、これら国々に対する国際協力を行なう。JICA 草の根技術協力による支援を得て、国際乾燥地研究教育機構「人間開発と健康グループ」によるフィリピンでの「生活の質改善を目指した糖尿病予防プロジェクト」を実施している (~2019年12月)。これまでに、現地の糖尿病患者の実態を把握し、今後の予防啓発活動策定のための知見を得た。



Feeding trials using crossbred Simmental male calves in Linze Research Station of Lanzhou University, China.

Nobuyuki Kobayashi (Assoc. Prof., Sociology/Economy)

Livestock:

Recognizing that comprehensive/sustainable development with environmental conservation and farmers' livelihood improvement is important especially in dry lands, we aim to discuss/propose applicable measures for achieving both land utilization and environmental conservation with livestock raising. In this regard, the collaborative research with Lanzhou University in China has been implemented since 2015.

In China, in order to prevent the increase of feeding amount for beef cattle caused by the increasing consumption of beef meat, the establishment of system to efficiently utilize feed is required. In Gansu Province, one of the prioritized areas for beef cattle production, feeding cattle in the pen is promoted. However as livestock raising with utilization of grassland have been prevalent there, the 'pen feeding' is under development. It is thus expected that the alfalfa, generally cultivated in the Province, is utilized as the feed of beef cattle, since it is high in the protein content and the resistance against drought. The collaborative research aims to study the effect of replacement of concentrate (C) with alfalfa hay (AH) on body weight daily gain (DG) and energy/nitrogen metabolism.

The following outputs have been obtained so far.

1. The replacement of C with AH increased in N intake without the DMI decline. However the high substitution of AH caused the decline in feed/energy efficiency and DG with increases in CH₄ production.
2. Certain amount of mixed AH didn't significantly decline DG nor increase CH₄ emission. Considering the economic feasibility, the AH mixture seemed relevant.
3. The ratio of roughage and concentrate with 34-47%, when design the feed, expectedly causes the 1.5-kg DG. The high energy requirement for maintenance of the cattle should be also considered.

International Cooperation:

As most technologies for drylands are applied in developing countries, the activities for development have been conducted. The Project for enhancing the preventive measures for diabetes in Philippines has started. Baseline surveys were implemented for planning the proper prevention/promotion activities for self-management of diabetes, in collaboration with JICA.



Baseline survey with medical check-up of diabetic patient, together with local health workers.

2) 環境保全部門

山中 典和 (緑化学)

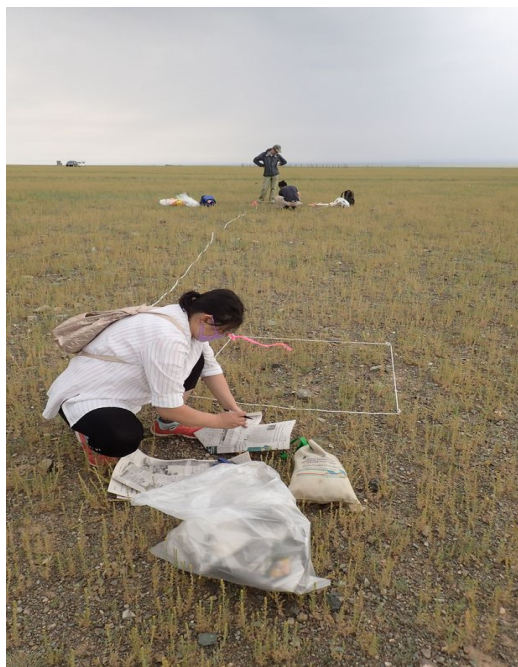
緑化学分野では植物生態学に基礎をおいた乾燥地域の緑化及び砂漠化土地の生態系修復に関する研究を行っている。主要な研究テーマは以下の様である。

- (1) 乾燥地における植物群落の生態学的研究
- (2) 樹木の耐乾・耐塩性に関する生理生態学的研究
- (3) 乾燥地の生態系修復に関する研究

これらの研究は、中国、モンゴル、スーダン、アメリカ等にある研究機関、および国内の大学・研究機関との共同研究で行っている。

本年度は、特に以下の研究で成果を得た。

1. 黄砂発生域における草原生態系の菌根共生とグロマリン蓄積(科学研究費(B))：モンゴル黄砂発生域の草原生態系において、菌根共生系とグロマリン蓄積に関わる現地調査を行った。本年はモンゴル・ブルガン地域のデザート・ステップ植生を対象に、家畜の食害に対する植生構造の変化を明らかにした。
2. 日本・中国(JSPS-NSFC)二国間交流事業/共同研究(日本学術振興会)：中国黄土高原において、二国間交流事業“Water Use and Nutrient Cycling in Typical Forests of the Semiarid Loess Plateau, China”に関する野外調査を行った。本年は黄土高原の延安地域の自然植生であるリュウトウナラ林における窒素動態と微生物動態の関係に関する調査を行った。



Vegetation survey in desert steppe areas in Bulgan,, Mongolia (August 2016).

2) Environmental Conservation Division

Norikazu Yamanaka (Prof., Revegetation Science)

The Revegetation science subdivision conducts research on the revegetation in arid areas and ecosystem restoration of desertified lands based on plant ecology. Main research topics of revegetation science subdivision are as follows.

- (1) Ecological studies on plant communities in arid lands
- (2) Eco-physiological studies on drought and salt tolerance of woody plants
- (3) Studies on the ecosystem restoration in arid lands

These researches are being conducted in overseas research institutions in China, Mongolia, Sudan, USA etc. and those in Japan.

In this fiscal year, I obtained results from following researches:

1. Glomalin accumulation and arbuscular mycorrhizal symbiosis of grassland ecosystem in dust source areas (JSPS Grant-in-Aid for Scientific Research (B)): Field research on the Glomalin accumulation and arbuscular mycorrhizal symbiosis of grassland ecosystem was conducted in Bulgan, Mongolia. We elucidated the effects of grazing pressure on vegetation structure in desert steppe areas of Mongolia.
2. Japan-China (JSPS-NSFC) Bilateral Joint Research Projects (JSPS): We conducted field researches on “Water Use and Nutrient Cycling in Typical Forests of the Semiarid Loess Plateau, China”. This year, we investigated the relationship between nitrogen dynamics and microbial dynamics in the *Quercus liaotungensis* forest, which is a natural vegetation of Yan'an area of the Loess Plateau.



Field survey on Water Use and Nutrient Cycling in a Typical Forest of the Semiarid Loess Plateau, China. (June 2016)

谷口 武士 (微生物生態学)

微生物はマイクロレベルの非常に小さい生物であるが、地球上のバイオマスや機能としては非常に大きく、グローバルスケールでの炭素や窒素の動態にも深く関与している。また、植物の定着や土壌の形成に大きな役割を果たす微生物も存在するため、これらの微生物の役割を解明し、乾燥地の環境修復への利用に関する研究を行うことは非常に重要である。このような背景から、微生物生態学分野では、主に乾燥地の環境修復への微生物利用を目指して研究を行っている。また、ミクロスケールからマクロスケールの様々な規模で観察される現象や問題の解明、あるいは解決に向けて、微生物（細菌や菌類など）に着目した研究を行っている。主な研究テーマは下記の通りである。

- ・ ストレス条件下における植物-微生物共生関係の解明と環境修復への利用
 - ・ ストレス条件下で植物に有用な複合微生物系の探索
 - ・ 黄砂発生源地域において家畜による攪乱が土壌の化学性と菌根菌に与える影響
 - ・ スーダンにおけるソルガムの菌根共生と系統特異性
- これらのテーマについて、アメリカ、中国、モンゴル、スーダンを中心に共同研究を行っている。本年度は主に以下の研究で成果を得た。

スーダンの主要穀物であるソルガムのアーバスキュラー菌根共生について、共生菌の種類とそのソルガム系統特異性の有無について調査を行った。スーダンの圃場においてソルガムと共生している AM 菌は 166 の OTU (Operational Taxonomic Unit) に分別され、Archaeosporaceae, Glomeraceae, Diversisporaceae, Paraglomeraceae, Claroideoglomeraceae に属する菌種が認められた (図)。出現した OTU の割合は、Glomeraceae が最も多く全体の 65% を占めた。このことから、本調査地におけるソルガムは Glomeraceae に属する菌類と強い関係を持っていること、およびこれらの菌がソルガムの共生菌として重要であることが推察された。また、ソルガム系統ごとの菌根群集については、本調査では違いが認められなかった。



Sorghum roots used for AMF analysis

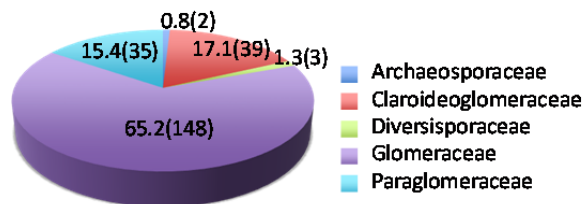
Takeshi Taniguchi (Assoc. Prof., Microbial Ecology)

Microorganisms are micro-level and very small organisms, but the biomass and function on earth is extremely large. Some microorganisms are also very important for ecosystem restoration in arid regions because they have roles for the enhancement of the establishment or stress tolerance of plants and the improvement and stabilization of soil. My laboratory mainly studies about the ecosystem restoration with microorganisms. Also, my laboratory focuses on the various scale of phenomenon and problems in arid region ranged from micro- to macro-scale and aims to reveal or solve them via microorganisms such as bacteria and fungi. Followings are the topics of my laboratory.

- ・ Plant-microorganism symbiotic relationship under stressful conditions and the application to ecosystem restoration
- ・ Exploration of useful microbial composition for plants under stressful conditions
- ・ Effect of disturbance by domestic animals on soil chemistry and arbuscular mycorrhizal fungi in the source region of Asian dust
- ・ Mycorrhizal symbiosis of sorghum and the genotype specificity

These researches are collaboratively conducted with overseas research institutes in the United States, China, and Mongolia, and Sudan. In this fiscal year, I obtained results from following researches:

Arbuscular mycorrhizal fungal (AMF) species of Sudanese sorghum and the genotype specificity were examined. AMF fungi in an experimental field in Sudan was divided into 166 operational taxonomic units, and belonged to Archaeosporaceae, Glomeraceae, Diversisporaceae, Paraglomeraceae, Claroideoglomeraceae. Glomeraceae accounts for 65% of all AMF family and appeared to be important for sorghum in Sudan. Regarding genotype specificity, we could not find any difference among Sudanese sorghum genotypes in this research.



Percentage of the number of OTUs at family level (Number of OTUs)

木村 玲二 (気象学)

気象学分野では以下のような研究を行っている。

- (1) 乾燥地における熱フラックスの定量的解明
- (2) 気象データとリモートセンシングデータを併用した地表面湿潤度のモニタリングとモデリング
- (3) 北東アジアにおいて植生がダストの発生を抑制する物理的メカニズム

これらの研究は、日本学術振興会による科学研究費 (課題番号 25304037、25220201、24510017、25300001)、および JAXA Global Change Observation Mission の援助によって、主として中国やモンゴル、エジプトで行われている。本年度は、特に以下の研究で成果を得た。

1. 「ダストが発生しやすい土地」を荒廃地と仮定した乾燥地のモニタリング方法を提示し、中国とモンゴルを対象に検証および適用可能性を行った。本手法によって抽出された「ダストが発生しやすい土地面積」と日本における黄砂現象の回数と比較を行うことで本手法の検証を行うとともに、本手法で抽出された中国やモンゴルにおける荒廃地が干ばつの現象等と良く対応することが明らかになった。
(Kimura, R.: *Int. J. Remote Sens.*, 38, 4553-4564, 2017)
2. 全球を対象とした「ダスト発生に基づいた乾燥地監視システム」を構築、パブリック公開した (<http://www.alrc.tottori-u.ac.jp/staff103/aridregions/en2.html>)。本システムは、全球データ自動ダウンロード・アーカイブサブシステムおよび準リアルタイム衛星データ自動ダウンロード処理サブシステムで作成された衛星画像を処理することによって、植生及び地表面湿潤度の両面からダストの発生しやすい地域を bi-monthly で大陸毎に特定・アップデートし (アジア、ヨーロッパ、北・南アメリカ、アフリカ、オセアニア)、全球レベルで乾燥地の分布を監視、結果をパブリックに公表するものである。このシステムによって、乾燥地の荒廃の進行度合いを細かい解像度、頻度でモニタリングすることが可能になった。
3. 劉・木村(2016)が提示した簡易な小型風洞を基に、乱流調整装置 (台形スパイヤーとラフネスブロック) を用いて、比較的厚い境界層の生成、自然界に近い粗度長、水平方向の均一な風速分布、風速の安定した観測場を同時に満たす方法・手順を提案した。将来的には、本実験で提案した簡易風洞の調整方法を利用して、飛砂実験に必要な諸条件を満たすことによって、飛砂発生メカニズムの解明や飛砂の抑止方法の開発に資する研究を行うことが期待される。本研究は、論文として公表されただけでなく、日本農業気象学会 2016 年中国四国支部大会において、優秀発表賞として評価された。
(劉・木村: *砂丘学会誌*, 63, 113-119, 2017)
4. モンゴルの黄砂発生源であるゴビ砂漠において熱収支の観測・解析を行った (2014 年 5 月~10 月)。期間平均の正味放射量、顕熱フラックス、潜熱フラックスは 85W/m^2 、 58W/m^2 、 11W/m^2 であった。渦相関法による総蒸発散量は 68mm であり、期間中の総降水量や総土壌水分減少量とほぼ一致した。また、地表面を覆うレキに凝結する水滴がゴビ砂漠の空気中の水蒸気量に影響している可能性を示唆した。
(Kimura, R.: *SOLA*, 12, 175-180, 2016)

Reiji Kimura (Assoc. Prof., Meteorology)

The Meteorology Subdivision conducts research as follows:

- (1) Quantitative analysis of heat fluxes in arid land.
- (2) Monitoring and modeling of surface moisture by combining the meteorological and remote sensing data.
- (3) To make clear the physical mechanism for preventing the dust outbreak by vegetation in northeast Asia.

These studies are conducting under the aid by Japan Society of the Promotion of Science Grants (KAKENHI 25304037, 25220201, 24510017, 25300001), and JAXA Global Observation Mission, especially in China, Mongolia, and Egypt.

In this fiscal year, I obtained results from following researches:

1. I defined degraded land area as “the area where dust can easily occur” and evaluated the yearly trend of degraded land area in China and Mongolia. As a result of verification by using a dust erodibility map and observations of ADEs (Asian Dust events) over Japan, ADE occurrence has been closely related to the severe dust areas of Mongolia in both March and April, i.e., the severe dust areas of Mongolia have had a relatively greater effect on the recent occurrences of ADE than did those in China.
(Kimura, R.: *Int. J. Remote Sens.*, 38, 4553-4564, 2017)
2. Global monitoring system of arid regions based on dust erodibility was developed and opened to the public (<http://www.alrc.tottori-u.ac.jp/staff103/aridregions/en2.html>). This is a system designed to search, visualize, analyze, and download high-level products produced by the Global Data Auto-Download and Archive Sub-system. This system enables to monitor the progress of degradation in arid regions with high resolution and frequencies over the each continent (Asia, Europe, North and south America, Africa, and Oceania).
3. Based on the results of Liu and Kimura (2016), we examined how to generate the boundary layer, roughness length close to the natural field, uniform distribution of wind speed in the horizontal direction, and stable observation field of a simple wind tunnel. Without rearranging the roughness block, we proposed to adjust only the shape and number of speyer. As a result, the boundary layer became 36 cm and roughness length became 0.01 cm, which was close to the natural condition. Additionally, it was possible to develop a uniform wind speed in the horizontal direction, and a stable observation field of the wind speed distribution.
(Liu, and Kimura: *Sand Dune Res.*, 63, 113-119, 2017)
4. We used the eddy covariance method to estimate heat fluxes in the Gobi Desert steppe of Mongolia from May to October 2014. Observation period averaged net radiation, sensible heat flux, and latent heat flux were 85W m^{-2} , 58W m^{-2} , and 11W m^{-2} , respectively. The sensible heat flux was larger than the latent heat flux throughout most of the study period, but the latent heat flux exceeded the sensible heat flux for a couple of days after rainfall events. Total evaporation estimated by the eddy covariance method almost equaled total rainfall and decreased the soil water content. Discussion is extended to the imbalance problem, especially the latent heat flux compared with precipitation and the soil moisture change.
(Kimura, R.: *SOLA*, 12, 175-180, 2016)

安田 裕 (水文学)

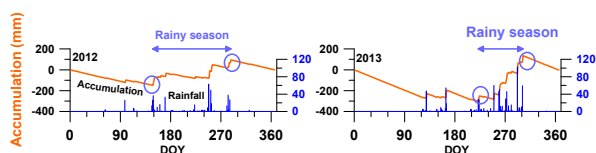
乾燥地での最大の問題は、きわめて単純で、水がないことである。この乾燥地で最重要である水につき研究を行ってきた。

1. スーダン東部 Kassala において、リモートセンシング解析と Ground truth を行い、外来侵入樹種メスキートの拡散過程を解析した。メスキート高密度域は、特定範囲の空間平均土壌水分に対してガウス分布を示していた。生物種拡散統計モデルの構築を行った。

2. モンゴル全土の降雨量時系列につき、全球海水面温度 (Global Sea Surface Temperature: GSST) とのテレコネクションを解明した。内陸国モンゴルの降雨量時系列は太平洋の特定海域との間に有意な相関を示した。このような相関をニューラルネットワークに適用し、予測モデルを開発した。

3. ミャンマー中部乾燥地域の月平均降雨量分布は、前雨季、後雨季のダブルピークを示す。それぞれの雨季降雨量の経年時系列は全球海水面温度 (SST) とリンクを持ち、数ヶ月前の SST と雨季降雨量の相関は 0.6 以上であった。SST からの雨季降雨量の予測モデルの開発が示唆されている。また、日雨量データから雨季の期間を同定した。年ごとに大きく変動していた。降雨量予測に基づく最適農法策定が期待される。

4. 乾燥地の土壌は非均一性が強く移動現象をダイナミクスで評価することは困難である。本件研究にあって、エジプト北東部で浸透実験が実施され、結果をフラクタルの一種である Diffusion Limited Aggregation (DLA) モデルで解析した。モデルパラメーターの最適同定には遺伝子アルゴリズムが用いられた。移動現象は著しい非均一性を呈していた。また、土壌特性により、移動現象は大きな差異を示していた。DLA により断面平均浸透を再現できた。



Hiroshi Yasuda (Assoc. Prof., Hydrology)

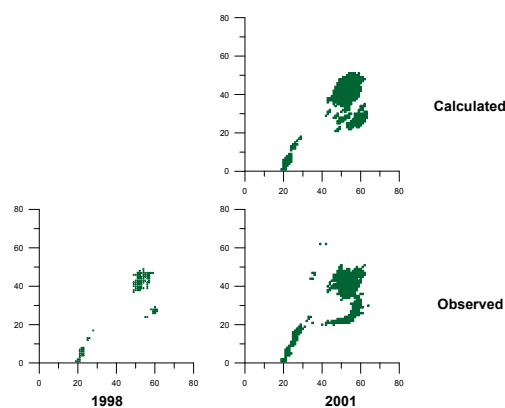
Most serious problem in arid land is quite simple. There is not water. I have worked for water problem for this fiscal year.

1. In Kassala of east Sudan, remote sensing analysis and land truth were performed to evaluate the dispersion process of alien plant species, mesquite. Region corresponding to high density of mesquite spread indicated the Gaussian distribution for soil moisture in a specific range. Construction of a statistical numerical model for biological species dispersion has been completed.

2. Teleconnection of rainfall time series over all Mongolia with Global Sea Surface Temperature (GSST) was clarified. There are significant correlations of the rainfall time series in inland Mongolia with SST over the Pacific Ocean. Links of the significant correlations were applied to the Artificial Neural Network and a rainfall prediction model was developed.

3. The monthly average rainfall of the dry area in the central Myanmar indicates double peak, the early monsoon and late monsoon. There are links of the inter-annual rainfall time series of the rainy season with GSSTs. A prediction model using the links is suggested. The rainy season was identified by daily rainfall data. The rainy season showed large fluctuation every year. Planning of the optimum farming is expected.

4. Since heterogeneity of soil property is so predominant in arid land, the transport phenomenon is difficult to be evaluated by dynamic models. In this study infiltration experiments were conducted in the northeastern Egypt and results were analyzed by a Diffusion Limited Aggregation (DLA) model, one of fractal model. For the optimization of the parameters the Genetic Algorithm was applied. The transportation process indicated apparent heterogeneity. There were great different on the transportation phenomena due to soil properties. The DLA model reconstructed the infiltration in the horizontal average.



Numerical simulation of mesquite spread in Sudan. A two dimensional statistical model was applied.

伊藤 健彦 (動物生態学)

動物生態学分野では、乾燥地に生息する動物の生態学および生態系や生物多様性の保全を中心的課題としている。とくにモウコガゼルやアジアノロバなどの中央アジアに生息する大型野生草食動物の生態学的・保全学的研究に力を入れている。衛星追跡や衛星画像解析、地理情報システム (GIS)、現地環境調査等を組み合わせて、大型野生動物の長距離移動の実態や移動・生息地選択要因の解明、野生動物への気象条件の年変動や、人間活動の影響の評価等を行っている。

本年度は、環境の予測可能性と不均一性を考慮した野生動物にとっての重要地域検出を目指したプロジェクト、モンゴル西部のアルタイ山脈に生息するユキヒョウの保全生態学的研究、モンゴルの伝統的食品である馬乳酒生産に使われる家畜ウマの行動学的研究、鳥取砂丘の野生動物研究手法開発を推進した。

本年度はとくに以下の研究で成果を得た。

1. モンゴルの長距離移動有蹄類の保全生態学的研究: 昨年度衛星追跡を開始したモウコガゼル個体は秋に南、春に北への約 300 km 直線的に移動した。これは、モウコガゼルの移動に記憶や方位認識能力が重要である可能性を示唆する。本年度秋には、昨年と同じ地域でモウコガゼル追跡個体の補充にも成功した。また、モウコガゼルの年間行動圏面積の地域差に関する論文を出版した。
2. ユキヒョウの保全生態学的研究: モンゴル西部のアルタイ山脈で、糞 DNA 分析を用いたユキヒョウの個体数推定および個体群間の遺伝的交流に関する研究のため、アルタイ山脈の複数の地域で糞サンプル採集を実施した。
3. 馬乳酒生産用ウマの行動研究: モンゴルの馬乳酒名産地における、馬乳酒生産用ウマの移動距離や行動圏が日中と夜間で大きく異なることとその要因を明らかにした。
4. 鳥取砂丘の動物研究: 地上での自動撮影カメラ観測による、現時点の中大型哺乳類相とその相対密度を明らかにした。無人航空機 (ドローン) に赤外線カメラを搭載したシステムでの観測で、夜間でも熱画像による大型動物検出と種判別が可能であることを確認した。



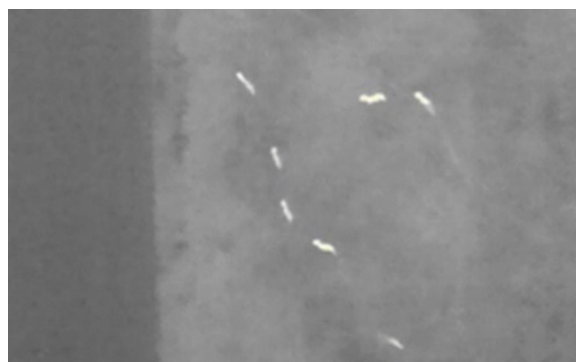
A group of Mongolian gazelles in Mongolia's steppe.

Takehiko Ito (Assist. Prof., Animal Ecology)

The Animal Ecology Subdivision conducts researches on the ecology of wild animals and conservation of ecosystems and biodiversity in drylands. Main targets are ecological and conservation studies on wild large herbivores, such as the Asiatic wild ass and the Mongolian gazelle, inhabiting central Asia. We combine satellite tracking of animals, remote sensing, geographic information systems (GIS), and field observations to analyze factors of their habitat selection and movements, and influences of climate fluctuation and impacts of human activities on wildlife.

We conducted following projects in this fiscal year; detection of important areas for wild mammals in Mongolia by evaluating habitat predictability and heterogeneity, conservation genetic research on snow leopards, behavior analysis of domestic horses for traditional fermented horse milk in Mongolia, and method development of researches on wild mammals in Tottori Sand Dunes. In the fiscal year, we obtained results on the following researches:

1. Conservation ecology on long-distance movement ungulates in Mongolia: The tracked gazelles linearly moved about 300 km from north to south in autumn and came back to the same area in spring, suggesting importance of memory or navigation ability for their movements. We added more tracked gazelles in this fiscal year in the almost same area with the last fiscal year. A paper on regional difference of gazelles' annual home range size was published.
2. Conservation ecology on snow leopards in Mongolia: We collected snow-leopard fecal samples for DNA analysis in the several habitats of snow-leopard regional populations in Altay Mountains.
3. Behavioral study on domestic horses for *airag* production: We revealed the great differences of horse movements between daytime and nighttime and its factors in a famous area for high-quality *airag* in Mongolia.
4. Research on wild animals in Tottori Sand Dunes: We researched the fauna and relative abundance medium- and large-mammal using camera traps. Animal monitoring system using an unmanned aerial vehicle (UAV, drone) with a near-infrared camera was adopted, and we confirmed possibility of detection and species discrimination of large mammals even at night.



A group of deer detected by a thermal infrared camera on drone at night in Tottori, Japan.

3) 農業生産部門

辻本 壽 (分子育種学)

気候変動下で増加する人口のための食糧の生産は、人類にとって大きな課題である。不良な環境下でも生育できる作物品種の開発は、この問題に対する重要な解決策の一つである。私達は、コムギ近縁野生種の遺伝子プール内にストレス耐性を提供する遺伝子を探しており、その遺伝子を利用してストレス耐性コムギの品種を作り出そうとしている。

コムギ近縁野生種には、コムギが育つことができない乾燥、高温、塩害土壌など、非常に過酷な条件下で生育するものがある。したがって、これらの種は、ストレス耐性コムギ育種のための遺伝子を保有することが期待される。役立つ機能をもつ野生遺伝子を見出すためには、栽培種と野生種の形態学および生態学的な差異を超えて正確にその性能を評価する必要がある。

私達は、種々の合成六倍体コムギとこの栽培品種との間の交配および戻し交配によってパンコムギ品種「農林 61号」の多重合成コムギ派生 (MSD) 集団を開発した。集団内の植物の性質は「農林 61号」に類似しているが、これら個々の植物は、野生種であるタルホコムギから様々な染色体部位を保有している。

私達は、この集団をスーダンの様々な高温環境に栽培し、高温耐性遺伝子型を選抜した。選抜された遺伝子型のいくつかは、「正常」環境よりも高温環境下でより優れた生理的および農業形質を示した。他のストレスについてもMSD集団を評価し、耐性系統が選抜された。

選抜された耐性系統および集団の多数の植物にDNAマーカーを割り当て、有用な形質を支配する染色体位置を解明しようと試みている。また、ストレス条件下での生理的および分子的パラメータを用いた耐性メカニズムの解明を目指している。選抜された植物材料は、耐性コムギ育種プログラムにとって貴重な遺伝資源であり、その遺伝学および生理学的情報は、実際の育種プログラムにおけるストレス耐性植物の正確な選抜を可能にするものである。



Collaborative research with Sudan Agricultural Research Corporation about wheat salinity stress tolerance

3) Agricultural Production Division

Hisashi Tsujimoto (Prof., Molecular Breeding)

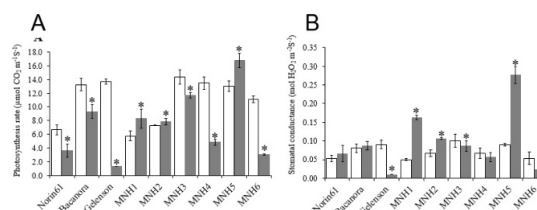
Production of foods for the increasing population under the changing climate is a big challenge for humankind. Development of crop varieties that can grow even under inadequate environments is a reliable solution to this question. We are looking for genes that provide stress-tolerance within the gene pool of the wheat-related wild species and trying to utilize the genes to produce stress-tolerant wheat varieties.

Some wheat-related wild species can grow under very harsh conditions, such as dry, hot and saline soil where wheat cannot grow. Thus, these species are expected to carry genes for stress-tolerant wheat breeding. In order to find out the wild genes with useful function, we need to evaluate the performance correctly beyond the morphological and ecological difference between cultivated and wild species.

We developed Multiple Synthetic Derivative (MSD) population of a bread wheat cultivar 'Norin 61' by crossing and backcrossing between various synthetic hexaploid wheat and this cultivar. The nature of the plants in the population are similar to 'Norin 61', but each plant possesses various chromosome segments from the *Aegilops tauschii*, wild species.

We cultivated this population in hot environments in Sudan and selected heat stress-tolerant genotypes. We found that some of the selected genotypes showed better physiological and agronomical performance under hot environment than 'normal' condition. The MSD population was also evaluated for the other stresses, and tolerant lines have been isolated.

We allocated a large number of DNA markers to the selected tolerant lines and the plants in the population and trying to elucidate the chromosome locations governing the useful traits. In addition, we are working to reveal the mechanism of the tolerance using physiological and molecular parameters under stress conditions. The selected plant materials are valuable genetic resources for tolerant wheat breeding program, and the genetic and physiological information will enable the accurate selection of stress-tolerant plants in actual breeding programs.



Photosynthetic rate (A) and stomatal conductance (B) of six wheat genotypes under heat stressed condition. The selected genotypes with the chromosome segments of a wild species showed better performance under the heat-'stressed' condition than a standard environment for wheat growth (Elbashir et al. 2017, Breeding Science)

藤巻 晴行 (乾燥地灌漑排水学)

乾燥地灌漑排水分野では、乾燥地・半乾燥地における節水灌漑と灌漑に伴う塩類集積の対策に取り組んでいる。昨年度は、主として以下の研究に取り組んだ。

1) 限界地プロジェクト予算による「パレスチナ西岸地区におけるウォーターハーベスティングによる食料安全保障の強化」。ラマラ市郊外の傾斜地に土壌水分および流出モニタリングシステムを設置するとともに、ビニールシートを用いたウォーターハーベスティングシステムを設置し、観測および栽培実験を行った。

2) 国際乾燥地研究教育機構予算による「パレスチナにおける下水処理水および脱塩処理水を利用した熱帯果樹栽培」。ジェリコ市の下水処理場内に実験圃場を設置し、マンゴーを供試作物とする灌漑実験を行った。

3) 限界地プロジェクト予算による「植物の生長モデルと天気予報を用いた灌漑水量の決定」に関する研究。センター内砂地圃場でサツマイモを、ヨルダンとモロッコで小麦を供試作物とする灌漑実験を行った。いずれも2次元の点滴灌漑水量決定シミュレーションモデル WASH_2D を実験に適用した。

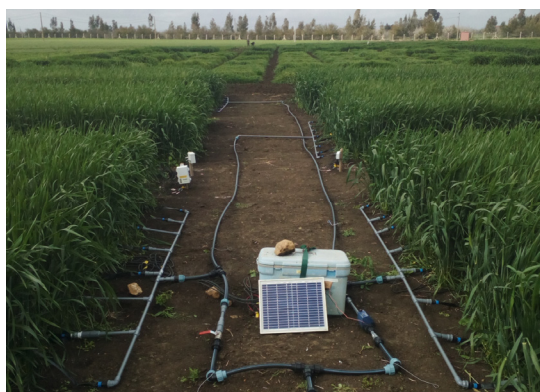
4) 国際乾燥地研究教育機構予算による「撥水性を有する灰の混入による流出率の向上」。撥水性を有する灰を表層に混入することにより、流出率がどの程度向上するかを圃場実験により調べた。

5) 限界地プロジェクト予算による「キャピラリーバリアによる砂丘圃場における保水性の向上」。砂丘圃場にキャピラリーバリアを敷設し、ラッキョウとサツマイモを無灌漑で栽培した。

6) 住友電工との共同研究「サンドポニックスおよび底面給水栽培システムの水管理および塩分管理に関する研究」。センター内のビニールハウスでトマトを供試作物とする灌漑実験を行った。

また、以下の海外活動を行った。

1. 「パレスチナ西岸地区におけるウォーターハーベスティングによる食料安全保障の強化」の遂行のためのパレスチナ出張 (3回、のべ20日)
2. 限界地プロジェクトに係る灌漑実験のためのヨルダンおよびパレスチナ出張 (3回、のべ20日間)
3. 限界地プロジェクトに係る灌漑実験のためのヨルダンおよびパレスチナ出張 (2回、のべ13日間)



Automated irrigation system in an experiment in Morocco

Haruyuki Fujimaki (Prof., Irrigation and drainage)

The subdivision of irrigation and drainage in dryland studies on water-saving irrigation and salinity management associated with irrigation.

The main research activities in the fiscal year were as follows:

1) “Enhancing Food Security using water harvesting in West Bank of Palestine” as an activity of husbandry group under the “Project Marginal Land”. Experiments using a monitoring system for soil moisture and runoff and water harvesting system in a slope in suburb of Ramallah were carried out.

2) “Tropical fruit tree cultivation using sewerage treatment water and desalination processing water in Palestine”, as an activity under IPDRE. An irrigation experiment for Mango was performed in Jericho municipal wastewater treatment plant.

3) Determination of irrigation depths using a numerical model and quantitative weather forecast as an activity of husbandry group under the “Project Marginal Land”. Irrigation experiments using sweet potato was carried out in ALRC. We also carried out an irrigation experiment using wheat in Jordan and Morocco. Two dimensional simulation model for determining irrigation depth of drip irrigation, WASH_2D, was applied to the experiments.

4) “Enhancing runoff using a water repellent ash.”, as an activity under IPDRE. Field experiment to compare run-off ratio was carried out in Jordan.

5) Enhancing water holding capacity using a capillary barrier as an activity of husbandry group under the “Project Marginal Land”. Rakkyo (Japanese variety of garlic) and sweet potato was grown above capillary barrier without irrigation in ALRC.

6) Water and salinity management for a sand-ponics and an upward irrigation system as a cooperative research with Sumitomo Electric Industry. Irrigation experiments using Tomato were carried out in ALRC.

Overseas research activities during the fiscal year were:

1. visits to Palestine for three times for topic 1 and 2.
2. visits to Jordan for three times for topic 3 and 4.
3. visits to Morocco for twice for topic 3.



Fababean in the experimental field in the West Bank

安 萍 (植物生理生態学)

植物生理生態学分野では、乾燥地における植物や作物の生理生態学と適正栽培技術の開発を中心的課題としている。特に、植物と作物の環境ストレス応答とその耐性機構の解明、乾燥地農業における水利用効率向上技術の開発、作物の塩および乾燥ストレス緩和技術の開発などに力を入れている。これらの研究は国内における基礎研究と国外での乾燥地の現場における応用研究を組み合わせた研究を進めている。また、砂漠と砂漠化地域において植物の分布と土壤環境を調査し、分布の特性から植物と土壤との相関関係を解明する研究も重点的に取り組んでいる。この研究は、砂漠及び砂漠化地域の植生回復に相応しい緑化用樹種・草種の選定、栽培方法の確立などの策定に役立ち、さらに、生態系の環境維持に重要な役割を果たす植物や経済的に価値の高い植物を発見した場合、これらの植物の生態生理特性を解明し、農業利用に適切な栽培技術を開発している。具体的には、以下の課題について進めている。

1. トマト、ワタおよび塩生植物の耐塩性機構の解明。
2. 作物の根の特性と環境ストレス耐性との関係の解明。
3. 経済価値の高い塩生植物の栽培技術開発。
4. 塩水灌漑による栽培技術の開発。
5. 中国の砂漠と砂漠化地域における植物の分布調査。
6. 根の細胞壁の化学性・物理性と作物の耐塩性の関係の解明。

本年度、国外での共同研究のため、中国科学院遺伝与發育生物学研究所農業資源研究センターを訪問し、共同研究として、中国渤海湾沿岸の塩性土壤を視察し、非均一塩性条件下での植物成長実験を行った。また、中国河北省林業科学院との共同研究「長根苗を利用した砂地での植林技術の開発」および中国科学院植物研究所との共同研究「中国北部における植生と環境との関係の解明」を本年度も引き続き取り組んだ。また、本センター特定共同研究「中国極乾燥地民勤オアシスにおける環境保全型農業の生産性向上に関する研究」を推進するため、中国科学院寒区乾区環境与工程研究所を訪問し、現地協力研究者と一緒に実験を行った。対象植物は下の写真に示したブラックゴゴジベリーとアカザ科の植物である。



Lycium ruthenicum grown in the desert area of China. It is a species with high tolerance to salinity and drought. Our lab is studying the properties of root cell wall in relation to the salt tolerant mechanisms of this plant.

Ping An (Assoc. Prof., Plant Eco-physiology)

The Plant Eco-physiology Subdivision conducts researches on the elucidation of eco-physiological characteristics of plants and crops and development of appropriate cultivation technology in arid lands. Particular efforts are being made to clarify the responses of plants and crops to environmental stresses and relevant mechanisms. The purpose of the studies is to develop cultivation technology for enhancement of water use efficiency and mitigation of drought and salinity stresses in dryland agriculture. The studies combined the basic research in Japan using the ALRC's facilities and applied research at real fields in drylands. Besides, plants distributions in deserts and desertified areas are also the focus of the studies. By knowing the interactions of plants and environmental conditions, measures for vegetation recovery in desertified areas would be established. Special plants that have important ecological functions or potentially economic value would be further investigated. The current studies are:

1. Salt tolerance mechanisms in tomato, cotton and halophytes;
2. Relationship between root and plant salt tolerance;
3. Development of cultivation techniques of halophytes with high economic value;
4. Application of saline water for crop irrigation;
5. Vegetation distribution in the desertified areas of China;
6. Relationship between the chemical and physical characteristics of root cell wall and salt tolerance in crops.

Overseas research activities during the fiscal year 2016 include several visits to the institutions of China. 1) Center for Agricultural Resources Research of the Institute of the Genetics and Developmental Biology, Chinese Academy of Sciences (CAS). This visit was to conduct a field survey and an experiment of plant growth under heterogeneous salinity. 2) Hebei Academy of Forestry Science. This visit was to investigate the growth of long-root seedlings planted in the sandy area of Hebei Province. 3) Institute of Botany of the CAS. This visit was to continue the field investigation of the vegetation in the desertified areas of north China. 4) Cold and Arid Regions Environmental and Engineering Research Institute, CAS. This visit was to continue the project about sustainable agriculture development in Minqing Oasis.



Kalidium foliatum grown in Badain Jaran desert of China. It is a species with high tolerance to saline-alkali soil. Our lab is studying the salt tolerant mechanisms of this

エリタイブ ハボラ E. アミン(植物遺伝子工学)

不規則で不十分な降雨、頻発する干ばつや気温上昇などの気候変動は、特に乾燥地や半乾燥地の食糧安全保障を脅かしている。このような環境的制約に関わらず、急増する世界人口に対する十分な食糧を確保するために、農業生産量を増加させることが必要である。この問題に対処するに当たり、最先端の生物工学と従来の伝統的な作物向上法の統合的な活用が必要不可欠である。

植物遺伝子工学分野では、(1)好ましくない生育環境への耐性又は適応能力の増強に有用な新奇遺伝子の同定と活用、(2)乾燥や塩害に代表される、環境的ストレス耐性の遺伝子機構解明を徹底的に研究している。実験には、ソルガム(*Sorghum bicolor*)やイネ(*Oryza sativa*)のような重要栽培作物や、タバコ(*Nicotiana tabacum*)やシロイヌナズナ(*Arabidopsis thaliana*)などのモデル実験植物を使用している。

平成 28 年度は、国際半乾燥地熱帯作物研究所(ICRISAT)、アメリカ合衆国農務省(USDA)、スーダン・農業研究機構(ARC)からユニークなソルガム系統種を収集することができた。これらの系統種を、乾燥条件化で精密に評価し、ステイ・グリーン(SG)形質を持つ系統種を同定した。ステイ・グリーン形質は、水不足条件でも枯れない特性のことであり、ソルガムの天水栽培に重要な形質のひとつである。ステイ・グリーン形質を持つ系統種は乾燥適応ソルガム品種の育種にとって重要な遺伝源を持っている。更に、乾燥地研究センターの出資により、東京大学と共同で、ステイ・グリーン形質を持つソルガム系統種のゲノム解析を実施した。

植物遺伝子工学分野の国際的活動としては、スーダン・農業研究機構とJSPS二国間交流事業の共同研究・セミナー(平成27~29年)を実施した他、平成28年9月に、スーダン・ワドメダニに於いて第二回「乾燥地での持続可能な農業生産のための穀物遺伝子改良国際研修会」を実施した。



Screening sorghum plants under drought conditions and identification accessions with of stay-green trait.

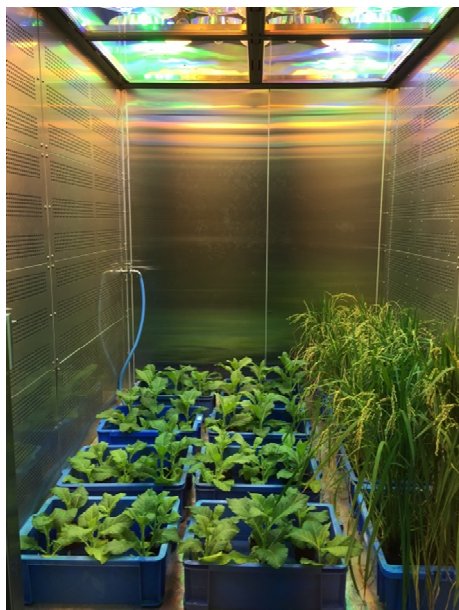
Amin E. Eltayeb Habora (Assist. Prof., Plant Genetic Engineering)

The effects of climate change in term of less and erratic rain fall, recurrent drought and rising temperatures are threatening food security, particularly in arid and semi-arid regions. Despite these environmental constraints, increasing agricultural production is essential to keep pace with the rapidly growing world population. This situation necessitates the integration of the most advanced biotechnologies with conventional and traditional crop improvement strategies.

The Plant Genetic Engineering Subdivision is conducting an in-depth research to (1) identify and utilize novel genes that contribute to the plant tolerance and adaptation to unfavorable growth conditions, and to (2) clarify the genetic mechanism of the plant's tolerance to major environmental stresses such as drought and salinity. I carry research on important cultivated crops such as sorghum (*Sorghum bicolor*) and rice (*Oryza sativa*), as well as model plants such as Tobacco (*Nicotiana tabacum*) and Arabidopsis (*Arabidopsis thaliana*).

During the fiscal year 2016, unique collection of sorghum accessions were introduced from The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the United State Department of Agriculture (USDA) and the Agricultural Research Corporation (ARC), Sudan. This collection was precisely evaluated under drought conditions, and several sorghum accessions that possess the Stay-Green (SG) trait have been identified. The SG trait is the ability of the plant to remain green under water shortage conditions, and it is considered an important trait for sorghum production under rainfed cultivation. The identified accessions represent valuable genetic sources to breed for drought adapted sorghum varieties. Furthermore, a joint-research with the University of Tokyo, funded by the ALRC has also been conducted during last year to investigate the genome of stay-green sorghum accessions.

Internationally, the Plant Genetic Engineering Subdivision continues to effectively manage the JSPS Bilateral open partnership for research/seminar (2015-2017) with the ARC of Sudan, and has successfully organized The 2nd International Workshop on Genetic Improvement of Cereals for Sustainable Production in Arid Lands² in September 2016 in Wad Medani city, Sudan.



Transgenic plants grown inside fully controlled and contained growth chambers.

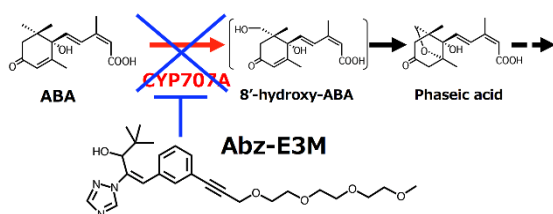
岡本 昌憲 (植物分子生物学)

陸上植物は動物と異なり、いったん発芽してしまうと、環境が悪化しても違う場所へ移動することができない。そのため、植物には様々な環境ストレス(乾燥、高塩、高温、低温ストレスなど)に対する防御システムを備えている。当研究室では、モデル植物であるシロイヌナズナや重要作物であるコムギ等を用いて、ストレス耐性の分子機構を様々な実験手法を駆使して解明することを目標としている。得られた知見を乾燥地における栽培作物に応用し、作物のストレス耐性向上に結び付けられるように多角的なアプローチをとって研究を進めている。現在、以下に示す研究を進めている。

- ・乾燥ストレス耐性を向上させる化合物の探索とその応用
- ・選択的アブシジン酸(ABA)アゴニストを用いた化学遺伝学的手法による ABA 受容体の機能解析
- ・選択的 ABA アゴニストを用いた新奇 ABA シグナル因子の探索
- ・ストレス環境下における mRNA 代謝制御の分子生理学的解析
- ・ストレス環境下におけるアントシアニン・フラボノイド生合成制御因子の分子生理学的解析
- ・遺伝子として未登録の領域に存在するスモールペプチド(sORF)の機能解析
- ・ABA 受容体を利用した乾燥耐性作物の創出
- ・合成コムギ系統からの乾燥・高塩ストレス耐性系統の選抜と分子生理学的解析

これらの研究は、カリフォルニア大学リバーサイド校、トロント大学、理研、九州工業大学、静岡大学、作物研究所などの研究機関と共同で研究を行っている。本年度は以下に示す成果を得た。

- 1.炭素安定同位体比測定、ABA 感受性試験と収量評価を組み合わせ、節水型耐乾性コムギの選抜に成功した。
- 2.ABA 不活性化酵素を阻害する化合物 Abz-E3M の投与によりトウモロコシの ABA 応答性遺伝子の発現が上昇することが明らかになった。
- 3.シロイヌナズナ転写因子 NIN-like protein 8 が硝酸にตอบสนองして ABA 不活性化酵素 CYP707A2 の遺伝子発現を誘導し、種子内の ABA 量を減少させ、発芽促進に関与している事が明らかとなった。



ABA catabolic enzyme is an attractive target for regulating the endogenous ABA levels in plants. Abz-E3M inhibits CYP707A2, which is a key enzyme for ABA catabolism, and its treatment confers drought tolerance in plants.

Masanori Okamoto (Assist. Prof., Plant Molecular Biology)

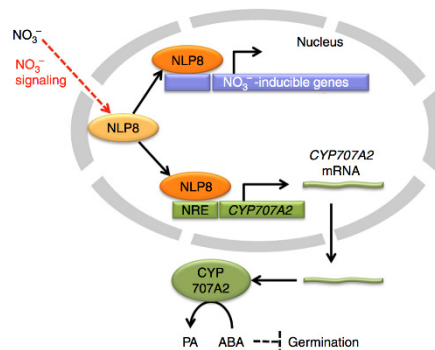
Higher plants are sessile organisms. Therefore, plants have complex defense system for various environmental stresses (cold, drought, heat and high salt stresses). In our laboratory, main goal is to elucidate molecular mechanism for stress responses using Arabidopsis or wheat as plant materials. Additionally, our task is that given knowledge applies to cultivated crops in semi-arid land region in order to develop stress tolerant crops. We are conducting research with multiple approaches using molecular biology, biochemistry, genetics and physiology. The followings are current main researches in our laboratory.

- ・ Screening and application of agrochemical that controls drought stress tolerance.
- ・ Functional analysis of abscisic acid (ABA) receptors by selective ABA agonist.
- ・ Identification of novel ABA signaling mutants by chemical genetic screening.
- ・ Molecular and physiological analysis of mRNA metabolic proteins in response to heat stress.
- ・ Molecular and physiological analysis of key factor for anthocyanin biosynthesis under the drought stress.
- ・ Functional analysis of small open reading frames (sORFs; 30-100 amino acids), which exist in the intergenic region.
- ・ Generation of drought tolerant wheat by using ABA receptor.

These researches are being conducted with UC Riverside, Toronto University, RIKEN, Kyushu Institute of Technology, Shizuoka University and NARO Institute of Crop Science.

The followings are highlights in this fiscal year.

1. We have isolated water-saving drought tolerant wheat by multiple analysis combined with stable *carbon isotope ratio analysis*, *ABA sensitivity test* and *yield evaluation*.
2. Treatment of Abz-E3M induced stomatal closure and improved drought tolerance in *Arabidopsis*. In addition, Abz-E3M also increased the ABA response in rice and maize. These results indicate that Abz-E3M is a more practical and effective inhibitor of CYP707A.
3. We have revealed that NIN-like protein (NLP8) induce expression of CYP707A2 gene, which is a key enzyme for ABA catabolism, reduces ABA levels and promotes seed germination in nitrate-dependent manner.



Nitrate activates NLP8 post-translationally, which facilitates DNA binding to the nitrate responsive elements (NREs) in the promoter of CYP707A2. Nitrate-induction of CYP707A2 decreases the ABA content, which promotes seed germination.

妻鹿 良亮 (植物分子生物学)

世界の陸地の約4割が乾燥地であり、年間降雨量が少ないために耕作不可能に陥っている乾燥地での耕作を可能にすることは、世界的に逼迫してくる食糧問題の解決に大きく貢献できる。植物の耐乾性の向上はこの問題を解決することができる重要なアプローチの一つである。

植物の耐乾性にはアブシジン酸 (ABA) が密接に関わっており、ABA 受容体の過剰発現により ABA に対する感受性が高まり、耐乾性が向上する。ABA は植物に普遍的に存在する適合溶質の一つであり、耐乾性作物の創出には ABA 受容体の利用と応用が適していると考えられる。しかし、世界の主要作物の一つであるコムギのゲノムデータベースは未だ十分に整備されておらず、ABA 受容体がほとんど同定されていない。そこで、本研究ではコムギの ABA 受容体 (TaPYL) を同定し、それを過剰発現したコムギ (TaPYLox) を作出した。TaPYL の機能解明により、水の少ない乾燥地でも栽培可能な作物育種への応用も期待される。TaPYL を利用した耐乾性の向上を軸に、乾燥地に適した形質を持つコムギをデザインするため、以下の内容で研究を進めている。

- ・ コムギゲノムに存在する TaPYL の探索
- ・ 生化学的解析による TaPYL の活性の確認
- ・ TaPYLox の生理学的解析
- ・ TaPYLox のトランスクリプトーム解析
- ・ TaPYLox に似た形質を持つ野生品種の探索

本年度は、特に以下の研究で成果を得た。

1. TaPYLox は水の使用量が少ないだけでなく、水 1L から得られる種子収量が向上しており、少ない水でより多くの収量が得られることを示した。
2. トランスクリプトーム解析により、水が潤沢にある条件でも、TaPYLox における ABA 応答性遺伝子の発現レベルが高いことを示した。
3. 同位体比質量分析計 (IR-MS) を用いた実験により、 ^{13}C が TaPYLox では蓄積しやすいことを示した。このことは、TaPYLox が少ない蒸散量で生育していることを示唆している。

本研究では、TaPYLox は水を節約して収量を向上させる、節水型耐乾性形質を持つことが示された。また、ABA 応答性遺伝子の発現レベルが高いことから、TaPYLox は常に乾燥ストレスに応答した状態を維持していると考えられる。

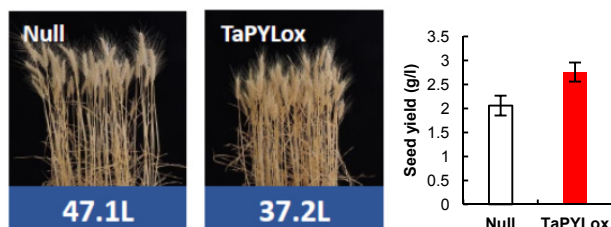


Fig.1. Photographs of Null and TaPYLox (Left and Middle). The under value indicates their water consumption volume. Seed yield produced from 1L of water of Null and TaPYLox is shown (Right bar graph).

Ryosuke Mega (Specially-appointed Assistant Prof., Plant Molecular Biology)

Arid area is known to occupy approximate 40% of land in the world. Improvement of drought stress in plant enables many arid areas due to little rain fall to convert arable in the world. Enhancement of plant drought tolerance can greatly contribute to solve the food problem that is becoming worldwide serious.

Abscisic acid (ABA) is closely involved in drought tolerance. ABA receptor overexpression improves ABA hypersensitivity to enhance drought stress tolerance of plant. Since ABA receptor exist universally in plant, utilization and application of ABA receptor can contribute to generate drought tolerant crop. Although wheat is one of important staples, few ABA receptors has been identified due to the incomplete genome database. In this study, we characterized wheat ABA receptors (TaPYLs) and generated TaPYL overexpressing wheat (TaPYLox). A set of functional analyses on TaPYLs is expected to be applied to crop breeding to generate cultivar that survive under strict drought environment. We are developing wheat suitable for arid land based on improvement of drought stress tolerance utilizing TaPYL as follows.

- ・ Screening of TaPYL genes of wheat genome
- ・ Biochemical analysis of TaPYLs
- ・ Physiological analysis of TaPYLox
- ・ Transcriptome analysis of TaPYLox
- ・ Search for ABA hypersensitive wild type wheat cultivar

The followings are highlights in this fiscal year.

1. Not only TaPYLox showed less water consumption, but improved seed yield produced from 1L of water compared with non-transgenic line (Null), suggesting that TaPYLox showed more yield by using less water (Fig. 1).
2. Transcriptome analysis showed that ABA responsive gene in TaPYLox is higher than Null even under well-water condition (Fig. 2).
3. IR-MS analysis showed that TaPYLox accumulated more ^{13}C rather than Null, suggesting that TaPYLox had lower transcription (gas exchange) activity (Fig. 2).

Our research demonstrated that TaPYLox improved seed yield with less water consumption, so called “water-saving drought tolerance”. And higher expression of ABA responsive gene in TaPYLox suggests that TaPYLox constitutively sustains the state responsive to drought stress.

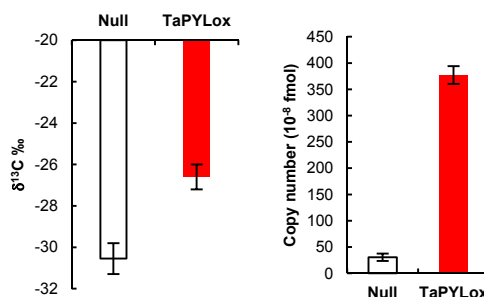


Fig.2. The left bar graph indicates $^{13}\text{C}/^{12}\text{C}$ ratio ($\delta^{13}\text{C}$) of Null and TaPYLox. The right one shows the transcript amount of LEA, which is one of ABA responsive gene.

山本 福壽 (特任教授・樹木生理学)

以下の研究は、平成 26～28 年度科学研究費補助金 (基盤研究 B) 「樹幹の菌感染防御システムの解明と抗菌物質の生成制御に関する研究 (山本福壽代表) (課題番号 26292086) によって行われた。

(1) *Aquilaria crassna* の沈香生産制御に関する研究

2016 年度は、4 月 17 日 (日) から 4 月 29 日 (金) までベトナム民主共和国とミャンマー連邦共和国を訪問、また 11 月 28 日 (月) ～12 月 4 日 (日)、2017 年 1 月 4 日 (水) ～1 月 13 日 (金)、さらに 3 月 1 日 (水) ～3 月 7 日 (火) までベトナム民主共和国を訪問し、*Aquilaria crassna* 樹の沈香生産に関する基礎的な研究を行った。この研究の方法および結果は、国際的な競争による新技術の漏洩と特許の申請を考慮して公表を差し控える。

(2) *Acacia* 属樹種のアラビアガム生産促進技術の開発

2016 年度は 10 月 31 日 (月) ～11 月 10 日 (木) および 12 月 10 日 (土) ～12 月 18 日 (日) の 2 回にわたってスーダン共和国の EIObeid 市を訪問し、*Acacia Senegal* および *A. sayal* のアラビアガムの生産促進技術の開発実験を行った。実験には Kordofan 大学のアラビアガム研究所の協力を得た。対象樹種として構内に植栽されている *A. Senegal* と *A. sayal var. sayal* とを用いた。2016 年 11 月 3 日、樹幹に皮ポンチを用いて剥皮傷を与え、塗布薬としてエスレル (Et)、ジャスモン酸メチル (MJ) のアラビアガム (AG) 40% ペーストを用いた。処理区は ① Control (AG のみ) ② Et 1% ③ MJ 1% ④ Et1% + MJ1% の計 4 処理であった。ガムの溢出量の観察と計量は 4 日後の 11 月 7 日に行った。この結果、*A. sayal var. sayal* はエスレルを含む処理区で顕著なガム溢出の促進が認められた。これに対してジャスモン酸メチルの効果は顕著ではなかった。このことからこの樹種のアラビアガム生産にはジャスモン酸よりもエチレンが中心的な役割を果たしていることがわかった。これによりアラビアガムの生産促進には比較的安価なエスレルの処理が有効であることが分かった。一方、*A. Senegal* は処理に対してまったく反応を示さず、処理による促進効果は認められなかった。この結果は、*Acacia* 属樹種の傷害応答を考えるうえで極めて興味深い結果であった。なお、前年度の *A. dealbata* は同様の処理によってガム溢出が強く促進されている。これらスーダンの 2 樹種はアラビアガム生産に最も重要な樹種であるが、質の高いガム生産が可能な *A. Senegal* 種のガム生産促進技術開発は、今後の大きな課題であろう。



Gum Arabic exuded from a wound treated with ethrel

Fukuju Yamamoto (Specially-appointed Prof., Tree Physiology)

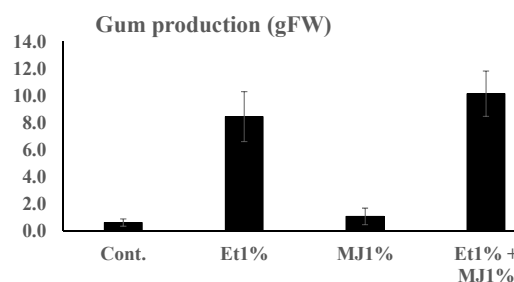
(1) Artificial control of agarwood production in *Aquilaria crassna* trees

Various experiments for clarifying the mechanism of agarwood production in *Aquilaria crassna* trees were performed mainly in Vietnam from April 17 to 29, 2016, from November 28 to December 4, 2016, from January 4 to 13, 2017, and from March 1 to 7, 2017. As a result, fundamental but meaningful data were obtained for the artificial control of agarwood production. However, I would like to withhold the publication of exact methods and results because of the possibility of patent application.

(2) Acceleration of gum Arabic production in *Acacia* species in Sudan

In Republic of the Sudan, Leguminosae woody species including *Acacia Senegal*, *A. seyal var. seyal* and *A. seyal var. fistula* are very important for gum Arabic production. Gum Arabic, which is the dried secretions on the wounded stem surface of those species, is used for sugar coating, emulsifier, powder flavor etc. It is also broadly used as a thickener and stabilizer in food applications and as dietary fiber. There are Senegal type and Seyal type in gum Arabic. In 2016, experiments for the enhancement of gum Arabic production were performed from October 31 to November 10 and from December 10 to 18 in EIObeid, Sudan. Six individuals of each of well-matured *A. Senegal* and *A. seyal var. seyal* were selected as plant materials for the experiment. Small-sized circular bark segments were taken off with a leather punch (15mm in diameter) and a hummer for making stem wounds. Gum Arabic pastes containing plant hormones were applied to the stem wounds. The concentration and combination of plant hormones diluted in 40% gum Arabic solution are as follows: 1) 40% gum Arabic solution as a control; 2) 1% ethrel, an ethylene releasing compound; 3) 1% methyl jasmonate; 4) 1% ethrel plus 1% methyl jasmonate. At the 4th day after treatments, gum Arabic was harvested to determine the quick response of wounds to stimuli of plant hormones.

Within 4 days, the application of gum Arabic pastes containing 1% ethrel significantly accelerated gum Arabic production in *A. seyal* trees, but not in *A. Senegal* trees. The pastes containing methyl jasmonate did not enhance gum production in both species.



Gum Arabic production at the 4th day after the application of plant hormones (fresh weight)

(3) 外国人客員研究員/ Visiting International Researchers

Mubarak Abdelrahman Abdalla Ali (Prof., Soil Chemistry)

October 2015- March 2016

Is H-proton release during N-fixation from some tree and shrub legumes can effectively ameliorate calcareous sodic soils

Prosopis glandulosa is widely distributed in the drylands of Sudan where grows vigorously in degraded lands. In 150 days, we evaluated the phytoremediation potential of a calcareous saline-sodic soil with *P. glandulosa* either relying on N₂ fixation (NFIX) or inorganic N (IN) and gypsum. Jahgaru soil was collected from the Okinawa Prefectural Kyushu Agricultural Research and classified as loamy, siliceous, thermic Typic Udorthents. The soil was made saline-sodic (SAR = 19.9 and EC of 16.0 dSm⁻¹). A filter paper was placed at the bottom of lysimeters and 2 cm height of acid/distilled water washed sand was placed on top of the filter paper. The developed saline-sodic soil was added to the lysimeter (3.0 kg) and packed gently to attain bulk density of 1.2 g cm⁻³. About 5 cm was then left on top for irrigation. The amount of distilled water equivalent to 70% of the soil WHC was added in increments to all lysimeters before sowing. *Prosopis* seeds were sown in the treatments with *Prosopis* and soil moisture content was kept at 70% of WHC. Lysimeters were arranged in a completely randomized design (CRD) with four replications and placed in the Biohazard Green House. After 150 (07/05/2016) days, plants were harvested and plant height was measured, oven dried, weighed, finely blended and analyzed for TC and TN and content of Na⁺, Ca²⁺, Mg²⁺ and K⁺. The soil in each lysimeter was removed, air dried, crushed and sieved. Soil pH_{paste} and electrical conductivity were measured. From each extract, soluble cations (Na⁺, K⁺, Ca²⁺ and Mg²⁺) and HCO₃⁻, Cl⁻, NO₂⁻, NO₃⁻



Fig. 1. Concentration of the roots hairs of *Prosopis* in the lower part

and SO₄²⁻ were determined.

The translocation factor (TF) of the element was calculated as the ratio of the element content in shoots to that in roots. For salinity stress tolerance, the K⁺/Na⁺ ratio in the straw and root was calculated. The SAS (1999) package was used to separate means between treatments whereas differences between N₂ fixing and non-fixing were determined using the T-Test.

Straw and root dry matter of *P. glandulosa* (NFIX) were 60 and 67% higher than of IN, respectively. While both plants retained nearly similar Ca²⁺, the Na⁺ level in straw of IN was 1.8 folds that of NFIX whereas levels of Na⁺ and K⁺ in roots of NFIX were 13% and 24% higher than that of IN plants. NFIX and IN *P. glandulosa* released 39 and 50% Na⁺ of that released by the gypsum. Both *Prosopis* produced significantly higher HCO₃⁻ than the gypsum but of 24% potential Ca²⁺ solubilization of the gypsum. Translocation factor of Na⁺ and the K⁺/Na⁺ ratio in NFIX and IN were 0.58, 0.99 and 13.2, 7.0, respectively. We conclude that NFIX or IN *P. glandulosa* on calcareous salt-affected soils is an alternative practice for amelioration of salt-affected soils.



Fig. 2. Set up of lysimeters with *Prosopis glandulosa*

Xinping WANG (Prof., Soil Physics)

October 2015 – March 2016

Identification of infiltration process in heterogeneous arid soil

Part I Identification of infiltration process in heterogeneous arid soil: dye tracer experiment. Soil water availability is limited by low intrinsic infiltration rate of water into the soil. Knowledge of the mechanisms of water movement in arid soil is of central importance in ecohydrology of the water-limited ecosystems. Characteristics of soil influence strongly the potential for soil moisture replenishment from natural precipitation at a given location under varied surface features. The vegetation itself, however, promotes the rate of infiltration, invoking a positive feedback between increased plant growth and enhanced infiltration. Vegetation improves the structural and water holding properties of the soil by forming root channels, by preventing crust formation through the interception of raindrops, and by stimulation of biological activity in the soil, resulting in higher infiltration rates. The field experiment on the dye infiltration to quantify the effects of dryland ecosystem management on the soil structure and infiltration processes (Figs. 1 and 2).

Part II Identification of infiltration process in heterogeneous arid soil: soil water potential experiment. In dry sandy soil, soil water is naturally redistributed by forces owing to matric, gravitational potential, and temperature gradients. Plant roots serve as conduits for water flow not only from soil to leaves but also from wetter to drier soil. This hydraulic redistribution through root systems occurs in soils worldwide and can enhance stomatal opening, transpiration, and plant carbon gain. Hydraulic redistribution through plant roots facilitates movement of water not only upward but also downward and horizontally along moisture gradients within soils, affecting plant physiology, landscape hydrology, and potentially even climate by moving deep water up to dry shallow layers, where it can support enhanced plant transpiration, and by quickly moving precipitation down into deeper soil layers, where it does not evaporate or run off the landscape.

In the present work, diel soil water potential and soil temperature fluctuation was investigated at hourly intervals for a desert shrub land. The fluctuation was compared to natural redistribution of soil water due to thermal gradients at a bare dune site. The variation patterns in soil water potential are caused by unsaturated zone processes, such as soil vapour movement in response to diurnal temperature gradients. This is evidenced by surface soil layer fluctuating between zero and -140 MPa each day. It is likely that the difference in soil water potentials between the shrub and bare sites are due to the organic matter content of the soils at the shrub stabilized dune site, which is absent from the bare dune site. Soil water potential fluctuations reflected daytime depletion and nocturnal re-supply of water due to hydraulic redistribution.

A typical spatiotemporal heterogeneity of soil water poten-

tial variation was found. The magnitude of daily maximum soil water potential variation exhibited in the directional sequence N, SEE, and SWW at 10 cm depth soil layer. In contrast, it changed to the sequence SWW, N, and SEE at the 25 cm depth, and with a sequence of SEE, N, and SWW at the 75 cm depth at the end of the growing season. In May, the maximum soil water potential variation at 50 and 75 cm depth was in N and SEE direction, respectively. In September, the maximum soil water potential variation at the 10 cm depth changed from N to SEE direction. The variation of soil water potential may reflect the spatial and temporal distribution of root systems.

Our work demonstrates that spatiotemporal heterogeneity of hydraulic redistribution may occur due to the root distribution pattern and the canopy influence on soil thermal status. This reveals that the root extended into different directions laterally that maximize water use and minimize shrub water stress. The spatiotemporal heterogeneity of hydraulic redistribution reflects the mechanisms underlying the ecological adaptive strategy of the desert shrub.

Part III Identification of infiltration process in heterogeneous arid soil: role of event-based rainfall characteristics. Distribution of rainfall event sizes and interval lengths between events are important characteristics of arid and semi-arid climates. Understanding their importance will contribute to our ability to understand ecosystem dynamics in these regions. Rainfall event timing and magnitude are important drivers of ecosystem processes and are instrumental in creating landscape heterogeneity in arid and semi-arid regions. Changing the minimum inter-event time (MIT) from 30 min to 24 h alters the number of rainfall events from 64 to 25 for the event depth larger than 0.1 mm. The mean rainfall intensity declined from 0.95 mm h⁻¹ to 0.53 mm h⁻¹, and the geometric mean event duration rose from 0.55 h to 4.4 h. The number of rainfall events, the mean rainfall intensity, and the geometric mean event duration differed under different criteria of individual rainfall depths. These findings suggest that identification of event-based rainfall in this specific arid region can be better achieved by setting the MIT at six hours. The wide variation in the properties of rainfall events indicated the need for paying more attention to the selection and reporting of event criteria in studies that adopt event-based data analysis, especially in quantifying the effective rainfall for soil water replenishment in terms of rainfall depth and intensity with infrequent rainfall events.

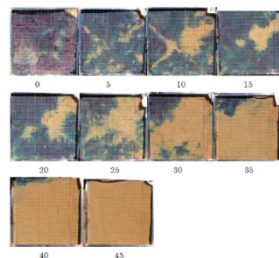


Fig. 1 The original photos at observed depths (cm)

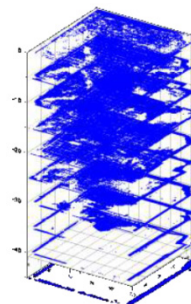


Fig. 2 Heterogeneous transport in arid soil

Awadalla Abdalla Abdelmula Yousif (Prof., Plant Breeding)

April 2016 – March 2017

Genetic, physiological and morphological characterization of Sudanese bread wheat (*Triticum aestivum L.*) varieties under salt and heat stresses

The consumption of wheat is increasing at an increasing rate every year; however, it is exposed to many adverse environmental conditions, such as drought, heat and salinity, which are the main limiting factors of its production. Salinity stress was found to negatively affecting crop yield and restricts the exploitation of agricultural land, under arid and semi-arid conditions, e.g., in Sudan. The main objectives of this study were: 1) to determine genotypic variability of bread wheat for salinity tolerance, using physiological, morphological and molecular markers. 2) to assess the interrelationship between the physiological, morphological and ion-contents traits under salinity. 3) to identify the most appropriate early-stage traits that could be used as selection criteria under salinity. 4) to apply SSRs DNA molecular markers for study of genetic diversity among wheat for salt tolerance.

Ten selected genotypes of bread wheat were screened under hydroponic system at glass house of ALRC- of Tottori University. These genotypes consisted of nine advanced breeding lines and one Sudanese released variety (Zakia). The seedlings of all genotypes were grown in a hydroponic system, and were subjected to three salinity levels (zero, as control, 100 mM and 200 mM of NaCl). During plant growth, two physiological traits; the chlorophyll content and chlorophyll fluorescence were measured, three times, using SPAD and Mini-pam, respectively. Then after harvest, number of tillers/plant, the shoot and root fresh weights were measured. Then the dry shoot and root weights were determined. Chemical analysis in dried detached leaves was conducted to estimate the content of Na, K, Ca, Mg, Cu, Zn and Mn, in mg/g dry matter of leaves, using the Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES), at University of Tottori- Japan.

The results revealed that the effect of salinity was highly

significant and significant for all of the studied physiological, morphological and ionic-content traits. The genotypes exhibited highly significant variability and differential responses to the three levels of salinity for most of the traits. All of the measured screening early-stage growth traits exhibited high estimates of broad sense heritability. Salinity resulted in significant reduction of most of measured traits. In case of ion-content, there was progressive increase in the amount of Na⁺, with increase in severity of salinity, and significant reduction in amount of K⁺ and Mg⁺⁺ with increase of salinity. The genotypes exhibited great variability for the Stress Tolerance Index (STI) for all of these traits. Based on STI, for root and shoot dry weights and ion-content traits, some genotypes could be identified as highly tolerant under severe salinity, such genotypes could be recommended for production under saline soil conditions. Significant associations between these early-stage physiological, morphological and ion-content traits under salinity were observed, which is indicative for efficient indirect selection. The DNA samples extracted from these selected genotypes were used for study of genetic diversity and tolerance to salinity using SSRs molecular markers, where about 35 SSRs primers were screened and most of these primers were found polymorphic. Some of the genotypes that exhibited high salinity tolerance, based on STI for morphological traits, showed close genetic and allelic association with a salinity-tolerant genotype, based on the SSRs molecular markers. In conclusion, there is great genetic diversity among the tested breeding lines of bread wheat for salinity tolerance based on all of studied early-stage physiological, morphological as well as ion-content traits, which could be effectively used as selection criteria. Also these results had been confirmed and were in agreement with the results obtained by using of SSRs molecular markers. These promising results could be applied for improvement of bread wheat productivity and production under saline soil conditions of arid and semi-arid lands, and also reflected the efficiency and usefulness of hydroponic system as screening method for salinity tolerance which could be applied appropriately for testing large number of genotypes.



Fig1: measurement of chlorophyll fluorescence of bread wheat genotypes tested under different levels of salinity, using Mini

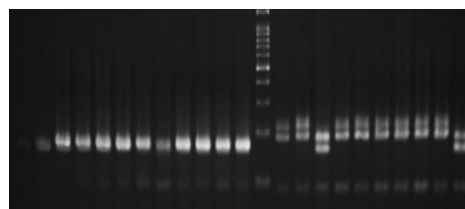


Fig.2: SSR primers for genetic diversity among the selected genotypes of bread wheat

Elsiddig Ahmed Elmustafa ELSHEIKH (Prof., Environmental Conservation)

October 2016 – January 2017

Searching for novel natural products in Sudanese microorganisms

Microorganisms produce a wide range of secondary metabolites such as antibiotics, pigments, toxins, pheromones, enzyme inhibitors, receptor antagonists and agonists, pesticides, antitumor agents and growth promoters of animals and plants. The rapidly growing world *population necessitates* an urgent need for new drugs, antibiotics, insecticides, and herbicides. Moreover, the prevalence of infectious diseases, food-borne diseases and plant and animal pathogens in addition to antibiotic resistance, increase the demand for improved or novel antibiotics. Unfortunately, resistance has eventually been seen to nearly all antibiotics that have been developed. Furthermore, Novel compounds are also needed in industry to improve production of dyes, polymers, fibers, glues, oils, waxes, flavoring agents, perfumes, and drugs.

Five soil samples were collected from highly saline soils. The samples were collected from different locations in the Gezira state, Sudan. The pH and the Electrical conductivity (ECe) of the soil were determined. The pH values were determined in saturated soil paste (250g) using a digital pH meter, whereas the ECe was measured in the saturated soil paste extract using a digital EC meter. The pH values of the five soil samples were: 7.1, 7.4, 7.5, 7.4, and 7.0; whereas the EC dS/m values were 110.0, 118.0, 54.0, 19.3 and 9.0.

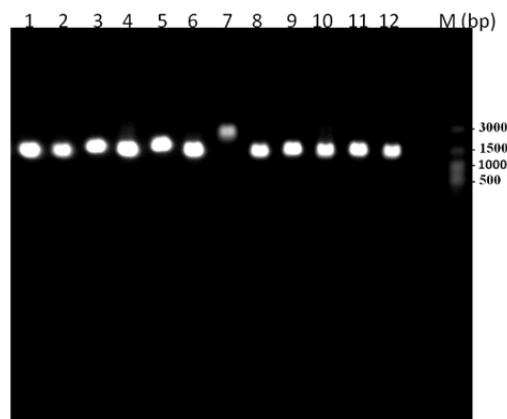
Bacterial isolation was performed in Nitrate Agar (NA) medium which is suitable to isolate microorganisms capable of growing on poor media, using soil dilution plate technique. One gram from each soil sample was added to 9ml of sterilized distilled water in a test tube. One ml of the blended primary suspension was transferred to 9 ml of sterilized distilled water then mixed well giving a dilution of 1:10. This step was repeated through a succession of tubes until the desired final dilution was reached. One ml aliquot was pipetted from each dilution and poured into 15 ml of cooled (45°C) Nitrate Agar. The soil suspension was mixed with the medium by gentle swirling. The plates were allowed to solidify for 30 minutes

and incubated at 27°C for 2-7 days. Similarly, another set of plates containing NA+5% NaCl was also prepared to isolate Halophytic bacteria.

Actinomycetes isolation was carried out using Starch Casein KNO₃ Agar (SCA) media, using soil dilution plate technique, in the presence and absence of 5% NaCl. The procedure of isolation was as described for the isolation of bacteria. The Petri dishes were incubated for 7-14 days. The selected colonies were cultured on ISP-2 slants and stored at 6°C.

Five bacterial isolates were carefully selected from the bacterial cultures (one from each soil sample) and stored in Nitrate Agar (with or without salt) slants. Also five isolates of actinomycetes (showing the morphological features of *Streptomyces*) were isolated from SCA medium without salt, one from each soil sample. All actinomycetes failed to grow in SCA medium in the presence of 5% NaCl. All isolates (bacteria and actinomycetes) were preserved in glycerol, where Equal amounts of 30% glycerol and culture broth are mixed, dispensed into tubes and then frozen at -80°C.

The DNA isolation from the soil samples was carried out using The PowerSoil® DNA Isolation Kit from MO BIO Laboratories using Inhibitor Removal Technology® (IRT).



MESHESHA, Derege Tsegaye (Assoc. Prof., Soil Erosion and Sedimentation)

October 2016 – March 2017

Rainfall Characterization and Determination of Erosivity and Soil Erodibility in Ethiopia

Since October 2016, I have been working on the rainfall characterization, soil erodibility and crop yield estimation. The rainfall data, which was collected in 2 consecutive rainfall seasons (2014 and 2015) in the highland of Ethiopia, was analyzed for different parameters such as drop size distribution (DSD), intensity, kinetic energy and erosivity (Fig. 1). I also conducted field survey in Ethiopia (Dec. 10, 2016 to Jan 13, 2017) which was primarily aimed at collecting soil samples and measuring crop yield at field. Thereby, crop yield measurement and soil sampling was carried out in a total of 74 plots at 4 different sites (Tilili, Addet, Fogera and Chagni). Besides, I wrote a paper based on my previously analyzed data (generated from rainfall simulator using optical disdrometer) and submitted to a journal.

Overall, from my 6 month research activities, I generated substantial data that can be published in reputable SCI journals. I completed the analysis of rainfall data and drafted a paper with title of “Characterizing rainfall and modeling kinetic energy of Ethiopian highland” and planning to submit it to the journal of “science of the total environment”. A total of 42 rainfall events were analyzed and the results indicated that kinetic energy has strong relationship with intensity and medial volume drop diameter (D50) than rainfall depth. Besides, I am drafting a paper through synchronizing the satellite data with ground measured crop yield data, with title of “Forecasting crop production using remote sensing data; the case of major agricultural commodities in Amhara region”. The research was conducted on 4 major crops of the country (Teff, Rice, Maize, and Wheat) and the result indicates that crop yield (ton/ha) is lower in Ethiopia as compared to developed country but higher than most of African countries (Fig. 2). This paper is expected to be submitted in the journal of “Agriculture ecosystem and

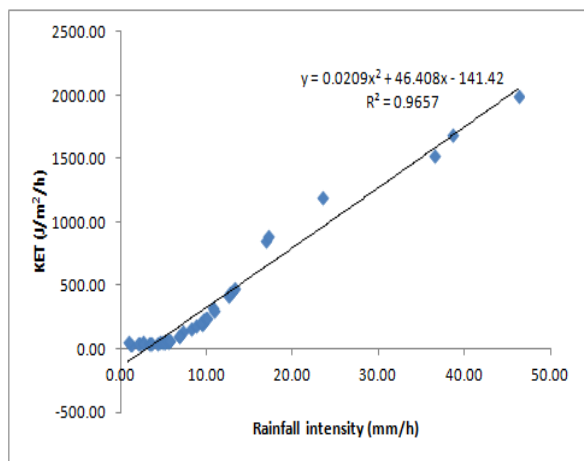


Fig. 1 Relationship between rainfall intensity Vs. kinetic energy

environment”. The paper which was written based on simulated rainfall data (Application of optical disdrometer to characterize simulated rainfall and measure drop size distribution) is already submitted to the journal of Geographical research and is found with status of “under review”.

One of my papers was accepted for poster presentation in European Geosciences Conference (EGU), which was held between April 23-28 in Vienna, Austria. Hence, I travelled in those days to Vienna and presented a poster in the conference and attended several other presentations and sessions.

In another development, I made a field survey trip to Ethiopia (May 7 to June 5, 2017) in order to contribute to the SATREPS project research work, which is a collaborative project between Tottori University (Japan) and Bahir dar University (Ethiopia). The survey was aimed at selecting sites for runoff plot experiment and identifies gully affected areas for treatment; whereby, I was the team leader and the local research members and the new PhD students who will come to Tottori University from October 2017 were the participants (Fig. 3). Overall, the field survey was successfully and the objectives were achieved.



Fig. 2 Crop yield measurement in Ethiopia (Dec, 2016)



Fig. 3 Field survey with new SATREPS PhD students

(4) プロジェクト研究員

留森 寿士 (乾燥地植物資源バンク室)

乾燥地は、生産性が低いため貧困度が高く、さらに生態系も脆弱なため、過放牧や過伐採、過耕作などの人為的要因により砂漠化が進んでいる。これら乾燥地が抱える問題に対処するため、地域住民の従前の農業形態や生活様式を極力変えない、環境保全と貧困削減を同時に達成する新しい栽培・緑化手法を開発することを目指している。このため、①植物資源の有効活用、②環境耐性を持つ品種・系統の開発、③乾燥地に適した栽培・緑化手法の開発を行っている。

バイオ燃料生産は日常生活に必要なエネルギーの確保のみならず、慢性的な貧困を抱える乾燥地の農村社会における収入の向上による貧困削減の手段として期待され、導入が促進されている。さらに、植物由来の原料を燃焼して排出される二酸化炭素は、植物が大気中から吸収したものであるため、二酸化炭素の排出量はゼロと考えられ、地球温暖化防止の対策として、石油に替わる非枯渇性資源として注目されている。しかし、乾燥地における植物によるバイオ燃料生産は、順調に進んでいるとは言えない。そこで、乾燥地での栽培が期待される油料植物であるジャトロファの植物資源を活用した、生産向上に資する研究を進めている。

また、文部科学省特別経費事業「限界地プロジェクト」(乾燥地植物資源を活用した天水栽培限界地における作物生産技術の開発 -世界の耕作限界地における持続的開発を目指して-)において、年間降水量300ミリメートル台の降雨依存農業地域で、持続的な生産を可能にする農業技術パッケージを作るため、乾燥地植物資源の収集と評価を進めている。

本年度は、以下の研究を進めた。

- オーストラリアにおいて、乾燥地関連植物の植生を調査した。
- ジャトロファの耐寒性系統を作るため、系統を選抜した。
- ソルガムの環境耐性評価を行った。
- 南アジアのコムギ系統を保存した。
- 土本ら(大阪大学)と共同で、油料植物の乾燥地での生産性向上に関する研究を行った。



Selection of cold tolerant *Jatropha*

(4) Project Researchers

Hisashi Tomemori (Project Researcher, Laboratory of Arid Land Plant Resources)

Owing to the low land productivity, drylands have high poverty rates. Furthermore, because their ecosystems are fragile, desertification is proceeding due to anthropogenic factors including overgrazing, excessive logging, and overcultivation. To deal with the problems faced by drylands, we aim to develop new cultivation and greening techniques that achieve both environmental conservation and poverty reduction with minimal changes to the inhabitants' customary forms of agriculture and ways of life. For this purpose, we are developing: (1) ways to effectively use plant resources; (2) crop varieties and strains with environmental tolerance; and (3) cultivation and greening methods suited to drylands.

Biofuel production is being encouraged because it offers hope not only for securing the energy needed for daily living, but also for providing a means of reducing poverty by raising incomes in dryland rural societies, which suffer from chronic poverty. And yet, it would be hard to say that biofuel production from plants in drylands is proceeding smoothly. For this reason, we are conducting research that will help improve the production of *Jatropha*, a drought-tolerant oil plant with prospects for dryland cultivation by utilizing of plant resources.

We are also promoting the MEXT special project "Project Marginal Region Agriculture (Development of crop husbandry technology in marginal rainfed environment using dryland plant resources -Toward sustainable improvement in global marginal regions-)". In this project we are collecting and evaluating of dryland plant resources in order to create an agricultural technology package that enables sustainable production in the regions with about 300 mm annual rainfall.

For the fiscal year 2016, we promoted the following research.

- I investigated vegetation of arid land plants in Australia.
- I selected *Jatropha* plants in order to make the cold-tolerant variety.
- I evaluated environmental tolerance of sorghum.
- I preserved South Asia wheat strains.
- In collaboration with Dr. Tsuchimoto and others at Osaka University, we did research on improve productivity of oil plants in arid lands.



Evaluation of sorghum

末継 淳 (土壌保全学)

土壌保全学分野 (藤巻晴行教授・井上光弘名誉教授) において以下のような研究を行った。

- (1) 植物のフラックス制限型乾燥ストレスのモデル化
- (2) サンドポニックスによる高糖度トマトの生産
- (3) 機能的被覆農薬によるリーチング時の汚染防止

(2) の研究は住友電気工業株式会社との共同研究 (代表: 井上光弘名誉教授) として行った。また、(3) の研究では学長裁量経費による補助を賜った。

本年度は、以下のような結果を得た。

1. 砂質土壌において低サクシオンで植物の乾燥ストレスが発生する現象を、フラックス制限として捉え、動水勾配と根の体積比から植物根にかかる乾燥ストレスを計算すると、木部キャピテーションが生じうる 1 気圧以上のサクシオンで蒸散量が半減することがわかった。この計算によって、砂質土壌と細粒質土壌における植物の乾燥ストレスの比較が可能となった。しかし、5TE センサー (Decagon Devices Inc.) による電気伝導度 (塩分ストレス) の計測は、約 3 mm の微小なセンシングピンで行われているため、根が発達した土壌では接触不良となり、十分な計測精度が出ないことが示された。
2. サンドポニックス (砂ベッド栽培) において、根圏を著しく制限し、不織布の毛管力を利用して慢性的な乾燥ストレスを意図的に負荷して栽培を行うと、トマト果実の糖度が上昇することがわかった。しかし、砂ベッド下端から水面まで 12cm 以上の高低差をつけると、不織布による給水速度が著しく低下し、トマトの生育障害が起きることが示唆された。また、この水位差が小さい場合でも、裂果や果皮の硬化などが認められたため、完熟前の早期の収穫が必要と考えられた。
3. 生大豆粉末に含有するウレアーゼ (尿素を分解してアンモニアに変換する酵素) とリパーゼ (油脂を分解する酵素) を利用した、機能的被覆農薬を作成した。この基剤にはダコニール 1000 (住友化学株式会社) を用い、被覆部はアルギン酸カルシウムと市販のマヨネーズ・生大豆粉末を含むゲル化層とした。この機能的被覆農薬の尿素水溶液への浸潤によって 2 日以内に被覆部が崩壊することを確認した。

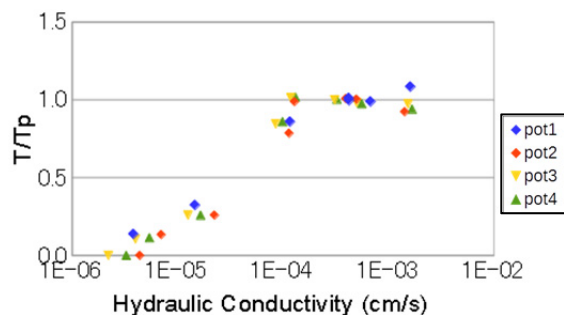


Fig. 1. Relationship between transpiration ratio of tomato (CF Momotaro York) and hydraulic conductivity of Tottori dune sand (T: transpiration, Tp: potential transpiration).

Atsushi Suetsugu (Project Researcher, Soil Conservation)

In this fiscal year, I worked on the following research subjects in the Soil Conservation Subdivision (Prof. Haruyuki Fujimaki, Emer. Prof. Mitsuhiro Inoue):

- (1) Modelling of flux-limiting drought for plants,
- (2) high sugar content tomato production by developing sandponics, and
- (3) prevention of water pollution in leaching treatments by developing functional coatings for agrochemicals.

The subject (2) was conducted as that of a cooperative research with Sumitomo Electric Industries, Ltd. The subject (3) was financially supported by the president discretionary fund of Tottori University.

Summaries of the above studies were as follows.

1. In coarse-textured soils, even a slight increase in the suction could generate a severe drought stress for plants. For an assessment of plant drought stress applicable to soils with any type of texture, we used macroscopic hydraulic gradient in soils and plant root volume ratio to the soils. The estimated suction at 50%-reduction in transpiration was greater than 1 atm, which can be explained by xylem cavitation. However, in the osmotic stress assessment, the sensing pin (screw) of the 5TE sensor (Decagon Devices, Inc) was too small (ca. 3 mm) to avoid the effects of disconnection by rooting.
2. An intentional restriction of root space and moisture has been conducted for high sugar content tomato production by using a thin sandbox and an unwoven cloth. The capillarity of the unwoven cloth was efficient in generating drought stress, but a harmfully sharp drop in water supply was found for over 12-cm height from liquid surface to the bottom of the sandbox. Cracked fruits and fruit skin hardening were found in the tomato cultivation, and therefore an earlier harvesting before full-ripening was considered to be necessary.
3. A functional coating of an agrochemical (Daconil 1000, Sumitomo Chemical Co., Ltd.) with calcium alginate, a commercially-available mayonnaise, and raw soy bean powder (a source of urease and lipase) was developed. The urease increases pH by producing ammonia from urea, and the increased pH promotes the activity of aliphatics degradation by the lipase. The functional coating was collapsed within two days after immersion in aqueous solution of urea.

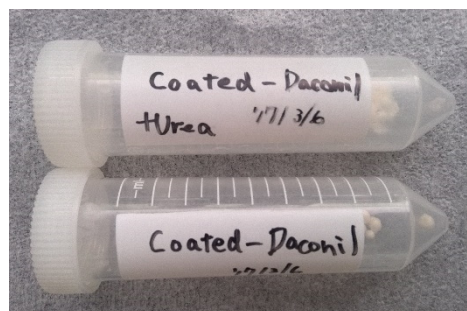


Fig. 2. Coated agrochemical (Daconil 1000) after immersion in aqueous solution of urea (upper) and in water (lower)

河合 隆行 (地下水水文学)

2016年度は以下の5つの研究課題を実施し成果を得た。なお、課題によって日本学術振興会による科学研究費の援助を受けたものには、番号を記してある。

1. 地下水の水みちを考慮したモンゴル草原地帯における浅井戸掘削最適地の判定 (15K12455, 25220201)

モンゴル北部の断層構造が発達する草原地帯において、地質構造と地下水の水みちの関係地表面から探査する手法を試みた。浅層地下水の新たな探査手法である地下流水音探査法と既存の地質探査法を組み合わせ、精度良く水みちを特定することが出来た。

2. モンゴルのアイラグ (発酵馬乳) の製造法の地理学的・生態学的検証 (15H02963)

モンゴルの発酵馬乳酒に水質や地質などの周囲の自然環境が及ぼす影響について、検討を行った。酸素・水素の安定同位体比の結果から、ウマの利用する水資源は、水量は豊富だが水温の低い永久凍土由来の湧き水ではなく、地表にしばらく貯留され周辺環境由来のミネラル分が増加した河川水や湖沼水を飲用していることが示された。

3. 複合的物理探査による農業用施設及び地盤中の流体・物質移動の高速可視化技術の開発 (16H02580)

磁気を増幅・共鳴させ、地中に存在する水分子の量を計測する手法 Magnetic Resonance Sounding (MRS)を用い、鳥取砂丘の浅層地下水帯水層厚の計測を試みた。既存の地中レーダー法や観測井網との比較から、良好な探査結果を得ることが出来た。

4. 熱画像による地表面温度分布から推定する地下環境中の水みち評価方法の確立 (26550069)

地質構造が比較的均一な砂地において、地下水が動きやすい水みち分布を、1m深地温探査により抽出した。

5. 山地の地下水水みち構造が林業作業道設置時に及ぼす影響

2次元比抵抗映像法-地中レーダー法-地下流水音探査法を組み合わせ、山地の水みち分布の立体構造を探索することで林道崩壊の危険度判定を行った。

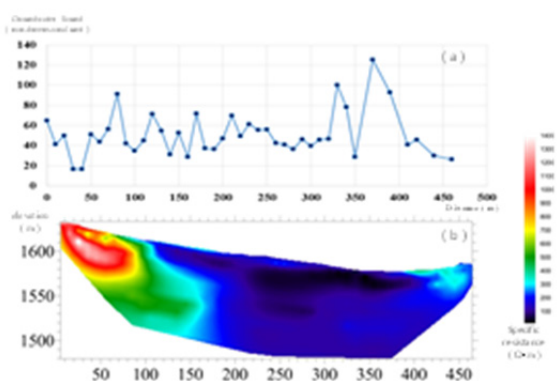


Fig. Direct current resistivity imaging and Groundwater aeration sound at northern Mongolia

Takayuki Kawai (Project Researcher, Groundwater Hydrology)

We carried out the following five research subjects in 2016 and obtained results as follows. In addition, we assigned numbers to the issues that were aided by Japan Society of the Promotion of Science Grants.

1. Determination of optimal points for shallow wells considering the groundwater path in Mongolian grassland (15K12455, 25220201)

Combining the new exploration method for shallow groundwater with the existing geological exploration method, we were able to identify the water path position with high accuracy in northern Mongolia.

2. Geographical and ecological investigation of airag (fermented mare's milk) production in Mongolia (15H02963)

From the results of Oxygen and Hydrogen stable isotopic ratios, it was found that horses drink river or lake water which increased mineral content rather than spring water derived from permafrost with low water temperature in Mongolia.

3. Developing fast visualization technology for fluid and mass movement underground and agricultural constructions with compound physical sensing (16H02580)

We tried to measure the thickness of the groundwater aquifer at Tottori sand dune using new method of Magnetic Resonance Sounding (MRS). MRS is a technique of amplifying and resonating magnetism and measuring the amount of water molecules present in the ground.

4. Evaluation of groundwater path situation estimating with ground surface temperature distribution (26550069)

We extracted the distribution of groundwater path where groundwater is relatively movable by geothermal exploration on the surface.

5. The influence of the groundwater path structure of the mountain area during the installation of forestry

Three types of geological exploration methods (.Direct current resistivity imaging - Ground-penetrating radar - Groundwater aeration sound) were combined to explore the three-dimensional structure of the groundwater path distribution in the mountains.

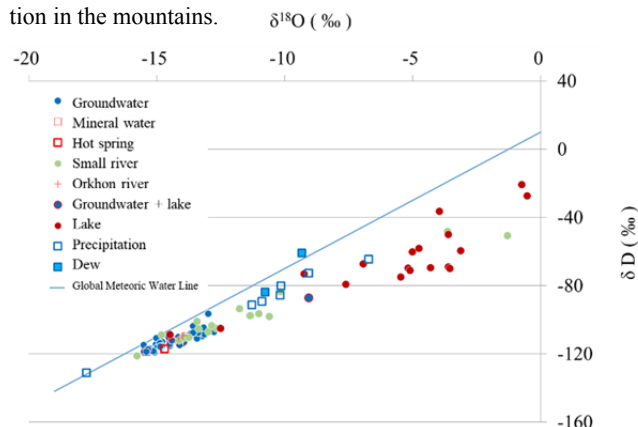


Fig. Distribution of Oxygen and Hydrogen Stable Isotope Ratios in Mongolian grassland area

杉本 太郎 (保全遺伝学)

ユキヒョウは、中央アジア 12 カ国の山岳地帯に 4500～7500 頭が生息するとされ、絶滅が危惧されている。モンゴルには中国に続き世界で 2 番目に多くのユキヒョウが生息している。特にモンゴル西部の山岳地帯は、複数の地域で生息が確認されており、ロシアと中国の個体群をつなぐ重要な生息地となっている。このモンゴル西部のユキヒョウ保全のためには、地域集団間の連結性を維持し、孤立化を防ぐことが最も重要である。集団の孤立化は、近親交配や遺伝的浮動による遺伝的多様性の喪失、劣性有害遺伝子の固定化を引き起こし、絶滅のリスクを高める。世界的に数が少ないユキヒョウの局所集団の絶滅は、地域固有の遺伝子を失う可能性が高く、種全体の持つ遺伝的多様性へのインパクトは大きい。WWF (世界自然保護基金) モンゴルによる西部山岳地帯の最新の調査では、8 つの地域で生息が確認されているが、生息数や集団遺伝構造などの詳細は不明である。

本研究は、モンゴル西部におけるユキヒョウ地域集団間の連結性の確保を目指した保全対策の提言を目的とし、1) 生息数推定や遺伝的多様性および集団遺伝構造解析を行い、2) 地形や人間活動などの環境要因が、ユキヒョウの移動・分散に与えている影響を解明する。3) 環境要因の影響を基に空間的連結性を地図化し、優先保護対策地域を特定する。

本年度は、バートル山とツルゲン山の 2 か所でサンプリングを実施し、約 200 個の試料を採集した。これまでジャルガラント山、ブンバット山の 2 か所でサンプリングを実施しており、合計 4 か所のサンプリングを終えた。遊牧民はユキヒョウの糞がよく見つかる場所を把握しており、彼らのアドバイスが効果的なサンプリングにつながった。輸出及び輸入許可書の取得後、約 130 個の糞を乾燥地研究センターへ持ち帰り、DNA 解析を進めている。



Setting up a camera trap

Taro Sugimoto (Project Researcher, Conservation Genetics)

Snow leopards are distributed across 12 countries in the central Asia and listed as endangered in the IUCN red list. Their population size has been estimated to be 4500-7500. Because of multiple factors such as habit loss, illegal hunting of both snow leopards and their prey species, and global warming, snow leopards are facing high extinction risk.

Mongolia has the second largest number of snow leopards next to China. Multiple habitats are recorded in the Altai Mountains in the western Mongolia, and these habitats play an important role for connecting populations between two countries, China and Russia. However, because of exploitation of natural resources and road construction, snow leopard habits seem to be fragmented. To protect snow leopards in the western Mongolia, it is essential to secure connectivity between patchily distributed populations. When populations are isolated, extinction risk will increase due to the loss of genetic diversity and fixation of deleterious genes through inbreeding and genetic drift. According to the recent survey by WWF Mongolia, snow leopards are distributed in eight different mountains; however the population size and genetic structure remain to be unknown. This is likely due to difficulty of obtaining ecological and genetic data of elusive high mountain animals.

This study uses fecal genetic techniques and aims to propose conservation implications for securing connectivity between populations. To be specific, I will reveal (1) population size and genetic structure and (2) geographical or artificial factors affecting movements of snow leopards, and (3) detect the high conservation priority areas.

In this year, I collected approximately 200 fecal samples in Baatar mountain and Turgen mountain. Local herders are well aware of where snow leopards leave scrapes and feces; therefore, their knowledge helped my fecal sampling. After getting appropriate export and import permits, I transported samples to ALRC. Fecal DNA is to be extracted from all samples and then species and individual identification will be conducted.



Collecting feces of snow leopard

Yasir Mohammed (Project Researcher, Molecular Breeding)

The research activities during April 2016 March 2017 included:

1. Development of heat stress tolerant germplasm.
2. Identification of salinity tolerant germplasm for wheat breeding.
3. Studies on the effect of fertilizers application and growing environment on wheat bread making quality.
4. Identification of high grain zinc and iron contents wheat germplasm for wheat nutritional quality improvement.

Previously we identified two cytoplasmic substitution lines with high photosynthesis rate under heat stress. These lines were crossed with elite wheat cultivars. The produced F₁ plants will be evaluated and backcrossed repeatedly to the elite cultivars to produce new cultivars with the desired cytoplasm. In addition, new cytoplasmic substitution lines developed in the background of elite Japanese bread wheat cultivars will be evaluated to identify the tolerant lines. The new identified lines will be crossed and backcrossed with elite wheat cultivars to introduce the tolerant cytoplasm and develop new tolerant wheat cultivars.

In Sudan, more than 20 heat tolerant cultivars have been developed based on evaluation of grain yield under heat stress conditions. These cultivars represent good material to study and explore the mechanism of heat tolerance in wheat, and hence development of super heat tolerant cultivars. We selected and crossed 8 heat tolerant wheat cultivars in different combinations and produced F₁ plants. These F₁ plants will be self-pollinated to produce F₂ populations. These populations will be evaluated for heat stress tolerance to identify the tolerance genes and elucidate the tolerance mechanism. Besides, the F₁s will be crossed again in different combinations to produce new population from which we can select for highly heat tolerant wheat lines.

We studied the effect of the fertilizers application and the growing environment (heat stress environment) on wheat bread making quality. The results showed significant differences ($P < 0.01$) in all quality tests among the growing environments, fertilization, and fertilization vs. environments. Multivariate analyses clearly identify the best growing condition, fertilizer amount and type, and time of fertilizer application.

To identify salinity tolerant germplasm to be used for wheat improvement, 247 synthetic wheat derivatives lines were selected from the multiple synthetic derivatives population based on our previous studies. We planted these lines in saline soil in Sudan. Some lines showed promising performance. The same



Fig. 1. Performance of the synthetic derivatives lines in saline soil in Sudan.

set of the lines will be evaluated in hydroponic system in the Arid Land Research Center to validate the field results and identify the tolerant lines and the genes underlying the salinity tolerance in the tolerant lines.

Fe and Zn deficiency are widespread worldwide. As wheat is the primary food for the majority of the world people, producing wheat grains with high mineral content can ameliorate the problem of mineral hunger. However, the genetic variation available for breeders is limited. We studied the iron and zinc concentrations in grains of 47 wheat synthetic lines. We measured the grain Fe and Zn contents using inductively coupled plasma atomic emission spectroscopy and performed genotyping using SSR markers. The results showed considerable genetic variation for these minerals. We identified three lines with high Fe and Zn contents and six quantitative trait loci of which three were associated with Fe content and the other three with Zn content. The minerals showed positive phenotypic and genotypic correlation and high heritability (>60%). The ratio of the σ^2_g to the $\sigma^2_{g \times e}$ was ≥ 1 for the two mineral contents indicating that breeding for increasing mineral content within the synthetic lines is possible. The synthetic wheat lines identified in this study are valuable genetic resources, and can be utilized for breeding wheat cultivars with high mineral content.

I had two publications, one from the study of the iron and zinc contents in the grains of wheat synthetic lines and the second one from the study of the fertilizers application and growing environment effects on bread making quality. I participated in the 12th International Conference on Dry Land Development. Alexandria, Egypt. Oversea activities included a research visit to Sudan.

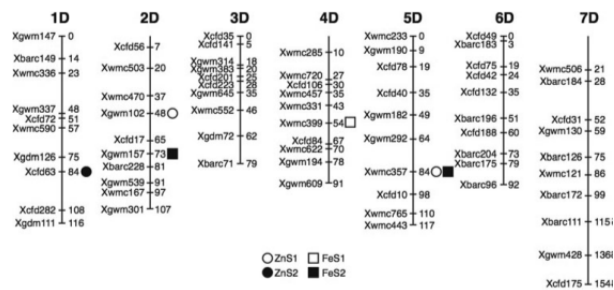


Fig. 2. Genetic map of SSR markers associated with grain Fe and Zn contents in different wheat chromosomes.

山崎 裕司 (分子育種学)

分子育種学分野では以下のような研究を行っている。

- (1) 乾燥地における非生物学ストレス、特に耐暑性、耐乾性を有するコムギ系統の構築
- (2) リン欠乏土壤に耐性を有するコムギ系統の開発、及び遺伝子特定
- (3) オミックスを利用したコムギにおけるストレス耐性メカニズムの解明

昨年度は赴任一年目として、以下の内容の研究を始めた。

1. リン欠乏土壤・通常土壤をスーダン（アルカリ土壤）及び鳥取砂丘（酸性土壤）に用意し、各地において準備したコムギ野生遺伝子を一部含んだコムギ系統を栽培することで、収量を含めたデータを集めて耐性系統を選抜する。用意した系統数が非常に多数であったことから、将来の実験への応用を目的としたリモートセンシングも同時に行っている。
2. 耐暑性系統を有する特定のコムギ系統の高速液体クロマトグラフ質量分析システム (LC-MS) を用いたメタボローム解析、同位体比質量分析システム (IR-MS) を用いた安定同位体比を測定し、耐暑性メカニズムの解析等の実験系を開始した。また耐乾性のメカニズム解明のため、耐暑性と同様に実験系を開始した。
3. 昨年度末に導入された ICP 質量分析システム (ICP-MS) の習熟を開始し、1で栽培している多系統のコムギのリン欠乏土壤・通常土壤環境の差における各元素の植物体への吸収・転流を含めたイオンーム解析を行う予定である。



The wheat lines containing wheat wild genes grown under phosphorus deficiency in Sudan and Tottori, Japan.

Yuji Yamasaki (Project Researcher, Molecular Breeding)

The molecular breeding lab team currently working on the following research topics:

- (1) Evaluation and selection of tolerant wheat lines under abiotic stresses especially dehydration and heat stress as main stresses of arid-land area
- (2) Evaluation and selection wheat tolerant line under phosphorus deficiency soil conditions
- (3) Characterizing and clarification of these stress tolerant mechanisms using omics technology

The following things are my projects, which start in the physical year 2016 as my first contract year.

1. We have started growing the multiple synthetic derivatives (MSD) wheat lines containing wild wheat genes under the phosphorus deficiency conditions in Sudan and Tottori, Japan, as alkaline soil and acidic soil respectively. This project will provide yield-related data and material to be analyzed for selection of tolerant lines under phosphorus deficiency. Also the remote sensing has been operated to this experimental field for acquiring big data of many wheat lines instantly in the next time.
2. Metabolome analysis and carbon isotope ratio analysis has been started for the heat tolerant wheat lines to reveal the mechanism of tolerance using Liquid Chromatography Mass Spectrometry (LC-MS) and Isotope Ratio Mass Spectrometry (IR-MS). Also this experimental system is used for the analysis of drought tolerance in wheat.
3. In the end of physical year 2016, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was introduced into the ALRC. We have started to make an experimental platform for quantification of total elemental compositions in the wheat tissue grown under phosphorus deficiency soil as same sample as the project 1.



Comprehensive Analysis System for Plant Responses including ICP-MS was introduced into the ALRC in March of 2017.

坂口 巖 (土壌保全学)

平成 28 年度については、以下の研究を行った。

(1) 中東乾燥地 (ICARDA ムシャカー、ヨルダン) での節水灌漑栽培の実施。

(2) アフリカ (ICARDA マシューシュ、モロッコ) での節水灌漑栽培用の実験システムの設置、およびその灌漑スケジューリングに用いる数値解析用パラメタの室内測定。

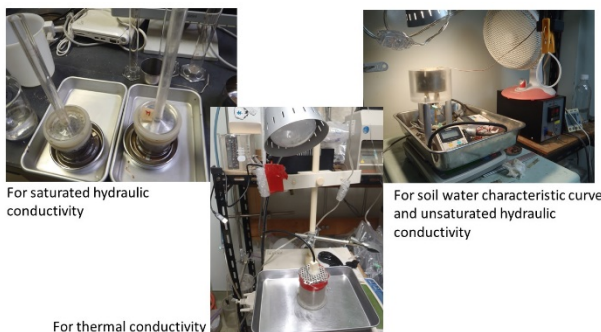
(3) 灌漑スケジューリングのための数値解析用パラメタの一つに関連する論文執筆。

これらについての実施状況を、以下に示す。

(1) については、2015 年 11 月中旬に ICARDA の小麦圃場で機械播種、灌漑設備設置、モニタリングセンサの設置を行い、2016 年 3 月上旬から灌漑を開始した。その後 2016 年 5 月中旬に灌漑を停止し、6 月中旬に収穫した。実験条件として設定した三つの灌漑処理区 (天水区、自動灌漑区、シミュレーション灌漑区) の各々で、収穫量を用いて算出した粗収益、灌漑水量から算出したコスト、および両者の差として得た純収益を求めて処理区間で比較した。これらの得られた結果やモニタリングデータなどを取りまとめて、論文執筆を行った。

(2) については、(1) と同様の小麦灌漑実験の対象地をモロッコに定め、2016 年 11 月中旬にモロッコの首都ラバトから南東に位置するマシューシュ村近郊にある ICARDA の実験圃場で機械播種、灌漑設備の設置、モニタリングセンサの設置などを行った。その後 2017 年 3 月上旬から、灌漑を開始した。その際 (1) と同様に、三つの異なる灌漑区 (天水区、自動灌漑区、シミュレーション灌漑区) を設けた。また、2016 年 11 月中旬に圃場で採取された未攪乱状態の土壌サンプルの物理特性パラメタとして、飽和透水係数を変水位法で、不飽和透水係数および土壌水分特性曲線を非定常蒸発法で測定した。その後、水分量を調整して再充填したサンプルの熱特性パラメタとして、熱伝導率を非定常線熱源法で測定した。

(3) については、シミュレーション灌漑での数値解析の際に用いられる入力パラメタの一つである土壌の熱伝導率に関連した内容 (熱伝導率の構成成分の内、土壌内の流体の移動に伴い発生する潜熱輸送成分) で、論文執筆を行い投稿した。



Pictures of measurements of hydraulic conductivity, soil water characteristic curve, and thermal conductivity.

Iwao Sakaguchi (Project Researcher, Soil Conservation)

My research activities during Apr. 2016 – Mar. 2017 are described as follows:

(1) Field experiment of the water saving irrigation of wheat at ICARDA Mushaqaq, Jordan.

(2) Setting experimental system for the water saving irrigation scheduling at ICARDA Marchouch, Morocco, and lab-scale measurement of parameters for simulation of heat and mass transfers in soil which used for the water saving irrigation scheduling at ICARDA Marchouch, Morocco.

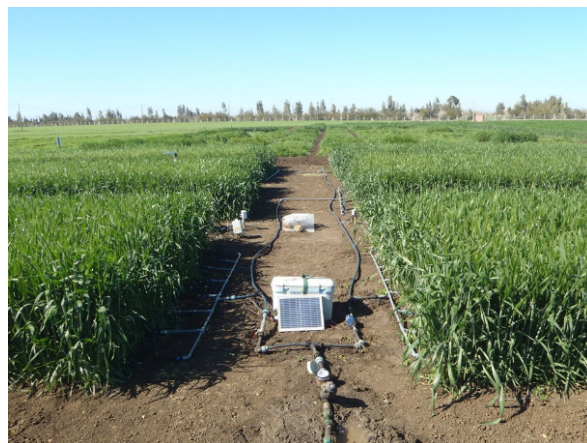
(3) Writing manuscripts relevant to one of the parameters for simulation of heat and mass transfers in soil which used for the water saving irrigation scheduling.

Achievement of each research activity in this fiscal year is described as follows:

(1) After Seeding, settings of irrigation system and monitoring sensors were conducted in mid-Nov. 2015, the irrigation experiment was started from early Mar. 2016. The irrigation was finished in mid-May 2016, wheat was harvested in mid-Jun. 2016. Three different treatments (Rainfed, Automated-irrigation, and Simulated-irrigation) were prepared. Income, cost, and net income of those treatments were estimated with measured yield, total amount of irrigated water etc. From those results and observed data, manuscript was prepared.

(2) Seeding, settings of irrigation system and monitoring sensors were conducted in mid-Nov. 2016, the irrigation experiment was started from early Mar. 2017. Three different treatments (Rainfed, Automated-irrigation, and Simulated-irrigation) were prepared. Soil samples taken from the experimental field at ICARDA Marchouch were used for the lab-scale measurements. As the hydraulic parameters of intact soil, the saturated hydraulic conductivity was measured with falling head method, the unsaturated hydraulic conductivity and soil water characteristic curve were measured with transient-state evaporation method. For the thermal parameter, moisture-adjusted soil samples were packed into container and used for measurement of the thermal conductivity with transient-state line heat source method.

(3) Manuscripts relevant to the soil thermal conductivity were prepared and submitted.]



Picture of field experiment at ICARDA, Marchouch, Morocco (7th Mar 2017).

(5) 日本学術振興会特別研究員

立石 麻紀子 (樹木生理生態学)

植物は環境ストレス（乾燥・高塩分など）に適応する仕組みを持つことで、様々な環境条件下で生育している。マングローブは熱帯から亜熱帯地域の河口汽水域に広がる樹木郡の総称であり、植物の中でも特に高塩濃度条件に適応する仕組みを利用して生育する。そのマングローブ樹木における水利用の定量的評価、生理的特性の解析を通じて、植物の耐塩メカニズムを明らかにすることを目的として研究を行っている。

なお、本研究は、日本学術振興会による科学研究費（課題番号 15J07750）の援助によって行われており、現在は以下の観測を進めている。

- マングローブ樹木の蒸散量の日変化と微気象パラメータとの対応関係の解明
- 光合成や蒸散といったガス交換に伴う樹体内水分量の変化と樹体内塩分濃度変化の解明
- 高塩分濃度条件下における、マングローブ樹木の樹体内塩分動態の解明

本年度は、研究対象を沖縄県に生育する1マングローブ樹種のおヒルギに絞り、条件が異なる二つのプロットを設定して樹液流速の集中観測を開始した。また、同時に葉の水ポテンシャルや個葉形態についても調査した。結果は以下の通りである。

樹液流速は両プロット共に観測地の日射に伴って日変化したが、夏季の測定結果に比べると冬季は半分程度の流速であった。潮汐に伴う水位変動による、樹液流速の日変化への影響は観察されなかったが、夜間のデータに多数のノイズが観察され、夜間も日中の給水では追いつかず夜間に給水している可能性が示唆された。夜明け前の給水ストレスが小さいと思われる時においても、葉の水ポテンシャルは生育場所の土壌の水ポテンシャルよりもわずかに低い値を維持していた。



Sap flow sensor installed into mangrove trees.

(5) JSPS Fellowship Researcher

Makiko Tateishi (Tree-Eco-Physiology)

With mechanisms of coping with various stresses (drought, salinity and so on), plants grow under various environmental conditions. Mangrove covers brackish-water region in tropical and subtropical area, and grows in high-salinity environment. The physiological characteristics in water use of mangrove trees are investigated to clarify the mechanism of salt tolerance.

This study is conducting under the aid by Japan Society of the Promotion of Science Grants (KAKENHI 15J07750). Following observations are conducted:

- Evaluation of relationships between diurnal changes of transpiration with micro-environmental parameters
- Evaluations of changes in stem water contents and salinity concentrations of trees associated with gas exchanges from leaves
- Dynamics of salt concentration in the mangrove trees under the hyper-saline condition.

In this fiscal year, *Bruguiera gymnorhiza* growing in Okinawa was selected, which is located in northern limits of its distribution and seems to be in severe environment. Water use was mainly monitored in two plots established in contrast conditions with sap flow measurement system. Leaf water potential and morphological characteristics were also investigated.

Diurnal variation in sap flow was varied with solar radiation, and sap flow in winter was half as large as that in summer in previous study. Sap flow was not affected by tidal fluctuation. We observed noises in nighttime sap flow, implying sap flow would occur to supply water at night. The waterless stress assumed to be minimized before dawn, however, water potential of leaves was slightly lower than that of soil.



1.2 研究プロジェクト・教育プログラム

(1) 限界地プロジェクト

栽培限界乾燥地での安定的作物生産を可能にする「植物+栽培技術パッケージ」の開発を目的としたプロジェクト、「乾燥地植物資源を活用した天水栽培限界地における作物生産技術の開発ー世界の耕作限界地における持続的開発を目指してー（通称：限界地プロジェクト）」（平成27年度～平成30年度）が文部科学省特別経費事業に採択された。

世界の20%以上の人々が乾燥地で暮らしているが、住民の生活は自然環境の影響を大きく受け脆弱で、貧困、食料不足等、様々な問題に直面している。本プロジェクトでは、生活の基盤である食糧、油糧、飼料作物を対象に、進んだ分子生物学的技術による作物改良と保全型栽培管理技術を合わせることで、年間降水量300mm台の降雨依存農業地域で、持続的な生産を可能にする農業技術パッケージを作ることに挑戦している。（プロジェクトリーダー：辻本壽）

研究内容

本プロジェクトは、育種研究グループ、栽培研究グループ及び、乾燥地植物資源バンク室の3つのチームで構成されている。

● 育種研究グループ（リーダー：辻本壽）

1. 野生植物の遺伝資源を利用した耐乾性・耐暑性コムギ品種育種のための育種素材の開発
2. 乾燥ストレス応答の分子メカニズムを基盤とした耐乾性油糧作物（ジャトロファ）等の開発
3. 植物ホルモン制御による耐乾性機構の解明と効率的選抜法の開発

● 栽培研究グループ（リーダー：藤巻晴行）

1. 内在菌類・菌根菌感染による作物の耐乾性・耐暑性の付与
2. 乾燥条件下における植物成長モデリング・適正栽培システム構築
3. 乾燥地における持続的草地管理技術の開発
4. 乾燥地における持続的栽培のための効率的な水利用、土壌保全技術の確立

● 乾燥地植物資源バンク室

1. 乾燥地植物資源、植物情報の収集拡大による充実
2. 海外連携機関ジーンバンクとの学術協定

本プロジェクトは、各チームの研究成果等を統合して、乾燥地の農業に有用な技術からなるパッケージを作成する。これまでの乾燥地研究センターにおける共同研究で培われてきた強力な学術及び国際的ネットワークによって本プロジェクトが可能になるものである。

1.2 Research Projects and Training Programs

(1) Project Marginal Region Agriculture

ALRC has started a four-year project “Development of Crop Husbandry Technology in Marginal Rainfed Environment Using Dryland Plant Resources - Toward Sustainable Improvement in Global Marginal Regions,” or shortly known as “Project Marginal Region Agriculture,” in FY 2015, funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Currently, more than 20% of world population lives in dryland regions, and their life faces various difficulties such as poverty and food shortage because their life is fragile and highly affected by natural environment. The challenge of this project is to make an agricultural package to enable sustainable production of food, oil and forage crops that are the base of their life, by combining the techniques of advanced molecular biology and conservation crop cultivation. (Project leader: Tsujimoto, H.)

Contents of the project

This project consists of three research groups (RG); Breeding RG, Husbandry RG, and Laboratory of Arid Land Plant Resources.

● Breeding Research Group (Leader: Tsujimoto, H.)

1. Production of materials for drought and heat stress tolerant wheat breeding by using the germplasm of wild species
2. Production of drought tolerant *Jatropha*, bio-fuel crop, based on the molecular mechanism of drought response
3. Elucidation of drought tolerance mechanism by plant hormone regulation and development of efficient selection method

● Husbandry Research Group (Leader: Fujimaki, H.)

1. Enhancement of drought and heat stress tolerance by plant-endophyte/mycorrhiza interaction
2. Modeling plant growth under drought condition and development of appropriate crop husbandry system
3. Development of a sustainable grassland management technologies in dryland
4. Development of an efficient water-harvesting and soil conservation system in dryland

● Laboratory of Arid Land Plant Resources

1. Enhancement of dryland plant resources and information
2. Academic agreement with overseas gene banks in the collaborative organizations

Combining the research performances from each group, the project aims at producing a package consisting of technologies that are useful for agriculture in dryland. The secure academic and international network that ALRC has developed through joint and collaborative researches allows smooth implementation of this project.

(2) SATREPS エチオピアプロジェクト

乾燥地研究センターの恒川篤史教授を研究代表者とする研究課題が、科学技術振興機構（JST）の国際科学技術共同研究推進事業「地球規模課題対応国際科学技術協力プログラム（SATREPS）」における平成28年度新規研究課題に条件付で採択された。

本事業は、科学技術と外交を連携し、相互に発展させる「科学技術外交」強化の一環として、文部科学省、外務省の支援のもと、JSTと国際協力機構（JICA）が連携して実施するものである。開発途上国のニーズを基に、地球規模課題を対象とし、将来的な社会実装の構想を持つ国際共同研究を政府開発援助（ODA）と連携して推進することによって、地球規模課題の解決及び科学技術水準の向上につながる新たな知見や技術を獲得することや、これらを通じたイノベーションの創出を目的としている。また、その国際共同研究を通じて、開発途上国の自立的な研究開発能力の向上と課題解決に資する持続的活動体制の構築を図ることを目指している。

条件付採択期間である平成28年度には、平成29年3月6日、7日の2日間、鳥取大学と相手国研究機関であるバハルダール大学は合同で、エチオピア・アディスアババにおいてキックオフワークショップを開催した。本プロジェクトによる国際共同研究は、平成29年度から本格的に実施される。

研究課題名：

砂漠化対処に向けた次世代型「持続可能な土地管理（SLM）」フレームワークの開発

相手国研究機関：

バハルダール大学

研究期間：

5年間（平成29年度～平成33年度）

相手国：

エチオピア連邦民主共和国

研究課題の概要：

本研究は、エチオピアを対象にして、土壌侵食防止機能の強化、土地生産力の向上、住民の所得向上を組み込んだ次世代型持続可能な土地管理（SLM: Sustainable Land Management）のフレームワークを開発することを目的とする。「持続可能な土地管理」は、砂漠化対処に向けて世界で広く実施されているが、その効果や持続性の問題が指摘されている。具体的には、降雨による土壌侵食の激しい青ナイル川上流域の3地域（高地、中間地、低地）に設置する研究サイトにおいて、土壌侵食の削減や耕畜連携システムの導入により土地生産力を向上する技術を開発し、さらにそれを住民の生計向上につなげる手法を開発する。最終的には、開発された個別要素技術と普及していくための取り組み・手法を定式化し、次世代型SLMフレームワーク（エチオピアモデル）を提案する。事業終了後は、青ナイル川流域及び世界の乾燥地への展開を目指している。

(2) SATREPS – Ethiopia Project

A research project proposed by ALRC's professor Atsushi Tsunekawa as its principal investigator was provisionally selected as one of the Fiscal Year 2016 Science and Technology Research Partnership for Sustainable Development (SATREPS) programs by Japan Science and Technology Agency (JST).

SATREPS is a science and technology diplomacy initiative that promotes international joint research using advanced science and technology from Japan in combination with Official Development Assistance (ODA). The program is a collaboration between JST and Japan International Cooperation Agency (JICA), supported by MEXT and the Ministry of Foreign Affairs (MOFA).

Based on the needs of developing countries, JST and JICA cooperate to promote international joint research targeting global issues with an objective of future utilization of research outcomes. Implemented through collaboration with ODA, the aim of the program is to acquire new knowledge and technology that lead to the resolution of global issues and the advance of science and technology, and through this process, to create innovations. International joint research under this program also aims to enhance the research and development capabilities of developing countries, and helps establish sustainable research systems that enable them to address and resolve issues.

In the interim period of FY 2016, Tottori University and its Ethiopian counterpart, Bahir Dar University, jointly held the kick-off workshop for the SATREPS project on March 6 and 7, 2017, in Addis Ababa, Ethiopia. This project will move forward with full-scale implementation from FY 2017 through FY 2021.

Project Title

Development of Next-Generation Sustainable Land Management (SLM) Framework to Combat Desertification

Project Summary

This project aims to develop a next-generation Sustainable Land Management (SLM) framework that can contribute for a significant reduction of soil erosion, improvement of land productivity and livelihood in Ethiopia. Sustainable Land Management has been widely implemented throughout the world as a response to desertification/land degradation, but there are issues about its effectiveness and sustainability. Specifically, in the research sites to be established in three contrasting environments (highland, midland, and lowland) of the Upper Blue Nile River basin of Ethiopia, there is extremely high soil erosion risk that affects downstream countries as well. This project will (1) develop effective technologies for soil erosion reduction, (2) develop technologies that can integrate the mixed crop-livestock farming system to improve land productivity of three main land use systems, and (3) link this improved technologies to improvement of the people's livelihoods. Finally, it will formulate the SLM technologies and approaches that have been developed, and propose a next-generation SLM framework (Ethiopian model). After the completion of this project, we aim to expand it to the Blue Nile River Basin areas and other drylands of the world.

1.3 共同研究/ Joint Research

(1) 特定研究 / Specific Research

特定研究 1 Specific Research 1	対応教員 Corresponding Staff	エルタイプ・アミン Eltayeb Habora Amin
研究代表者 Principal Researchers	岩田 洋佳 (東京大学大学院農学生命科学研究科) Iwata, Hiroyoshi (Graduate School of Agricultural and Life Sciences, Tokyo University)	
研究課題 Research Subject	スーダンにおける作物生産性向上を目指したソルガムのステイ・グリーン形質のゲノム情報学的研究 A genome informatics study of the sorghum stay-green trait for improving crop production in Sudan	
共同研究要旨 Summary of Joint Research	<p>Detailed analysis was carried out on re-sequencing data taken in 2015 for 4 lines of rainwater cultivation, salt damage soil cultivation, and irrigation cultivation. Among detected DNA polymorphisms, there were ca. 3000 polymorphisms expected to have a strong influence on gene function. We also perform RNA-seq for 7 lines including the 4 re-sequenced lines to analyze the response to drought stress at the gene transcription level. As a result, it was found that three repetitions performed for each line and treatment showed expression patterns similar to each other, suggesting that a highly reliable result was obtained. Under the drought stress, the expression level changed greatly in many genes, and the tendency varied among lines. As the tendency common to all strains, the expression level of genes involved in photosynthesis, metabolism, and intracellular transport have decreased, suggesting that the drought condition strongly exerts a negative influence on the growth of sorghum. On the other hand, the expression level of genes involved in the removal of intracellular harmful components is elevated, suggesting that the defense response to the adverse effect of drought is induced. In addition, it was shown that some of the defense responses are in common with biotic stress such as diseases. In addition, clustering analysis of 7 lines based on the gene expression pattern, the 3 lines showing the stay-green phenotype in the drought experiment showed patterns similar to each other and were classified into one cluster. These 3 lines showed a pattern that was significantly different from the remaining four lines showing non stay-green phenotypes.</p>	

特定研究 2 Specific Research 2	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	柏木 純一 (北海道大学農学研究院) Kashiwagi, Junichi (Graduate School of Agriculture, Hokkaido University)	
研究課題 Research Subject	中国極乾燥地民勤オアシスにおける環境保全型農業の生産性向上に関する研究 Study for agricultural productivity improvements based on environmentally-friendly farming systems in arid oasis, Minqin in China	
共同研究要旨 Summary of Joint Research	<p>(1) Identifying the relevant traits for drought tolerance in wheat: The results from an on-site local farmer's field trial in Minqin showed the large yield reduction in wheat under less irrigation, which revealed the necessity of substantial irrigations for their wheat cultivations. The wheat genotypes which had drastic yield reduction under less irrigations tended to show relatively higher leaf canopy temperatures. This may indicate that the importance of stomata sensitivity under soil water scarcity situations for improving the wheat yield under drought environments.</p> <p>(2) Exploring the high commercial value plant with salinity tolerant: The <i>Lycium ruthenicum</i> is a suitable target material. After salinity treatments, the detailed analysis was conducted for the roots. The results showed that the root growth was clearly inhibited by high salinity (8.82 ms/cm). The changes in cell wall composition in elongation zone (especially the cellulose content) may indicate a close relation with the regulation of root growth although the further investigations are needed.</p> <p>(3) Analyzing the mechanisms on drought tolerance for fodder crops: The alfalfa fields in Minqin produced first harvests of 17.5–30t/ha as fresh weight, and 4.6–7.5t/ha as dry weight, which is much more productive than Yuzhong (FW12t/ha, DW4t/ha) or Dingxi (FW15t/ha, DW4.2t/ha), and an almost equivalent to Hokkaido region. It could be attributed that, in Minqin, suitable alfalfa species for their environments were chosen, and the appropriate management was applied. The other results suggested that proper irrigation is needed until alfalfa root systems developed suffi-</p>	

	ciently to establish an alfalfa field because high drought and salinity tolerance in alfalfa could be obtained by its deep-rooting ability.
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特定研究 3 Specific Research 3	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	石塚 正秀 (香川大学工学部) Ishizuka, Masahide (Faculty of Engineering, Kagawa University)	
研究課題 Research Subject	モンゴル現地実験と冷涼帯砂漠シミュレータによる土壌表層のクラスト形成過程の解明 Study on soil crust formation by field experiment in Mongolia and dryland simulation systems for cold desert	
共同研究要旨 Summary of Joint Research	<p>(1) Laboratory experiment: Rainfall simulator and artificial meteorological control room, those were managed by ALRC, Tottori University, were used. Soils were sampled at Tsogt-Ovoo in the northern part of Gobi Desert, Mongolia. By using the rainfall simulator, realistic rainfall was able to simulate. The artificial meteorological control room has large space and is able to measure many necessary data, such as soil evaporation and soil surface temperature (by an infrared thermo camera which is owned by ALRC, Tottori University). In addition, sand falling instrument was newly developed to measure soil crust destruction. Sand fall from 1 m height and the crust-formed soil vat is set to the bottom of the instrument.</p> <p>(2) Field study: Kosa (Asian dust) and crust observations were continuously carried out at Tsogt-Ovoo.</p> <p>(3) Results: Crusts were formed after the rainfall and dry experiments for all soil samples. The crust width increased with supplied water amount. This characteristic is the same whether the presence of gravels or not. The sand fall experiment shows ablated soil mount decreases with supplied water amount. This result indicates precipitation can control the surface hardness and crustiness has a relation to the dust emission amount from ground to atmosphere. However, in 24 hours experiment, soil moisture might effect on the soil harness and experimental condition should be considered for future works.</p>	

(2) 重点研究 / Focused Research

重点研究 1 Focused Research 1	対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researchers	土本 卓 (大阪大学工学研究科) Tsuchimoto, Suguru (Graduate School of Engineering, Osaka University)	
研究課題 Research Subject	乾燥地に適した産業用油料作物の開発 Development of industrial oil crops suitable for cultivation in arid lands	
共同研究要旨 Summary of Joint Research	<p>T1 plants of transgenic jatropha that highly express the Arabidopsis <i>AtPPAT</i> gene were obtained by cultivation and crossing of the T0 plants at the isolation greenhouse in Arid Land Research Center. We found that the transgene was inherited from T0 to T1, and was present in the T1 plant genome. The trasngene was expressed in T1 leaves. The Mexican elite jatropha line has not been transferred from Mexico to the Japanese side in FY2016, and its research will be conducted in FY2017. We identified 37 SSRs (Simple Sequence Repeats) of jojoba, and developed 12 SSR markers showing polymorphism among jojoba accessions. Phylogenetic analysis was conducted on a total of 73 DNA samples from stocks of Arid Land Research Center, and from accessions originated from California or Arizona, USA, which is the origin of jojoba, transferred from USDA-ARS, etc. The results showed that the California population has the highest genetic diversity, the two USA populations (California and Arizona) are genetically close to each other, but Arizona has a genetic group not found in California. <i>Agrobacterium</i> was used for transformation of jojoba by the marker gene (GUS gene). Regeneration shoots from calli could not be observed, so we developed a method to efficiently cultivate multiple shoots from axillary buds of stem sections, and to select transformed shoots with hygromycin. By using the method, regenerative shoots with transformed cells could be obtained.</p>	

(3) 一般研究 / General Research

一般研究 1 General Research 1	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	関山 剛 (気象庁気象研究所) Sekiyama, Tsuyoshi Thomas (Meteorological Research Institute, Japan Meteorological Agency)	
研究課題 Research Subject	エアロゾル数値モデルと観測データの比較による黄砂発生プロセス理解の深化 Deepening the comprehension of the aeolian dust emission process by comparing aerosol numerical simulations with observational data	
共同研究要旨 Summary of Joint Research	<p>We conducted a numerical simulation of Asian dust and sulfate aerosol distributions using the Japan Meteorological Agency (JMA) Model of Aerosol Species IN the Global Atmosphere (MASINGAR) mk2, which was installed into the server equipped at the Arid Land Research Center (ALRC) of Tottori University during the period of our last collaborative research project. Although we conducted a similar numerical simulation last time, the horizontal resolution was altered from 110 km into a two times higher 55 km (approximately 10 times computationally burdened); a 9-year simulation was performed from 2009 to 2016 with the 55 km resolution. This high-resolutionization made higher the accuracy of the Asian dust and sulfate aerosol simulation at the Gobi desert and Tottori Area.</p> <p>Furthermore, we conducted a similar model simulation of Asian dust using a regional aerosol community model (WRF-Chem) experimentally at the IRIMHE of the Mongolian government. The simulation result was compared with that of MASINGAR mk2 quantitatively. These simulation results were, then, validated by comparing with the observations from a dust observational station at Tsogt-Ovoo (the Gobi desert) managed by ALRC. These inter-comparison and validation resulted in finding the problems of our dust emission estimation scheme.</p> <p>In addition, we conducted a statistical comparison between the MASINGAR simulation result and the epidemiological data from the faculty of medicine of Tottori University at Yonago City. The comparison in 2011 and 2012 indicated that the cross-border sulfate aerosol pollution calculated by MASINGAR mk2 was highly correlated with the health survey result collected in/near Yonago City, although the Asian dust concentration did not show a clear correlation with the health survey in this period. This is the first report, at least in Japan, of a clear correlation between an aerosol model simulation and epidemiological asthmatic survey data to the authors' knowledge.</p>	

一般研究 2 General Research 2	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	三橋 渉 (山形大学農学部) Mitsuhashi, Wataru (Faculty of Agriculture, Yamagata University)	
研究課題 Research Subject	植物ホルモン・アブシジン酸による植物細胞周期新規制御機構の検討 Study of new regulation mechanism of cell cycle by a phytohormone, abscisic acid	
共同研究要旨 Summary of Joint Research	<p>Under the normal condition, plant growth was controlled by cell division (cell cycle) and cell expansion at meristem or elongation zone. Progression of cell cycle is mainly controlled by a protein complex which consists with cyclin-dependent kinase (CDK) and cyclin as a regulatory subunit. There are several groups of "inhibitor for CDK (ICK)". Major group of ICK is Kip-related proteins (KRPs) in <i>Arabidopsis thaliana</i>. When we started this project, we had isolated an ABA-related protein and two of stress responsible proteins that can bind to some of KRP members. It indicates that ABA may contribute to cell cycle regulation via the ABA related protein and some of KRPs.</p> <p>In 2016, we searched highly efficient tag species for ectopic expression protein in <i>Escherichia coli</i>, because former tag {i.e. glutathione S-transferase (GST) for KRP and 6x histidine (6x His) for ABA related protein} fused proteins had low expression rate in <i>E. coli</i>. Finally, maltose binding protein (MBP) and glutathione S-transferase (GST) tags were selected to fuse with KRP and ABA related protein as high expression fusion protein. After pull-down assay between MBP-KRP and GST-ABA related protein, we found that GST-ABA related protein is able to co-precipitate with MBP-KRP.</p> <p>For <i>ex vivo</i> analysis, we applied Bimolecular Fluorescence Complementation (BiFC) method by using Enhanced Yellow fluorescent protein (eYFP). Conclusively, nucleus was detected as the place of those protein assembling.</p> <p>We also selected homo-lines for KRP over expresser (KRPox), KRP-knockout mutant (knp) and knp</p>	

	x ABA related protein-knockout mutant. We will analyze these mutant to clarify physiological role(s) of the complex between KRP and ABA related protein.
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一般研究 3 General Research 3	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	轟 泰司 (静岡大学農学部) Todoroki, Yasushi (Faculty of Agriculture, Shizuoka University)	
研究課題 Research Subject	植物のストレス耐性を制御する新奇化合物の創出 Development of new chemicals for controlling stress tolerance in plants	
共同研究要旨 Summary of Joint Research	<p>The signaling of the plant stress hormone abscisic acid (ABA) is triggered by activation of Arabidopsis PYR/PYL/RCAR receptors (PYLs) to bind and inhibit group-A protein phosphatases 2C (PP2Cs), which normally repress ABA signaling as a negative regulator. We previously created 3'-hexylsulfanyl-ABA (AS6) that interferes PYL-PP2C interactions by protruding the 3'-hexyl chain from a tunnel that opens at the PP2C binding interface. Although AS6 acted as an effective antagonist of PYLs both in vitro and in vivo, the partial ABA-like agonistic activity was observed in vitro, suggesting the incomplete interference of the formation of PYL-PP2C complex. We here focused on another tunnel that plays a crucial role to form and stabilize the PYL-ABA-PP2C complex to develop a novel, complete PYLs antagonist with no in vitro agonistic activity. The 4'-O-phenylpropynyl ABA analogs, which were designed to incorporate the crucial interactions between PYL-ABA and PP2C, bound to PYLs more tightly than AS6 to act as more excellent PYLs antagonists (PANs) than AS6 both in vitro and in vivo, with no in vitro agonistic activity. The observed various degrees of ABA antagonistic effects of PANs and AS6 on various plants suggest that these PYLs antagonists can be chemical scalpels to dissect the complicated regulatory mechanism of ABA signaling.</p>	

一般研究 4 General Research 4	対応教員 Corresponding Staff:	小林 伸行 Kobayashi, Nobuyuki
研究代表者 Principal Researchers	苗川 博史 (東京農業大学教職・学術情報課程) Naekawa, Hirofumi (Teacher Education and Scientific Information Course, Tokyo University of Agriculture)	
研究課題 Research Subject	モンゴル夏営地における動物福祉評価指標としての羊・山羊母子間の音声と行動 The vocalization and behavior between sheep-goat mother and child as an animal welfare evaluation index in Mongolia summer pasture	
共同研究要旨 Summary of Joint Research	<p>The animal state of emotions which serves as an objective criteria for the evaluation of animal welfare extent is observed in the situation where the sheep/goat herd in Mongolia temporarily leaves the summer pasture during grazing period and forced to struggle until encountering again. Given these circumstances, in this research we mainly focused on the examination of the significance of vocalization and behavior observed between mother and child among sheep and goats in Mongolia summer location.</p> <p>Our research is focused on the analysis of the audio recorded in August 2016 in the Alushantz district of Bolgan district, Mongolia, under the four main factors where sheep and goat maternal and child separation occurs during day-long grazing in nomadic summer pasture. These factors are ① Movement ② Meal and migration ③ Meal transfer ④ Rest. The objects of the vocalization analysis are the following four criteria - vocalization duration, fundamental frequency, formant and sound pressure. We also analyzed the characteristics of the herd by attaching GPS to each of sheep and goats in order to figure out the route of travel during grazing. Furthermore, a vegetation survey was also conducted to investigate under what kind of environmental conditions the vocalization individual uttered.</p> <p>From the acoustic parameters, the differences in vocalization time, fundamental frequency, formant and sound pressure depending on the action form of sheep/goat were observed and such differences were significant ($P < 0.05$). Moreover, as a result of comparing the components of fundamental frequency and sound pressure between lactation and suckling between sheep and goats, mothers and children, and as a result of comparing the components of the fundamental frequency and sound pressure at the time of nursing and sucking, the difference was recognized which became an important factor in considering emotional situation.</p> <p>In the grazing routes in which food behavior was observed, it was found that the families of <i>Stipa</i></p>	

	<i>grandis</i> , <i>Artemisa frigida wild</i> and <i>Sedge</i> occupied the dominant species, and on the contrary, in some parts of the dominant plants of the family <i>Caragana</i> the moving behavior is fast. Basing on the observation of the behavior trajectory between sheep and goats from GPS follow-up survey it was found that these trajectories are nearly consistent therefore leading to the conclusion that the sheep/goat herd choose the environment and grass species optimal for the growth conditions and act within this environment.
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一般研究 5 General Research 5		対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researchers	中川 啓 (長崎大学水産・環境科学総合研究科) Nakagawa, Kei (Graduate School of Fisheries Science and Environmental Studies, Nagasaki University)		
研究課題 Research Subject	地表面温度分布を利用した砂丘地域の帯水層における水みちの推定 Evaluation of flow path in the sand dune aquifer by using soil surface temperature		
共同研究要旨 Summary of Joint Research	<p>In general, natural aquifers and soils have a hydrogeologically heterogeneous structure. The movement of water and solutes in the subsurface environment is affected by these structural properties. It is therefore indispensable to evaluate spatial heterogeneity of aquifer permeability structure when developing groundwater resources and investigating the extent of pollution. In this study, a new method is proposed using thermography images of the soil surface temperature to evaluate the groundwater flow and the geological structures that represent obstacles to the flow.</p> <p>A laboratory experiment was conducted using flow tank filled with glass beads. The obstacle blocks (5 × 5 × 5 cm) were arranged in the bottom of the flow tank. The obstacle block layer (5 cm) was covered with the homogeneous glass beads layer (5 cm). Ten different patterns of obstacle distribution were designed, and the hydraulic head difference between the upper and lower boundary was set to 5 mm for all cases. Tap water was heated to 60°C and was used as a tracer. During the experiment, surface temperature was taken using a thermography camera at specified time intervals. Temperature averaged by block size was used to detect obstacle distribution with image analysis. Next, the rate of detection of the obstacle block arrangement were evaluated for each case. Additional experiments of different thickness cover layer were performed for selected cases to investigate covering rate effects on the detection. Covered thickness effects were evaluated by comparison with the experimental results without obstacles.</p> <p>The experimental results showed that the distribution of the obstacles had an influence on the surface temperature difference. However, the detection of the obstacles distribution was dependent on the thickness of the cover layer. When a thinner cover was present, it was easy to determine the distribution of the obstacles and the groundwater flow path. In addition, macroscopic dispersivities for observed points were calculated based on the temporal change of temperature. Scale dependence of macroscopic dispersivities was also confirmed.</p>		

一般研究 6 General Research 6		対応教員 Corresponding Staff	木村 玲二 Kimura, Reiji
研究代表者 Principal Researchers	高山 成 (大阪工業大学工学部環境工学科) Takayama, Naru (Faculty of Engineering Department of Environmental Engineering, Osaka Institute of Technology)		
研究課題 Research Subject	草原化に対する景観保全活動による鳥取砂丘の植生分布の変遷と砂移動回復状況のモニタリング Monitoring of sand move remediation and distribution of vegetation with landscape conservation activity for anti-glass-land in Tottori sand dune		
共同研究要旨 Summary of Joint Research	<p>The landscape conservation activity such as weeding have been continued after 1990th era, to recover once a characteristic landscape in Tottori sand dune. We proposed the method of monitoring for long term changes of sand movement and vegetation cover including the period from grass land to sand dune, to verify the effect of such a landscape conservation activity for recovery of sand movement. In this study, the relationship between a tendency of sand movement and degree of vegetation flourish was analyzed in Tottori sand dune.</p> <p>Quantity of sand movement was evaluated as variation of height at each grid. Aero-photo sensing was done by using UAV from 120 meter height. One synthesized image which cover a whole of sand dune was generated from 955 piece of images. The image was imported to GIS as map after ortho geometric correction, and each pixel (UAV pixel) have been discriminated whether vegetation or bare sand surface. We made the congruent shape which matchs each 30 meter pixel of Landsat image using GIS that called "pixel polygon". Vegetation coverage was tallied based on a number of vegetation UAV pixel each pixel polygon. Normalized Vegetation Index (NDVI) was calculated by using Land-</p>		

	<p>sat-8 OLI image acquired at October 7 2016, and obtained the equation of regression between NDVI and vegetation coverage. Estimated distribution of vegetation coverage were obtained by applying the formula to several Landsat series archive scenes from 1986 to 2016.</p> <p>Sand erosion and accumulation have been balanced during about 50 years in the whole of sand dune. Sand movement had been deposition trends over a slope area beside inland of the second sand dunes and around the third sand dunes of Tottori sand dune from 1964 to 2011. On the other hand, around the second sand dunes, both a back yard and front old ridges had been erosion trends. Distribution and its transition of vegetation could be estimated from before starting the landscape conservative weeding to recent based on UAV aero-photo and satellite archive data.</p>
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一般研究 7 General Research 7	対応教員 Corresponding Staff	伊藤 健彦 Ito, Takehiko
研究代表者 Principal Researchers	中野 智子 (中央大学経済学部) Nakano, Tomoko (Faculty of Economics, Chuo University)	
研究課題 Research Subject	モンゴル草原における放牧圧の定量化と生態系への影響評価 Quantitative evaluation of grazing pressure and its effects on the ecosystem in Mongolian grasslands	
共同研究要旨 Summary of Joint Research	<p>The purpose of this study is to examine quantitatively the effects of livestock on plants, soil and carbon cycle in the semiarid grassland ecosystem. The study site was located in Bayan Unjuul county (BU) and Baganuur district (BN), Mongolia, which contain typical steppe vegetation that is grazed by livestock. We constructed fences (10 m × 10 m) at the study sites to prevent livestock from grazing and installed 4 interval cameras facing northward, eastward, southward, or westward at each corner of the fence in each site. The images shot at intervals of 10 minutes were stored from mid-May to mid-August, 2016 and the number of animals in the images were counted. In August 2016, we conducted the measurements of plant species composition, plant aboveground biomass, and CO₂ fluxes both inside and outside the fences.</p> <p>During the three months (May-August), more livestock were photographed at BN than at BU, suggesting that the grazing pressure was stronger at BN than at BU. At both sites, the species compositions were different between inside and outside the fences due to grazing. Aboveground biomass and CO₂ fluxes outside the fence declined significantly compared to those inside the fence at BN, meanwhile there were no significant differences of plant biomass and CO₂ fluxes between inside and outside the fence at BU.</p>	

一般研究 8 General Research 8	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	馬場 貴志 (鳥取大学農学部) Baba, Takashi (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	好塩性植物の窒素代謝及び光合成におけるナトリウムの役割 Role of sodium in nitrogen metabolism and photosynthesis in salt-loving plant species	
共同研究要旨 Summary of Joint Research	<p>In this study, we investigated the optimal Na concentration, Na-dependence, the response to Na in the initial growth and the role of Na in salt-loving plant.</p> <p>As these results, the optimal Na concentration in the nutrient solution varied according to the plant species. Na in salt-loving plant might take a role of K in glycophytes (<i>Baba et al. submitted</i>). The optimal Na concentration in germination was different from that in vegetative stage (<i>Baba et al. in preparation</i>). In salt-loving plants, Na rather than K regulated the stomatal movement, rather than K (<i>Baba et al. submitted</i>).</p>	

一般研究 9 General Research 9	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	三木 直子 (岡山大学大学院環境生命科学研究科) Miki, Naoko (Graduate School of Environmental and life, Okayama University)	
研究課題 Research Subject	温帯性広葉樹における木部通水阻害の解消 Repair of xylem embolism in temperate broad-leaved tree species	

共同研究要旨 Summary of Joint Research	<p>Recovery of water transport occurs due to vessel refilling. The recovery by the refilling has recently been found to be different with species. Therefore, attention is drawn to what kind of physiological characteristic affects interspecific difference of the xylem recovery performance. Considering the refilling process, the sugar content, the physiological activities associated with its production and transport, the structure of the xylem related to the xylem parenchyma that is important as the transport pathway for sugar and water storage capacity as a water source and waterway is expected to be related to the interspecific differences in recovery performance. In this study, six species of deciduous broad-leaved trees were used to evaluate integrately what kinds of these characteristics are affecting the interspecific differences in the xylem recovery performance. According to the principal component analysis, each characteristic value was reduced to two principal components. As a result of generalized linear model analysis using their principal component scores as explanatory variables, the xylem recovery index tended to be significantly higher as the sugar content under dry condition and the safety against the turgor pressure loss of leaves was higher. And, the higher the water storage and the lower the parenchyma area in xylem, the higher the recovery performance. It was considered that the concentration of soluble sugar content of the stem is high because of high safety to turgor loss during drying and high leaf activity, and thereby increasing the sugar concentration of the cavitated vessel, probably osmotic gradient occurs. It was thought that because of the low parenchymal area in xylem, the proportion of the area of the water storage tissues such as the vessel is high, and the water storage capacity of the stem would be high, and therefore, water inflow was brought into the cavitated vessel and refilling of vessel occurs.</p>
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一般研究 10 General Research 10	対応教員 Corresponding Staff	木村 玲二 Kimura, Reiji
研究代表者 Principal Researchers	王 秀峰 (北海道大学大学院農学研究院) Wang, Xiufeng (Graduate School of Agriculture, Hokkaido University)	
研究課題 Research Subject	人工衛星データを用いたデータ同化のダハラオアシスにおけるコムギ生育モデルへの適用 Application of data assimilation with satellite data to crop response model of wheat for Dakhla oasis, Egypt	
共同研究要旨 Summary of Joint Research	<p>In this research, we aimed to establish a method to simply and objectively determine parameters in the crop growth model by replacing information on the growth condition of the crop with satellite data and by data assimilation. We introduced a data assimilation method to the parameters of the module of the soil moisture model, and compared it with the conventional model.</p> <p>Data assimilation is a method to optimize parameters for simulations describing the dynamics of changing phenomena with time. In the nonlinear / non-Gaussian time series model, if the value of the state vector at a time t-1 and the value of system noise are assigned to the right side, the state vector at time t on the left side is determined. Therefore, from this fact, if the vector quantity in the system calculation is appropriately embedded in the state vector, the simulation calculation can be described by the system model of the nonlinear / non-Gaussian time series model. Based on this principle, tuning of parameters becomes possible.</p> <p>Conventionally, the soil moisture content change obtained by empirical parameter tuning after hypothesis and the parameter determined by data assimilation i) soil moisture characteristic curve, ii) soil porosity, iii) unsaturated permeability coefficient, iv) field the amount of crack in the soil was compared. As for the result of data assimilation, compared to the result by empirical tuning, different parts can be seen daily, but generally good results were obtained as the overall tendency. This time I used actual data such as the timing of irrigation, so on simulation, I did not give the increase of soil moisture content at irrigation as an unknown parameter. When considering a simulation using data from satellites as input, it is also necessary to consider a method to assimilate data by giving interruption periods for irrigation timing as well.</p>	

一般研究 11 General Research 11	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	鹿島 薫 (九州大学大学院理学研究院) Kashima, Kaoru (Faculty of Science, Kyushu University)	
研究課題 Research Subject	モンゴル・ゴビ砂漠における湖沼環境と風成塵 (黄砂) の長期的変動 The long-term fluctuation of lake environment and aeolian dusts (KOSA) at Gobi Desert in Mongolia	
共同研究要旨 Summary of Joint Research	There are two methods to monitor the dust fluctuation (KOSA) changes and desertification at arid and semiarid regions. The first one is the short-term monitoring, and examined the changes during	

	<p>several years or decades by meteorological, hydrological, geophysical and geochemical observations. The second one is the long-term monitoring, and presumed changes of environment during hundreds or thousands years using geologic and geographical methods. Although a lot of expeditions have reported short-term changes, the reports for long-term environmental changes have been limited because it takes a lot of efforts to take efficient samples to presume in detail environmental histories.</p> <p>Department of Earth and Planetary Sciences, Kyushu University has started international research project to make long-term monitoring of desertification in East Asia to correspond with the East Asian Environmental Problems Project of Kyushu University. In cooperation with Mongolian Academy of Sciences, National University of Mongolia, Xinjiang University in China, the field surveys have been done to obtain samples for long-term monitoring at lakes, ponds and marshes in Mongolia and north western China using geological and geographical methods. Our researches presumed long-range (about hundreds or thousands years) changes of the lowering of lake levels and under ground water levels, the reducing of forest areas and the expanding of deserts in those regions. The desertification has been accelerated in these two hundred years in both regions.</p> <p>In 2017, we took the environmental discussion at the western Mongolia using the lake core at “Big Around Lake”. Our preliminary analysis made clear the distinct lake level changes during these four thousand years. We will discuss about the relationship between the lake level changes in western Mongolia and the dust fluctuations in central Mongolia.</p>
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一般研究 12 General Research 12	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	伊藤 秀臣 (北海道大学大学院理学研究院) Ito, Hidetaka (Faculty of Science, Hokkaido University)	
研究課題 Research Subject	高温活性型トランスポゾンを用いた乾燥耐性植物の作出 Creation of a drought-tolerant plant by a heat-activated transposon	
共同研究要旨 Summary of Joint Research	<p>We found a heat-activated retrotransposon that was conserved in <i>Arabidopsis</i> and Azuki. The homology of DNA sequence was 82% and the transcriptional activation was detected on the heat-stressed seedlings. An extrachromosomal DNA derived from the retrotransposon was detected on the heat-stressed Azuki. The result indicated that the retrotransposon might be transposable. The heat-activated retrotransposon was also found in Japanese radish. We used a draft genome sequence of Japanese radish so that we could not get a DNA sequence of an intact copy of the retrotransposon. Many of seeds of Japanese radish from a seed company were the first filial generation and the copy number of the retrotransposon has not been fixed. We selected a variety of Japanese radish that contained fixed number of the heat-activated retrotransposon and analyzed the retrotransposition. The retrotransposition was induced by callus-mediated method that was established in our previous study in <i>Arabidopsis</i>. The result showed that transpositions were detected in the heat-activated retrotransposon both in Azuki and Japanese radish. We are going to modify the stress condition to improve the transposition frequency in order to produce mutant lines that contain new insertion of the heat-activated retrotransposon. We are planning to screen a stress tolerant Azuki and Japanese radish from the transposon inserted population.</p>	

一般研究 13 General Research 13	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researchers	山中 高史 (森林総合研究所きのこ・森林微生物研究領域) Yamanaka, Takashi (Department of Mushroom Science and Forest Microbiology, Forestry and Forest Products Research Institute)	
研究課題 Research Subject	砂漠地帯に生息する desert truffles の乾燥ストレス耐性機構の解明 Mechanisms of drought tolerance of desert truffles	
共同研究要旨 Summary of Joint Research	<p>I obtained fruit-bodies of desert truffles (<i>Picoa juniper</i>, <i>Terfezia boundieri</i>) from Tunisia. These fruit-bodies were already dried up and difficult to obtain cultures from them. Therefore, these fruit bodies were used as inoculants for infection of plants of <i>cistus</i> and <i>Helminthorum</i>, which are considered as host plants for these truffles in desert areas. <i>Cistus</i> cuttings and <i>Helminthorum</i> seedlings were cultivated sterilized mixture of perlite and volcanic soil (commercial name: akadama soil) (1:1) sup-</p>	

	<p>plemented with a converter slag to make the soil alkaline (ca. pH 8). The fruit bodies were immersed in sterilized distilled water and stirred to make spore suspensions. The suspension was inoculated at a dose of 1.7×10^6 (<i>Picoa</i>) or 1.0×10^6 (<i>Terfezia</i>) per a plant. Five and 6 months after the inoculation, the plants were fertilized with ammonium nitrate and trace elements.</p> <p>After N fertilization, the growth of <i>Helminthorum</i> seedlings was improved when the plants inoculated with <i>Picoa</i> or <i>Terfezia</i>. On the contrary, cistus cutting, seedlings of pine (<i>Pinus densiflora</i>), oak (<i>Quercus serrata</i>) and birch (<i>Betula grossa</i>), which are host plants for Japanese truffles.</p>
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一般研究 14 General Research 14	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	杉本 幸裕 (神戸大学大学院農学研究科) Sugimoto, Yukihiro (Graduate School of Agricultural Science, Kobe University)	
研究課題 Research Subject	アブシジン酸応答に着目した根寄生雑草ストライガの生存戦略の解析 Responses of <i>Striga</i> to abscisic acid and their roles in survival strategies	
共同研究要旨 Summary of Joint Research	<p><i>Striga hermonthica</i> is an obligate root hemi-parasitic angiosperm and a major biotic constraint on cereal production in Sub-Saharan Africa. <i>Striga</i> infection reduced shoot growth and transpiration of the host plant. <i>Striga</i> transpiration is much higher and less affected by drought stress than that of the host. The unusual behavior of stomata contributes to maintenance of a gradient in leaf water potential towards the parasite and thus facilitates the translocation of water and solutes to the parasite. Although stomatal closure of most of the plant species is regulated by abscisic acid (ABA), our previous studies revealed that ABA concentration in <i>Striga</i> was about 10-fold that in the host sorghum. ABA concentration in the host plant increased by <i>Striga</i> infection. In the academic year 2016, we studied the involvement of ABA of <i>Striga</i> origin in the host stomatal closure. <i>Striga</i> inoculation reduced stomatal conductance of sorghum grown in rhizotron within 3 days. ABA concentration in <i>Striga</i> seeds drastically increased 12 hour after GR24 treatment. Application of ABA at 1 μM to aqua culture reduced stomatal conductance of sorghum. ABA concentration in exudate from <i>Striga</i> seedling was 4 times higher than that in extract of <i>Striga</i> seedling, 1000 times higher than that in extract of sorghum root. <i>Striga</i> germinates nearby the host plant root in response to a germination stimulant exuded from the host plant. These facts suggest that ABA exuded from <i>Striga</i> seedlings is involved in stomatal closure of host plant.</p>	

一般研究 15 General Research 15	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	館野 隆之輔 (京都大学フィールド科学教育研究センター) Tateno, Ryunosuke (Field Science Research and Education Center, Kyoto University)	
研究課題 Research Subject	黄土高原の半乾燥林における優占樹種の菌根タイプの違いが窒素循環に与える影響 The effects of mycorrhizal type of dominant tree species on nitrogen cycling in semi-arid forests in Loess Plateau, China	
共同研究要旨 Summary of Joint Research	<p>The types of mycorrhizal fungi, i.e. Arbuscular-mycorrhiza fungi (AM) and Ectomycorrhiza fungi (EM), associated with dominant tree species significantly affects soil microbial community structure and then soil nitrogen dynamics. We investigated the differences in soil prokaryote community, soil fungal community and soil nitrogen dynamics between plantation forests of <i>Robinia pseudoacacia</i> (associated with AM) and natural forests of <i>Quercus liaotungensis</i> (associated with EM), on Loess Plateau, China. We collected top soils (0-10 cm) from both types of forests and extracted soil DNA and dissolved nitrogen. Next generation sequencing for 16S rRNA and ITS region revealed the considerable differences in soil prokaryote community and soil fungal community between forest types. Functional analysis using fungal community data revealed that Saprobiotic fungi dominated in <i>Robinia</i> forests and symbiotic fungi dominated in <i>Quercus</i> forests, suggesting main decomposer of soil organic matter are Saprobiotic fungi and symbiotic fungi for <i>Robinia</i> forests and <i>Quercus</i> forests, respectively. For dissolved nitrogen, amount and ratio of dissolved organic nitrogen, ammonium nitrogen and nitrate nitrogen were also different between two types of forests. These results suggested that differences in types of mycorrhizal fungi associated with dominant tree species could affect soil microbial community structure and function as well as soil nitrogen dynamics.</p>	

一般研究 16 General Research 16	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi																																	
研究代表者 Principal Researchers	片岡 良太 (山梨大学生命環境学部) Kataoka, Ryota (Faculty of Life & Environmental Sciences, University of Yamanashi)																																		
研究課題 Research Subject	根圏微生物を利用した塩性土壌でのファイトレメディエーションの高度化 –トルコ・コンヤ地方での農業生産性の向上を目指して– Enhancement of phytoremediation for salinity soil using plant rhizo-microbes. –Improvement of agro-productivity in Turkey–																																		
共同研究要旨 Summary of Joint Research	<p>Phytoremediation of salinity soil using <i>Salsola grandis</i> that is endemic plant in turkey was conducted in this study. Na concentration in <i>S. grandis</i> and Na tolerance of bacteria isolated from the rhizosphere of <i>S. grandis</i> were investigated after cultivation in pot experiment. The soil taken from Aksaray was used in the pot experiment and soil chemical properties were shown in table 1. The dry weight and Na concentration of <i>S. grandis</i> was measured after 82 days cultivation. The results showed that the dry weight of <i>S. grandis</i> was 12.3 mg and 0.16 mg in stem + shoot and root, respectively. In addition, Na concentration was 15447 mg/kg and 1459 mg/kg in stem + shoot and root, respectively. The value of Na concentration in stem & shoot was quite higher compared with that in wheat (346 mg/kg (stem and shoot) and 1563 mg/kg (root)). It suggests that <i>S. grandis</i> is able to absorb NaCl from soil and transfer it to stem and shoot from root. As subsequent experiment, NaCl tolerance rhizo-bacteria were selected from the bacteria isolated from the rhizosphere of <i>S. grandis</i>. The result showed that there were 21 strains out of 50 strains which have NaCl tolerance (OD600 (700 mM NaCl)/OD600 (0 mM NaCl) > 0.5).</p> <p>(Table 1) Soil chemical properties</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2"></th> <th style="text-align: center;">Aksaray</th> </tr> </thead> <tbody> <tr> <td>pH (H₂O)</td> <td></td> <td style="text-align: center;">8.36</td> </tr> <tr> <td>EC</td> <td style="text-align: center;">(dS/m)</td> <td style="text-align: center;">2.37</td> </tr> <tr> <td>Total Nitrogen</td> <td style="text-align: center;">(%)</td> <td style="text-align: center;">0.40</td> </tr> <tr> <td>Organic Materials</td> <td style="text-align: center;">(%)</td> <td style="text-align: center;">5.42</td> </tr> <tr> <td>CaCO₃</td> <td style="text-align: center;">(%)</td> <td style="text-align: center;">40.3</td> </tr> <tr> <td>Phosphate</td> <td style="text-align: center;">(mg kg⁻¹)</td> <td style="text-align: center;">8.19</td> </tr> <tr> <td>Ex-Na*</td> <td style="text-align: center;">(mg kg⁻¹)</td> <td style="text-align: center;">746</td> </tr> <tr> <td>Ex-Ca</td> <td style="text-align: center;">(mg kg⁻¹)</td> <td style="text-align: center;">5501</td> </tr> <tr> <td>Ex-Mg</td> <td style="text-align: center;">(mg kg⁻¹)</td> <td style="text-align: center;">2282</td> </tr> <tr> <td>Ex-K</td> <td style="text-align: center;">(mg kg⁻¹)</td> <td style="text-align: center;">402</td> </tr> </tbody> </table>				Aksaray	pH (H ₂ O)		8.36	EC	(dS/m)	2.37	Total Nitrogen	(%)	0.40	Organic Materials	(%)	5.42	CaCO ₃	(%)	40.3	Phosphate	(mg kg ⁻¹)	8.19	Ex-Na*	(mg kg ⁻¹)	746	Ex-Ca	(mg kg ⁻¹)	5501	Ex-Mg	(mg kg ⁻¹)	2282	Ex-K	(mg kg ⁻¹)	402
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一般研究 17 General Research 17	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	花田 耕介 (九州工業大学若手研究者フロンティア研究アカデミー) Hanada, Kousuke (Frontier Research Academy for Young Researchers, Kyushu Institute of Technology)	
研究課題 Research Subject	次世代シーケンシングによるオオハマニンニクのマーカー作成 Development of DNA marker in <i>Leymus racemosus</i> by next generation sequencing	
共同研究要旨 Summary of Joint Research	<p><i>Leymus racemosus</i> tends to have not only high biomass but also high stress tolerance such as drought, salinity and heat. Such the traits are lost in most of crops. Since <i>Leymus racemosus</i> can be breeding with wheat, wheat lines integrated with <i>Leymus racemosus</i> chromosome A, E, F, H, I, J, K, L and N were generated by Prof. Tsujimoto (The National University Corporation Arid Land Research Center, Tottori University). To determine DNA markers of wheat lines integrated with <i>Leymus racemosus</i> chromosome A, E, F, H, I, J, K, L and N, we performed RNA-seq analysis of Illumina short reads. Wheat lines integrated with <i>Leymus racemosus</i> chromosome A, E, F, H, I, J, K, L and N were grown in several conditions. After checking the quality of the extracted RNAs from root, we performed the next-generation sequencer analyses using the facilities of Tokyo Agriculture University. In first run, we generated 300bp-PAIR-END library by TruSeq RNA Sample Preparation v2 (illumine), 5-6 GB</p>	

	Transcribed sequences were determined by Illumina HiSEQ 2500. The determined sequences were assembled in oases software. Homologous sequences of assembled sequences were collected from available wheat and barley annotated genes. We have performed comparative genomics analysis right now.
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一般研究 18 General Research 18	対応教員 Corresponding Staff	木村 玲二 Kimura, Reiji
研究代表者 Principal Researchers	松島 大 (千葉工業大学創造工学部都市環境工学科) Matsushima, Dai (Department of Civil and Environmental Engineering, Chiba Institute of Technology)	
研究課題 Research Subject	ダスト発生頻度と地表面状態の関係～高空間分解リモートセンシングプロダクトを用いた研究 Relationship between dust outbreak frequency and surface conditions - A study of using remote sensing products with high spatial resolution	
共同研究要旨 Summary of Joint Research	<p>In this study, we examined the relationship between the threshold wind speed of dust emission and the land surface conditions, especially the soil moisture and the aboveground vegetation, with the scale of several kilometers to several tens of kilometers. Specifically, we focused on the relation of the threshold wind speed ut5% (5 percentile value of the frequency of dust emission) in the vicinity of the respective meteorological observation points (Tsogtovoov and Dalanzadgad, Mongolia) to the thermal inertia or the bulk transfer coefficient of the vegetation canopy in the area of upwind directions that corresponded to the respective dust emissions occurred. Thermal inertia and the bulk transfer coefficient of the vegetation canopy are the proxy variables of the soil moisture and the aboveground vegetation, respectively.</p> <p>Threshold wind speed at Tsogtovoov was approximately 9 m/s and did not depend on thermal inertia, namely the soil moisture condition, in case the source area of observed dust is assigned as illustrated in Fig. 1. On the contrary, the threshold wind speed at Dalanzadgad increased as the thermal inertia increased. The threshold wind speed at the two locations both increased as the bulk transfer coefficient of the vegetation canopy increased.</p> <p>The footprint analysis was performed for determining where the observed dust emission by eyes at the respective stations originated. We employed the footprint model developed by Kormann and Meixner (2001). This model requires the values of sensible heat flux to calculate the source area according to the atmospheric stability. We used the sensible flux data measured at the Tsogtovoov station managed by the ALRC, Tottori Univ. to determine the source area at Tsogtovoov. The measurement height of the model was set at 100 m above the ground to correspond to the dust observation method. The average source area (90% level) was 0.2- 7 km upwind and the maximum width was approximately 1200 m. We applied the average source area to the data when the dust emission occurred during 2009 – 2012, and obtained the approximate result that the threshold wind speed increased as the thermal inertia increased. This implies that the local difference of the earth's surface conditions especially the soil moisture affected dust emissions.</p>	

一般研究 19 General Research 19	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	板井 章浩 (京都府立大学大学院生命環境科学研究科) Itai, Akihiro (Graduate School of Life and Environmental Sciences, Kyoto Prefectural University)	
研究課題 Research Subject	マングローブ3種の比較ゲノミクス・トランスクリプトミクス Comparative genomics and transcriptomics of three mangrove species	
共同研究要旨 Summary of Joint Research	<p><i>Avicennia marina</i> RNA from various tissues was sequenced using Ion torrent sequencer. Total of 45,000 unigenes were obtained. About 14,000 unigenes showed no homology to <i>Arabidopsis</i> genes (TAIR) database. To investigate the relationship between salt tolerance and compatible solutes accumulation, the expression analysis of three Betaine aldehyde dehydrogenase (BADH) genes were conducted with response to 0%, 3%, 6% NaCl solution. The expression of <i>AmBADH1</i> and <i>AmBADH2</i> was higher among all concentrations tested, while that of <i>AmBADH3</i> was not significantly different at any concentrations. This data show that highest expression of BADH genes was observed at sea salt level. Based on Gene Ontology analysis, total over 3000 ESTs related to salt response were picked. Genes</p>	

	encoding transporter, pump and channel such as ABC transporter c family member, heat shock protein, V-type proton ATPase, and Calcium transporting ATPase showed higher expression level in <i>Avicennia marina</i> . <i>Bruguiera gymnorhiza</i> , <i>Kandelia obovata</i> , and <i>Sonneratia alba</i> are major mangrove species, which live in the intertidal zones of estuarine areas. Total RNAs from several tissues of three species including leaves, shoots, roots, and flower were extracted, cDNA libraries were constructed from various species and were sequenced using next generation sequencer. Data analysis is in progress.
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一般研究 20 General Research 20	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researchers	明石 欣也 (鳥取大学農学部) Akashi, Kinya (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	乾燥地植物のクチクラ層強化の分子生理メカニズムの解明 Molecular physiology of cuticle layer fortification in the leaves of arid land plants	
共同研究要旨 Summary of Joint Research	The aerial part of plant is covered by a cuticle layer, a hydrophilic layer composed of very long chain fatty acids, long-chain alcohol, and alkanes, which are polymerized by ester bonds to form wax layer. Cuticle layers are implicated in the resistance to water deficits in plants. In this study, physiological and molecular response of a xerophyte wild watermelon was analyzed, particularly in focus on the cuticle layer development. In wild watermelon, amount of wax deposition was 8 times higher under drought condition in comparison to the irrigated control. Under the stress condition, an alkane compound of carbon length of 31 was specifically induced in the cuticle layer, showing that both quantity and quality of the cuticle layer were altered under drought stress. Gene expression analysis indicated that the expression of CER1/CER3 fatty acid reductase genes were significantly up-regulated under drought in the leaves of wild watermelon, suggesting that the fortification of cuticle layer under drought stress in this xerophyte plant is regulated at least in part at the gene expression level.	

一般研究 21 General Research 21	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	長田 和雄 (名古屋大学環境学研究所) Osada, Kazuo (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Subject	黄砂など越境大気成分の観測 Observation of transboundary atmospheric constituents such as Kosa	
共同研究要旨 Summary of Joint Research	Location of ALRC building has the geographical advantage to obtain various atmospheric samples such as Asian dust (Kosa) particles, PM2.5 and other pollutants transported from areas where air pollution is severe. Continuous measurements of PM10, PM2.5, and Optical black carbon (OBC) mass concentrations were maintained at the roof of the main (until Nov/16) and new (from Nov/16) buildings of ALRC. Concentrations of PM2.5 and OBC showed somewhat decreasing trends during the past 4 years, although no clear trend was found for mass concentrations of coarse particles. Tape filter samples for size-segregated continuous mass monitor described above were analyzed for major ionic constituents such as nitrate and sulfate. Valuable data were obtained for simulating dust-nitrate formation and transboundary pollution (see Itahashi et al., 2017). Measurements of gaseous species were also conducted for NH3, SO2, HNO3, CO, and O3 to study transboundary gaseous pollution. These instruments were placed in the former calculation room at first, but moved to the Arid-tron Control and Experiment Building since November 2016. Variations of gaseous species associated with high PM2.5 events and sea breezes were observed at the site, as aimed to utilize geographical advantage of location. HNO3 concentrations increased from spring to summer, and then decreased from summer to autumn and winter. Diurnal variations of HNO3 concentrations had daytime maximum and nighttime minimum values regardless of seasons. Further analysis with model simulation will be performed to reveal various interactions and mechanisms on transboundary pollution.	

一般研究 22 General Research 22	対応教員 Corresponding Staff	小林 伸行 Kobayashi, Nobuyuki
研究代表者 Principal Researchers	山下 博樹 (鳥取大学地域学部) Yamashita, Hiroki (Faculty of Regional Sciences, Tottori University)	
研究課題 Research Subject	オーストラリアにおける砂漠都市の大都市化・ゴースト化の動向 The trend of metropolitanization and ghosted of desert cities in Australia	
共同研究要旨 Summary of Joint Research	<p>In a joint research in 2015-2016, I surveyed and analyzed several cities about the livability and sustainability of the desert cities scattered in the major cities and inland areas of Australia. In this fiscal year we first analyzed trends of ghosting in desert cities across the continent of Australia. B. McGowan (2002) Obtained "Australian Ghost Town" in the old book and about 80 ghost towns are being analyzed about its existence basis, features, background of decline and so on. While the current major cities in Australia are unevenly distributed in the coastal part of the continent, many of the ghost towns are located relatively inland, and the distribution is highly ubiquitous so far It became clear.</p> <p>On the other hand, we are planning on-site survey in Western Australia on March 23 - 31, 2017. In the first half, we will conduct a field survey of large-scale gold mining sites called Gold Field, located about 600 km east of Perth, using this joint research fund. This area is mainly Kalgoorlie-Boulder city, a gold mine with a huge open pit and is supplying water from Perth through pipeline to maintain it. The existence of multiple ghost towns has also been confirmed in the vicinity, and we are planning to clarify the maintenance mechanism of the giant gold mine and the background of the ghosting of surroundings. In the second half, Yamashita will investigate the livability of the Perth metropolitan area where metropolitanization progresses, using the Grant-in-Aid Expenses adopted as representative this year.</p>	

一般研究 23 General Research 23	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	松浦 朝奈 (東海大学農学部) Matsuura, Asana (School of Agriculture, Tokai University)	
研究課題 Research Subject	雑穀の乾燥耐性機構の解析 Mechanisms of dehydration tolerance of millets	
共同研究要旨 Summary of Joint Research	<p>Setaria italica cv.46 and cv.47 were used. Seeds of each species were sowed in Wagner pot (1/5000 a) filled 5 kg of sandy soil at 25 % soil water content. Water stress treatment started at 25 days after sowing. Half of the pot was imposed to 12 % of soil water content (dry treatment) and the other half pot was continuously irrigated as 25 % soil water content.</p> <p>Cutting of a half of leaf area did not change grain yield at two treatment both of variety. This suggest that sink mainly limit of grain yield. Grain yield of cv.47 did not change by dry treatment, however, that of cv. 46 decreased to 79% of wet treatment. This suggest that cv. 47 was strong dehydration tolerance than cv. 46. Number of grain per panicle, percentage of ripening and total dry weight mainly accounted for the varietal difference of dehydration tolerance of foxtail millet.</p> <p>Accumulation of soluble carbohydrate of stem did not change of cv. 47, which decreased to 63 percent of the control in cv.46. PGR and NAR of cv.47 between heading and ripening were higher than cv.46. There was no varietal differences of transpiration and water use deficiency. Dry matter partitioning ratio to grain tended to increase in cv.47 and did not change in cv.46.</p> <p>Photosynthetic rate of both cultivar decreased to 70% by soil drying after heading. Photosynthetic rate, which cut panicle, decreased during 15 to 30 days after heading. These suggest that varietal difference of dehydration tolerance of foxtail millet accounted for activity of sink come from accumulation of soluble carbohydrate in the stem and amount of assimilation product after heading.</p>	

一般研究 24 General Research24	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researchers	大和 政秀 (千葉大学教育学部) Yamato, Masahide (Faculty of Education, Chiba University)	
研究課題 Research Subject	海浜植物群落におけるアーバスキュラー菌根菌群集の垂直分布に関する研究 Vertical distribution of arbuscular mycorrhizal fungi in a coastal vegetation	

共同研究要旨 Summary of Joint Research	<p>Most of coastal plants grow their roots deeply to avoid various environmental stresses near the soil surface. In this study, we investigated community structure of arbuscular mycorrhizal (AM) fungi in a coastal vegetation in the Arid Research Center at Tottori University in order to see the effect of soil depth on the AM fungal community.</p> <p>Five 10 m lines, parallel to the sea coast, were set at 5, 15, 25, and 35 m from the seaside edge of the vegetation, and three sampling points were arbitrarily determined for each line. Soil samples were collected for the 50 cm depth by using soil core sampler WLS1020 (ISIS), and the collected soil was divided at the 10 cm depth each.</p> <p>Total DNA was extracted from the fine roots isolated from the soil sample, and ITS2 rDNA of AM fungi and chloroplast DNA of plants were amplified by PCR using specific primer sets. The reads by NGS sequencing using Ion PGM was divided with 97% similarities to define operational taxonomic unit (OTU), and the reads of each OTU was used for multivariate analysis as well as environmental variables.</p> <p>NMDS analysis based on Bray-Curtis dissimilarities for the reads of OTU in each sample showed that the effects soil depth and distance from the sea were not significant for the community structure of AM fungi. The effect of soil depth was neither significant for the distribution of plant roots, meanwhile significant effect was found for the distance from the sea. Since some roots were collected from the depth of 40-50 cm, it is likely that plant roots would be distributed at the further deeper region. We will study the AM fungal community at the deeper soil region in the next fiscal year.</p>
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一般研究 25 General Research 25	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searchers	牧 輝弥 (金沢大学理工研究域) Maki, Teruya (College of Science and Engineering, Kanazawa University)	
研究課題 Research Sub- ject	ゴビ沙漠で発生するバイオエアロゾルの微生物の群集構造解析 Analysis of microbial communities in bioaerosols transported Gobi desert region	
共同研究要旨 Summary of Joint Research	<p>Asian dust events transport the airborne bacteria in Chinese desert regions as well as mineral particles and influence downwind-area varying biological ecosystems and climate changes. However, the airborne bacterial dynamics were rarely investigated in the Gobi Desert area, where dust events are high frequent. In this study, air samplings were sequentially performed at a 2-m high above the ground at the sampling site located in desert area (Tsogt-Ovoo of Gobi Desert, Mongolia). During the dust event days, the bacterial cells and mineral particles increased to more than ten folds of concentrations. MiSeq sequencing targeting 16S ribosomal DNA revealed that the airborne bacteria in desert area mainly belonged to the classes <i>Acidobacteria</i>, <i>Actinobacteria</i>, <i>Bacteroidetes</i>, <i>Chloroflexi</i>, <i>Bacilli</i>, <i>Alpha</i>-, <i>Beta</i>- and <i>Gamma-proteobacteria</i>. The bacterial community structures were different between dust events and non-dust events. The air samples collected at the dust events indicated high abundance rates of Alpha-proteobacteria, which were reported to dominate on the leaf surfaces of plants or in the saline lake environments. After the dust events, the members of <i>Firmicutes</i> (<i>Bacilli</i>) and <i>Bacteroidetes</i>, which are known to form endospore and attach with coarse particles, respectively, increased their relative abundances in the air samples. Presumably, the bacterial compositions and diversities in atmosphere significantly vary during dust events which carry some particles from grassland (phyllo-sphere), dry-lake, as well as sand surfaces, and some bacterial populations such as <i>Firmicutes</i> and <i>Bacteroidetes</i> maintain in atmosphere for longer time.</p>	

一般研究 26 General Research 26	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searchers	衣笠 利彦 (鳥取大学農学部) Kinugasa, Toshihiko (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	モンゴルの低嗜好性雑草 <i>Artemisia adamsii</i> の根系構造と地下貯蔵物質の動態 Root system architecture and dynamics of belowground storage resources in a low palatable weed, <i>Artemisia adamsii</i> , in Mongolia	

共同研究要旨 Summary of Joint Research	<p>We investigated the root system architecture of <i>Artemisia adamsii</i>, a weed in Mongolia of which palatability for livestock is low, and tested the contribution of matter transportation through rhizome connection (physiological integration) to the regrowth of ramets after clipping. In this year, we established the experimental system that enable to observe development of root system, and evaluated nitrogen (N) transportation between ramets through rhizome by applying stable isotope of N (^{15}N). We prepared root boxes of which inside dimensions were 45cm wide, 2 cm deep, and 30 cm high inside. The side of boxes was made with acrylic plate to observe root system architecture. After filling sand into root boxes, <i>A. adamsii</i> seeds were sown on the center of the boxes. At 90 days after sowing, roots of mother ramets already reached the bottom of root boxes, and the length between mother ramets and farthest daughter ramets was at most 17 cm.</p> <p>To confirm the physiological integration among ramets, we investigated the N transportation through rhizome by using ^{15}N. After clipping the daughter ramets farthest from mother ramets, ^{15}N labeled NH_4NO_3 was applied to the rhizosphere of mother ramets with limiting the diffusion of labeled N by inserting partition panels around the rhizosphere of mother ramets. 40 days after ^{15}N application, all ramets were sampled and their ^{15}N content were measured. ^{15}N content at 40 days after ^{15}N application was increased from that of pre-application not only in mother ramets but also in the daughter ramets that regrew after clipping. Thus we concluded that the regrowth of <i>A. adamsii</i> after clipping depend in part on physiological integration among ramets. Considering above results, in the next year, we will investigate the effect of rhizome disconnection on ramet regrowth after clipping and thereby we will discuss the method to control <i>A. adamsii</i>.</p>
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一般研究 27 General Research 27	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researchers	福澤 加里部 (北海道大学北方生物圏フィールド科学センター) Fukuzawa, Karibu (Field Science Center for Northern Biosphere, Hokkaido University)	
研究課題 Research Subject	森林における林床植生の除去が土壌水分および菌根菌組成に及ぼす影響 Effects of understory vegetation removal on soil moisture and mycorrhizal fungi composition in a forest	
共同研究要旨 Summary of Joint Research	<p>We investigate soil moisture and mycorrhiza infection rate of oak (<i>Quercus crispula</i>) fine roots before understory bamboo (<i>Sasa senanensis</i>) removal in a cool-temperate forest. We also quantified fine root of trees and <i>Sasa</i> and above-ground biomass of <i>Sasa</i>, and then considered the relationship between soil moisture, amount of <i>Sasa</i> and mycorrhiza infection rate. We established plots surrounding the mature oak trees in a natural forest in northern Hokkaido and measurements were conducted in each plot. We monitored soil volumetric water content at 5 cm soil depth continuously. We measured fine root biomass, root length, and specific root length (SRL) of trees and <i>Sasa</i> at each soil profile (organic layer, 0-10 and 10-20 cm soil). We also collected oak roots and measured mycorrhiza infection rate by stereo microscopic observation. Mycorrhizal analysis was conducted at Arid Land Research Center, Tottori University. We measured <i>Sasa</i> above-ground biomass, density and height of culm, and diameter at culm base. Soil volumetric water content was ranged in 22-56 %. It increased after rain event but spatial variation was larger than temporal variation. Soil moisture may be influenced by micro-topography in upper hill slope. Mycorrhiza infection rate had large variation ranging from 11 to 51 %. Fine root biomass was significantly larger in trees but root length based fine root amount of <i>Sasa</i> was comparable with that of trees. SRL was significantly larger in <i>Sasa</i>, showing that <i>Sasa</i> root was thinner than tree root. Amount of <i>Sasa</i> root was correlated with that of <i>Sasa</i> above-ground which was explained by culm density and culm base diameter. There was no clear relationship between mycorrhiza infection rate and amount of <i>Sasa</i> root, tree:<i>Sasa</i> root ratio or soil moisture. <i>Sasa</i> root spreads in soil efficiently by producing dense thinner roots, resulting in severe competition between trees and <i>Sasa</i> for soil resources.</p>	

一般研究 28 General Research 28	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	島田 章則 (麻布大学生命・環境科学部) Shimada, Akinori (School of Life and Environmental Science, Azabu University)	

研究課題 Research Subject	モンゴルの家畜の疾病診断調査 Diagnosis of the diseases of domestic animals in Mongolia
共同研究要旨 Summary of Joint Research	<p>Desertification, global warming and over population of the domestic animals induced the increase of plant poisoning and respiratory failure by sand dust in the Mongolian domestic animals including goats and sheep.</p> <p>Experimental pathological study using mouse renal epithelial cell culture showed that signs of mitochondrial damage and following mitophagy in electron microscopy. Study using rat renal epithelial cells, which are more vulnerable to the toxin compared to mouse cells, demonstrated that low level (10-50 µg/ml) of swainsonine, major toxin of the plant <i>Oxytropis glabra</i>, induced cytoplasmic vacuolar changes in the rat cultured cells, enabling further experimental study focusing on the electron microscopic analysis of the vacuoles with the use of small amount of the valuable toxin.</p> <p>In addition, field study of the Mongolian livestock demonstrated occurrence of iron deficiency anemia in the sheep flock with high mortality during harsh winter climate, suggesting anemia would be one of the factors responsible for the high mortality of the sheep flock. Prevention of the iron deficiency anemia by monitoring blood parameters and following treatment by iron supplement may make a great contribution in minimizing the livestock mortality in Mongolia.</p>

一般研究 29 General Research 29	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	岩永 史子 (鳥取大学農学部) Iwanaga, Fumiko (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	中国クブチ砂漠の埋砂・退砂環境における緑化樹種の水分生理特性と形態的適応に関する研究 Studies on water relations and morphological adaptability of reforestation trees under sand burial/exposure condition.	
共同研究要旨 Summary of Joint Research	<p>Desertification and soil degradation in arid area have expanding worldwide. In Kubuqi Desert, Inner Mongolia, China, <i>Populus simonii</i> Carr. is important species as stabilizer of moving sand dune by high survival rate and enormous root coppicing. Previous <i>Populus</i> studies proposed that success of root coppicing may need shallow root distribution and/or matured root system. However, it is still limited information about root coppice characteristics around moving sand dune where soil depth is variable.</p> <p>We surveyed root coppice frequency around sand dune and discussed the relationships between root coppice and root depth. We settled research plots around moving sand dune: a) top of moving sand dune; b) midslope of sand dune, c) flat area around sand dune. Most root coppice was observed in sand-dune top site, and least root coppice was observed in flat site.</p> <p>Root coppice number per planted tree was also same trend. Root system with root coppice were distributed between -150 and +10 cm soil depth, and most root coppice developed from roots between -10 and -5 cm soil depth. These results were consistent with previous reports that root coppice survival is correlated with root size and depth.</p> <p>Generally, there is a strong correlation between aboveground and belowground biomass. The successive shoot growth would have positive feedback on root growth. Thus, it is still obscure whether root coppice of <i>P. simonii</i> can be frequent on mature and large diameter roots. We will investigate coppice development and the survival on various sized roots treated by coppice stimulation.</p>	

一般研究 30 General Research 30	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	土屋 雄一郎 (名古屋大学トランスフォーマティブ生命分子研究所) Tsuchiya, Yuichiro (Institute of Transformative Bio-Molecules, Nagoya University)	
研究課題 Research Subject	鳥取砂丘に自生する寄生雑草ハマウツボのストリゴラクトン受容体の同定 Identification of strigolactone receptors in <i>Orobanchae coerulescens</i>	
共同研究要旨 Summary of Joint Research	<p>Parasitic plant of genera <i>Striga</i> causes huge damages on African crop productions. The plant hormone strigolactones (SLs) function as host factors that induce seed germination in <i>Striga</i>. Interestingly, the copy number of SL receptors are increased to at least 11 members, suggesting a functional diversification of SL receptors provides advantages to parasitic physiology. In this project I have been investigating SL receptors in <i>Orobanchae corulences</i>, which is a native specie in Tottori sand dunes, with a</p>	

	<p>goal to understand evolutionary relevance of copy number of the SL receptors in Orobanchaceae.</p> <p>In <i>Orobanche aegyptiaca</i> and <i>Orobanche minor</i>, pre-conditioning of dormant seeds potentiate their response to SLs along with increased expression of SL receptors. To survey SL response in <i>O. corulences</i>, I harvested the dry seeds in June 2016. After maturation and pre-conditioning at 4°C, 25°C or 30°C for two weeks, however, the seeds still do not respond to synthetic SL GR24. There are two possible explanations. First, the pre-conditioning method is not suitable to this particular parasitic plant specie. Second, <i>O. corulences</i> do not respond to SLs but other unknown host factors. I will continue to modify pre-conditioning methods along with testing other candidate germination stimulants. After establishment of pre-conditioning, I will identify SL receptors by RNA-seq method.</p>
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一般研究 31 General Research 31	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researchers	登尾 浩助 (明治大学農学部) Noborio, Kosuke (School of Agriculture, Meiji University)	
研究課題 Research Subject	安定同位体比を指標にした砂丘農地の窒素循環解析:地下水面上部の NO ₃ ⁻ の挙動解析 Soil Nitrogen Dynamics in an Agricultural Sandy Field using Stable Isotope: Dynamics of NO ₃ ⁻ above Groundwater	
共同研究要旨 Summary of Joint Research	<p>Objectives and Methods:</p> <p>To investigate a suppression method of NO₃⁻ leaching with capillary barriers, an in-situ irrigation experiment was carried out. Moreover, we determined nitrate reduction rates with batch tests and infiltration experiments.</p> <p>1. In-situ irrigation experiment In a sand field at ALRC, a capillary barrier was installed at a depth of 30 cm. We measured volumetric water content (θ) above the capillary barrier.</p> <p>2. Batch test To obtain nitrate reduction rate, sand was saturated with potassium nitrate solution including 5 mg sugar or not. Periodically, nitrate concentration and electrical conductivity (EC) were measured.</p> <p>3. Lab infiltration experiment The soil sample was obtained from the field for in-situ irrigation experiment during pre-harvesting period of shallots. The soil was packed homogeneously, and potassium nitrate solution (0.05 mol L⁻¹) was added on the soil surface. Drainage was obtained at the bottom of soil column to measure nitrate concentration and EC.</p> <p>Results:</p> <p>Use of the sand field at ALRC allowed us to investigate a suppression method of NO₃⁻ leaching with capillary barriers.</p> <p>1. Comparison of θ at a depth of 15 cm with a depth of 30 cm, capillary barrier effect was confirmed at EM plot. Water entry value was 7.2 cm, and θ was 0.32 m³ m⁻³ (Magara et al., 2016) .</p> <p>2. In the case of sugar addition, EC decreased from 6.5 to 6.0 dS m⁻¹ for 5 days. This suggested that nitrification occurred even in a sand field.</p> <p>3. Nitrate reduction was also confirmed based an analyses of drainage samples using ion chromatography.</p>	

一般研究 32 General Research 32	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researchers	近江戸 伸子 (神戸大学大学院人間発達環境学研究科) Ohmido, Nobuko (Graduate School of Human Development and Environment, Kobe University)	
研究課題 Research Subject	ジャトロファの遺伝子組換え体の繁殖ならびに染色体に関する研究 Transformant propagation and chromosome research in <i>Jatropha</i>	
共同研究要旨 Summary of Joint Research	<p>In this study, early flowering gene transformation was produced and evaluated in <i>Jatropha</i> plants. In the recombinant production experiment, the coexisting culture medium was changed from the agar to the filter paper medium. As a result, the survival rate of the plants (17.5%) became higher in the filter paper medium. In this study, transformation experiments were conducted 42 times in total for 2 years, and the conditions for transformant were examined. Eventually, there were no individuals rooted and not able to be induced in the soil culture medium. Since many individuals were resulting in death reproductively, then overexpressing <i>FT</i> gene is considered to disturb the plant metabolism.</p> <p>In <i>Jatropha</i> chromosome analysis by the FISH method, specific retrotransposons exist in a higher amount in the heterochromatin region. In addition, signals were observed near on the end of the chro-</p>	

	<p>mosomes. Since 29.9% of the <i>Jatropha</i> genome is constructed from retrotransposon, analysis of repetitive sequences is important to understand <i>Jatropha</i>'s genome diversity and evolution.</p> <p>By grafting experiments, we examined the shortening of the growth cycle of genetically modified plants and the mass propagation. In grafting experiments between plants of ordinary soil cultivation, scion adhered to the rootstock and grew well. On the other hand, the plants on the culture medium were not able to adhere, and the scion was resulting death in the 2nd day. Cultured plants <i>in vitro</i> seems to fail to adapt the natural environment, because they grew in a sterile condition and in a humid environment. As future developments, transformants are necessary to examine the possibility of vegetative propagation for <i>Jatropha</i> breeding resources. We should examine whether to propagate the <i>Jatropha</i> transgenic plant by grafted or cutting trees system.</p>
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一般研究 33 General Research 33	対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researchers	坂本 敦 (広島大学大学院理学研究科) Sakamoto, Atsushi (Graduate School of Science, Hiroshima University)	
研究課題 Research Subject	ストレス応答のプライミング現象を利用した環境温度耐性植物の作出 Production of temperature-tolerant plants based on stress-priming phenomena	
共同研究要旨 Summary of Joint Research	<p>When plants are exposed to non-serious stress conditions or certain chemical agents, whether natural or synthetic, they often induce a unique physiological state called “priming”. Primed plants show either rapid, better, or both activation of the cellular defense responses, which is often associated with increased tolerance to both various abiotic and biotic stresses. Thus, induction of the priming state is considered to provide plants with a better strategy to cope with unfavorable or stressful conditions. Allantoin is a major intermediary metabolite of purine ring degradation, and has been reported to accumulate in several plant species, including <i>Arabidopsis</i> and rice, in response to various environmental adversities. Recently, we reported that this purine metabolite could prime abiotic stress responses in <i>Arabidopsis</i>. In fact, drought and osmotic stress tolerance was significantly augmented in <i>ALLANTOINASE</i>-knockout (<i>aln</i>) mutants of <i>Arabidopsis</i> that accumulated allantoin due to the loss of the catabolic enzyme. The <i>aln</i> mutants moderately activated several genes involved in heat acclimation under normal conditions, suggesting that allantoin might also increase heat tolerance. In response to heat shock (HS), <i>aln</i> mutants enhanced the extent of HS-responsive gene expression. Moreover, both <i>aln</i> mutation and exogenously supplied allantoin caused higher survival of <i>Arabidopsis</i> seedlings upon exposure to HS. These results suggested that allantoin might alleviate HS stress.</p>	

一般研究 34 General Research 34	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	加納 靖之 (京都大学防災研究所) Kano, Yasuyuki (Disaster Prevention Research Institute, Kyoto University)	
研究課題 Research Subject	史料の収集・翻刻・解析による過去の黄砂の調査 Interpretation of Historical Documents on Asian Dust Event	
共同研究要旨 Summary of Joint Research	<p>We developed online database for historical Asian dust event based on <i>Nihon Kishou Shiryou</i> (Collection of materials for the history of Japanese weather events). <i>Nihon Kishou Shiryou</i> is the compilation of articles describing meteorological phenomena such as Storm, flood, thunder, tornado, drought, long rain, snow, hail, frost, anomalous cloud, rainbow, fog, aurora, season, drop of anomalous material. Articles are quoted from historical documents with date of the events in Japanese and western calendar, and reference information,</p> <p>We referred existing database on earthquake (Yamanaka et al., 2016) to choose the items to be included in the database. Here we chosen (1) name of the source, (2) Date of the event in Japanese and western calendar, (3) type of the events, and (4) description in the document. The time and place of the observation of events are included in (4).</p> <p>In addition to development of the database, we transcribed the historical documents which are not collected in <i>Nihon Kishou Shiryou</i> Including the diaries and newspapers describing the mud rain event in 1882. The number of articles in the database is 300. The URL of the database is http://tensaichihen.info/.</p>	

一般研究 35 General Research 35	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searchers	清水 英幸 (国立環境研究所地域環境研究センター) Shimizu, Hideyuki (Center for Regional Environmental Research, National Institute for Environmental Studies)	
研究課題 Research Sub- ject	水欠乏環境における半乾燥地域の植物種のオゾン応答 Response to ozone of semi-arid plant species under water deficient condition	
共同研究要旨 Summary of Joint Research	<p>Various simulations have shown that air pollution such as ozone is expanding to semi-arid grassland in the North-East China. Because of no available data, we clarify the impacts of ozone on major plant species constituting semi-arid grassland in these regions, from the viewpoint of combined effects with water deficiency, in order to accumulate the basic information for vegetation conservation/recovery.</p> <p>From the germination tests of preserved seeds of major shrub species, <i>Artemisia halodendron</i> was selected for the next growth experiments.</p> <p>Each seedling of 2-6 weeks after sowing were transplanted to a pot (100 mm × 40 cm²) packed with river-sands (similar particle size composition of Mu Us Sandy Land) and grown for 4-8 weeks in a glasshouse. Plants were treated with 4 water regimes (30, 60, 90 or 120mm precipitation/month) and 2 ozone exposure (0 or 50 ppb) with using the environment- controlled plant growth cabinets (14-hr light/10-hr dark period, 1,200 μmol m⁻² s⁻¹ photon flux density, 25/15°C (light/dark), 50/60%RH (light/dark)). Growth experiments were conducted for 4 weeks, with irrigating every 2-3 days. The mean water potentials during the treatment period were -15.2, -6.7, -3.1, -2.6 kPa.</p> <p>No significant visible injury was observed during ozone exposure, while plant growth was suppressed by ozone. Plant growth was promoted by 120 mm water treatment, while inhibited by 60 and 30 mm treatments, compared with 90 mm treatment (control). The total number of leaves per plant increased as the amount of irrigation increased, whereas the number of dead leaves increased as the amount of irrigation decreased. Ozone exposure tended to increase the total number of leaves and the number of dead leaves. Comparing the impacts of ozone exposure in plants of each water treatment, the growth was suppressed and the leaf senescence was accelerated by ozone in all water-treatments. Particularly, the ozone impacts were remarkable in the 90 and 60 mm water treatments. In the 30 mm water treated plants, development of new leaves was suppressed extremely regardless of ozone exposure.</p> <p>Eco-physiological analyses such as NAR, assimilate partitioning, etc. with statistics and combined effects of water deficiency and ozone are currently being analyzed.</p>	

一般研究 36 General Research 36	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searchers	西原 英治 (鳥取大学農学部) Nishihara, Eiji (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	乾燥地に生育する薬用植物ウラルカンゾウの主根に含まれるグリチルリチン蓄積の促進方法 Promoting method of glycyrrhizin accumulation induced in taproot of licorice (<i>Glycyrrhiza uralensis</i> Fisher) growing on arid land	
共同研究要旨 Summary of Joint Research	<p>This study aimed to research the effects of application of additional fertilizer in spring and summer for the growth of licorice and glycyrrhizin (GL) contents in root. The experiment was carried out in the field of Arid Land Research Center. The appropriate amount and time of additional fertilizer application were determined. The seedlings of licorice were transplanted in the farm on June 18, 2015. The methodology was as follows: two rows per ridge, interval of the ridge: 115cm, and planting density: 5000plant/10a (35cm×30cm), rain-fed cultivation. Ridges were covered with silver plastic mulching film. The amount of basal fertilizer was applied as follows, cow manure of 20t/ha, dolomite of 1t/ha, and chemical fertilizer of N-P₂O₅-K₂O=340-190-180kg/ha. The four treatments were established while making several combination of different amount and time of additional fertilizer application. The times of application were May 30, 2016 (spring) and August 26, 2016 (summer). Total amount of additional fertilizer were N: 320kg/ha, P₂O₅: 70kg/ha, K₂O: 240kg/ha. Treatment-1: No additional fertilizer, Treatment-2: 100% of N and K₂O were applied at spring, Treatment-3: Amount of application N and K₂O were distributed in spring and summer (3:1), Treatment-4: Amount of application N and K₂O were distributed in spring and summer (1:1). P₂O₅ was applied at only spring in Treatment-2, 3 and 4. The investigation dates were May 30, August 26 and November 18, 2016. We measured dry matter</p>	

	weight of licorice and the contents of glycyrrhizin in root. As a result, the dry matter weight of licorice was the highest in Treatment-2. In particular, the dry matter yield of underground part of licorice was 4t/ha in Treatment-2 in November. Thus, it was suggested that the additional fertilizer (N-P ₂ O ₅ -K ₂ O=320-70-240kg/ha) until May is effective for the increase of the dry matter yield of underground part. It was confirmed that the contents of GL in root dramatically increased from August to November, regardless of difference in the amount and time of additional fertilizer application.
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一般研究 37 General Research 37	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researchers	依田 清胤 (石巻専修大学工学部) Yoda, Kiyotsugu (Faculty of Science and Engineering, Ishinomaki Senshu University)	
研究課題 Research Subject	乾燥が樹木の木部通道組織の内腔構造に及ぼす影響の解剖学的解析 Analytical study of drought effects on internal structure of xylem conduits of trees	
共同研究要旨 Summary of Joint Research	<p>Tree hydraulics interrelates closely to environmental water conditions via leaf evaporation and root water absorption. However, the mechanism to sustain the continuity of liquid phase from roots to leaves is still debating, especially for embolism formation and recovery. Patterns of water flow in excised branches and in extra-thin tubes as single-vessel model were investigated to assess the characteristics of sap flow more precisely. Branches of <i>Zelkova serrata</i> (Ulmaceae, deciduous broad-leaved tree with typical ring-porous wood) were used for sap flow experiment, measuring electrical potentials under suction treatment. Extra-thin tubes inserting micro-filters (pore size: 0.22um) were used to investigate the pattern of water flow through two single vessels intervened by end-wall pit membranes. Liquid and/or vapor phases of water stream in the tubes under suction treatment were monitored by photo-interrupting detector.</p> <p>Variations of electrical potential were detected in branch samples under suction treatment. Rectangular waves repeated in tens of seconds' interval when the potential falling was small, whereas in the case of large potential falling, signal waves altered to pulse-like forms. All these waves disappeared and potential levels returned to their initial state after the cessation of suction treatment. In the single-vessel model experiment, serial rectangular waves were detected along the down-stream of filter-insertion point in extra-thin tubes. The rectangular waves indicated the flow of liquid phase in the tubes, which transformed into pulse-like one in the stream downward. All these signals disappeared after finishing suction treatment. Results mentioned above suggest that sap flow may be characterized as a stream of alternative liquid and vapor phases, or two-phase flow, in trees.</p>	

一般研究 38 General Research 38	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	近藤 謙介 (鳥取大学農学部) Kondo, Kensuke (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	塩水利用による間断施肥管理法に関する研究 Studies on utilization of saline water for intermitted fertilization management method	
共同研究要旨 Summary of Joint Research	<p>The objective of this study was to investigate the utilization of saline water for intermitted fertilization management method for hydroponic systems on the growth and quality of Mizuna. Mizuna 'Kyomizore' seeds were sown twice (March 17th and October 18th, 2016) in urethane foam with tap water in a greenhouse. The seedlings were transplanted to a deep flow technique system for 28 days and harvested (May 10th and November 29th). The experiment involved 4 treatments with differing concentration of saline water (0 mM NaCl, 50 mM NaCl, and 100 mM NaCl). Quarter strength OAT-house-A solution was used during all cultivating periods as a control. Treatments intermitted all nutrient solution by changing top water every 7 days. This hydroponic system treatment is called the intermitted fertilization management method. The maximum growth was in control. 0 mM NaCl and 50 mM NaCl treatments were bigger than 100 mM NaCl treatment compared with three differing intermitted fertilization management treatments. On the other hand, the three differing intermitted fertilization management treatments reduced nitrate concentration and increased total sugar and ascorbic acid content compared with the control. Moreover, 50 mM NaCl treatment's ascorbic acid content intended to higher than other treatments. These results indicated that the growth of 0 to 50 mM NaCl treatment</p>	

	was same as control and improved quality.
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一般研究 39 General Research 39	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	大手 信人 (京都大学情報学研究科) Ohte, Nobuhito (Graduate School of Informatics, Kyoto University)	
研究課題 Research Subject	モンゴルゴビステップの養分循環における key resource 群落を含む多年生草本種の役割 Studies on molecular mechanisms of stress resistance in wild tomatoes	
共同研究要旨 Summary of Joint Research	<p>“Key resource” means the vegetation resources which available for forage by livestock under the meteorological calamity such as drought and dzud. The ecological information of key resource was required for appropriate vegetation management and conservation. In Mongolian Gobi steppe, <i>Achnatherum splendens</i> which have large biomass perennial grass is the most important key resource species. In this study that entitled “Study of the nitrogen cycle and utilization of herbaceous species in Mandal Gobi, Mongolia” was intended to clarify the importance of nutrient cycle for a growth of herbaceous species included <i>A. splendens</i> as the key resource in Mongolian Gobi step.</p> <p>We already take the soil samples from four typical vegetation plot by the previous study (2012 – 2013, 2016, General research) and, soil organic and inorganic nitrogen concentration and isotope ratio of soil extract solution were measured. From these results, under <i>A. splendens</i> community showed significantly higher soil organic and inorganic nitrogen concentration than other vegetation. Nitrogen isotope ratio of nitrate corresponded with the ratio of organic nitrogen and it assumed most of all nitrogen which produced by the mineralization converted to nitrate. Higher soil organic compound and nitrification capacity of the large <i>A. splendens</i> community may have an important role in soil nutrient cycling in Mongolian rangeland.</p>	

一般研究 40 General Research 40	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Researchers	齊藤 忠臣 (鳥取大学農学部) Saito, Tadaomi (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	樹木の水ポテンシャル・体積含水率・電気伝導度の同時測定と水ストレス指標としての評価 Simultaneous monitoring of water potential, water content and electrical conductivity of trees and its evaluation as water stress indices	
共同研究要旨 Summary of Joint Research	<p>Trees in arid and semi-arid regions have several mechanisms to make efficient use of limited water resources to survive harsh conditions. Monitoring of water condition indices of trees are important for to clarify such mechanisms. The objective of this study was simultaneous monitoring of water potential, water content and electrical conductivity of trees and its evaluation as water stress indices.</p> <p>A field experiment was conducted to monitor above indices using several sensors. The target tree was <i>Machilus thunbergii</i> in the campus of Tottori University. Stem water potential was measured by a newly developed stem psychrometer (PSY-1). Stem water content and electrical conductivity were measured by capacitance sensors (GS3). Sap flow was measured by a sap flow sensor (SFM-1). Monitoring of soil water content at different depths using capacitance sensors and monitoring of metrological conditions were also conducted around the tree.</p> <p>The monitoring results from the PSY-1, SFM-1 and GS3 sensors showed that the velocity of the sap flow increased with decrease in the stem water potential, and then the stem water content decreased clearly with increase in the velocity of the sap flow, meaning simultaneous monitoring of stem water potential, sap flow and stem water content is important to clarify water use characteristics of trees.</p>	

(4) 若手奨励研究/ Incentive Research by Young Scientists

若手奨励研究 1 Incentive Research by Young Scientists 1	対応教員 Corresponding Staff	エルタイプ・アミン Eltayeb Habora Amin
研究代表者 Principal Researchers	永野 惇 (龍谷大学農学部) Nagano, J. Atsushi (Faculty of Agriculture, Ryukoku University)	

研究課題 Research Subject	ステイグリーンソルガムの RNA-Seq による干ばつ耐性機構の研究 Transcriptomic analysis of the drought tolerance mechanism in the stay-green Sorghum
共同研究要旨 Summary of Joint Research	<p>Four QTLs of stay-green trait has been reported in Sorghum bicolor. However, the causal genes of the QTLs were not identified and molecular mechanisms of stay-green trait were largely unknown. The aim of this project is to investigate molecular mechanisms of stay-green trait and its notable drought tolerance.</p> <p>Two parental strains and four NILs were cultivated in Tottori University. Physiological traits including drought tolerance of these lines were evaluated. Mature leaves were collected during the cultivation. Total RNA were extracted from the leaves used for RNA-seq library preparation. Samples were composed of 3 replicates of 2 parental lines and 2 NILs in 2 conditions (drought / control). In total, 24 libraries were prepared. The libraries were sequenced in 1 lane of HiSeq2500. Average of read number obtained per a sample was 6.9 M reads. The sequence read data were analyzed with RSEM software to quantify gene expressions. Now, we are analyzing the quantitative data of transcriptomes of stay-green Sorghums to reveal molecular mechanisms of its drought tolerance. Especially, we focus on genes associated with plastid differentiation and chlorophyll metabolism because it has been suggested that these processes play important roles in stay-green traits. We are also trying to perform an integrative analysis of our transcriptome data and previously-reported QTL analysis data.</p>

若手奨励研究 2 Incentive Research by Young Scientists 2	対応教員 Corresponding Staff	伊藤 健彦 Ito, Takehiko
研究代表者 Principal Researchers	吉原 佑 (三重大学生物資源学研究所) Yoshihara, Yu (Graduate School of Bioresources, Mie University)	
研究課題 Research Subject	植物種の消失が植物の生産性と土壌微生物の活性に与える影響 The effects of plant species loss on plant productivity and soil microbial activity	
共同研究要旨 Summary of Joint Research	<p>Ecosystem functions are threatened by continuing global loss of biodiversity. Both multifunctionality and realistic nonrandom extinction scenarios are noteworthy approaches for evaluating ecosystem function, along with biodiversity loss, from the viewpoint of ecosystem management. Thus, we simultaneously investigated four ecosystem functions following potential species extinction scenarios in a Mongolian grassland. ANPP, forage nutrient values, litter decomposition rate, and soil respiration rate were measured one and/or two years after the plant removal experiment. Analysis of correlation was performed between soil microbial diversity and the ecosystem functions. Among ecosystem functions, ANPP decreased, litter decomposition rate decreased, and forage quality increased the under the random, rare species, and dominant species extinction scenarios, respectively. Diversity and species composition of soil microorganism was not affected by plant species richness or removal scenario. Only genus-level diversity of bacteria and ANPP was significantly correlated for the relationship between microbial diversity and ecosystem functions. Ecosystem functions were relatively robust to realistic disturbances and species extinction in natural grasslands. However, as each function responded differently to the order of species loss, the consequences of realistic nonrandom extinction scenario and multiple ecosystem functions should be critical in the study of the relationship between biodiversity and ecosystem functions to manage the ongoing biodiversity loss caused by various disturbances.</p>	

若手奨励研究 3 Incentive Research by Young Scientists 3	対応教員 Corresponding Staff	岡本 昌憲 Okamoto, Masanori
研究代表者 Principal Researchers	中道 範人 (名古屋大学トランスフォーマティブ生命分子研究所) Nakamichi, Norihito (Institute of Transformative Bio-molecules, Nagoya University)	
研究課題 Research Subject	新規時計調整化合物を用いた植物の乾燥耐性付与技術の開発 Improving drought stress responses by novel plant clock modulators	
共同研究要旨 Summary of Joint Research	<p>Plant circadian clock regulates daily timing of genetic, metabolic, and physiological process, including water stress responses. Some of these processes are attenuated or enhanced by clock-associated genes mutations. For improving water stress responses by other than genetic mutations or breeding, we assumed that newly identified small molecules that perturb clock function, may be utilized.</p> <p>We administrated four clock modulators to <i>Arabidopsis thaliana</i>, and analyzed expression of genes</p>	

	<p>implicated in water stress responses, and also directly regulated by the clock-associated transcription factors. We found that expression of a gene encoding key transcription factor involved in water-stress responses (<i>Dehydration response element binding 1 C: DREB1C</i>) was up-regulated by one-day treatment of compound A. In order to examine whether treatment of compound A confers water stress tolerance to <i>Arabidopsis thaliana</i>, plants were treated with compound A for a day, and transferred into media containing high salinity as first trial because salt test can be done with few amount of compound. Over 90% of seedlings without pre-treatment of compound A resulted in bleaching phenotype by high-salinity (300 mM NaCl), whereas only 40% of seedlings treated with compound A (25 μM) bleached by high-salinity. Pre-treatment of compound A also gave tolerance to seedlings by relatively low-salinity (150 and 200 mM). These results indicate that compound A is potent molecule to improve water stress tolerance. We will perform drought stress test for <i>Arabidopsis</i>, wheat, and soybean treated with compound A in next fiscal year.</p>
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若手奨励研究 4 Incentive Research by Young Scientists 4		対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	鈴木 康平 (名古屋大学大学院環境学研究科) Suzuki, Kohei (Graduate School of Environmental Studies, Nagoya University)		
研究課題 Research Subject	モンゴルステップにおける植生劣化地図の作成~ Degradation mapping of vegetation in Mongolian steppe		

若手奨励研究 5 Incentive Research by Young Scientists 5		対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researchers	竹中 祥太郎 (龍谷大学農学部) Takenaka, Shotaro (Faculty of Agriculture, Ryukoku University)		
研究課題 Research Subject	4 倍性コムギにおけるアブシシン酸感受性の遺伝学的解析 Genetic analysis of abscisic acid sensitivity on tetraploid wheat		
共同研究要旨 Summary of Joint Research	<p>Abscisic acid (ABA) is known as a phytohormone related to environmental stress such as drought-resistance. ABA is present in common to all land plants and contributes to drought stress by promoting stomatal closure and/or accumulation various compatible solute. Therefore, ABA sensitive wheat is expected to be excellent in drought tolerance.</p> <p>Our previous studies have shown that tetraploid wheat is rich in diversity of ABA sensitivity. In this study, we are advancing QTL-seq analyses for ABA sensitivity. We used two F₂ populations (each 120 seeds) crossed between standard line (<i>T. t. ssp. durum</i> cv. Langdon) and ABA hyper-sensitive line (4x033: <i>Triticum turgidum</i> ssp. <i>dicoccoides</i>), ABA hyper-insensitive line (4x062: <i>T. t. ssp. dicoccum</i>). ABA sensitivity was evaluated by the shoot length with ABA treatment (0.25 μM).</p> <p>Vary range of ABA sensitivity variations were detected in both F₂ populations. We selected more ABA sensitive and less ABA sensitive individuals (ca. 20 individuals) from both populations (total 80 individuals). They were genotyped by RAD-seq method.</p> <p>Now, we are searching SNPs which are closely linked to ABA sensitivity from the RAD-seq data.</p>		

若手奨励研究 6 Incentive Research by Young Scientists 6		対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Researchers	徳本 家康 (佐賀大学農学部) Tokumoto, Ieyasu (Faculty of Agriculture, Saga University)		
研究課題 Research Subject	脱石油依存による循環型乾燥地農業の構築;不耕起栽培と水中放電分解による液肥の利用 Development of recycling-based arid land agriculture due to extrication from dependence on oil; No-till farming and utilization of decomposed liquid fertilizer by underwater sparks		

共同研究要旨 Summary of Joint Research	<p>As one of non-tillage cultivation methods, we used the spot drilling method with an artificial macropore.</p> <p>To maintain the macropore and facilitate the root growth, rice hulls were inserted in the macropore. In 2016, we determined the water balance to understand water flow due to heterogeneous root distribution. Two dimensional pressure head profile around the roots were measured with tensiometers to figure out relationship between water flow and root distribution. Our findings were:</p> <ol style="list-style-type: none"> 1. When the amount of irrigation was regarded as 100%, evapotranspiration reached 152%. In the case, the amount of evaporation was 114%, suggesting that root water uptake was 38%. This indicated the increase in water retention due to rice hulls in the macropore. 2. Because of filled macropore with rice hulls, pressure head was measured successfully. After irrigation, infiltration rate was 10 times as high as saturated conductivity of the soil for the non-tillage cultivation method. 3. Spatial variability of water content was observed based on preferential flow through the macropore. This suggests that relevant determination of the amount of irrigation seems difficult using soil moisture sensors on the soil surface. <p>Moreover, development of decomposed liquid fertilizer by underwater sparks was carried out at Osaka University. We will evaluate the liquid fertilizer using the non-tillage cultivation method in 2017.</p>
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若手奨励研究 7 Incentive Research by Young Scientists 7	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researchers	大西 一成 (山梨大学総合研究部医学域附属出生コホート研究センター) Onishi, Kazunari (Center of Birth Cohort Studies, Interdisciplinary Graduate school of Medicine, Yamanashi University)	
研究課題 Research Subject	黄砂・大気汚染物質濃度上昇イベントにおける健康影響評価 Adverse health effect of Asian dust and air pollution	
共同研究要旨 Summary of Joint Research	<p>We administered diary-style web questionnaires to 104 volunteers who lived in Yonago City between 2013 and 2015. The subjects answered questions regarding symptoms related to the nose, throat, eyes, respiratory system, skin, body temperature, occurrence of headaches, and stress levels, as well as about the occurrence of common cold and influenza. The results were evaluated using a 6-level subjective symptom score (29 variables in total). We used the Japan Meteorological Agency's method of determining the occurrence of Asian dust on each day. Data on climate (temperature, humidity, and atmospheric pressure) were used as covariates. The data were analyzed using t-test, as well as linear and logistic mixed models, and subjected to a multifaceted investigation, including covariate adjustment.</p> <p>Statistically significant differences were observed in 23 of the 29 variables, between participants' symptoms on Asian dust day and the non Asian dust day. The difference in scores for skin tenderness on the Asian dust day compared to the non Asian dust day was 0.11 (95% CI: 0.06-0.15, $p < 0.001$), suggesting that it is associated with Asian dust. Moreover, the odds ratio for the development of skin tenderness on the Asian dust day compared to the non Asian dust day was 3.2 (95% CI: 1.34-7.63, $p = 0.008$). A strong correlation was also observed for symptoms in the eyes, nose, respiratory and throat.</p> <p>The effect of Asian dust on the eyes, nose, respiratory, and skin was confirmed by the data collected over 3 years. We also confirmed that the participants developed symptoms related to the skin, which are considered a characteristic of exposure to Asian dust. In the future we plan to study symptoms related to the skin using Light Detection and Ranging (LIDAR) as an indicator of Asian dust, and investigate the synergistic effects of pollen, other air pollutants, heavy metals, and microorganisms with Asian dust.</p>	

若手奨励研究 8 Incentive Research by Young Scientists 8	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researchers	辻 渉 (鳥取大学農学部) Tsuiji, Wataru (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	“Hardening”を利用した耐乾性向上栽培技術の開発とその作用機構の解明 Development of cultivation technology to enhance drought resistance using “Hardening”, and elucidation of its mechanism	

(5) 研究集会/ Research Meeting

研究集会 1 Research Meeting 1	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researchers	篠田 雅人 (名古屋大学環境学研究所) Shinoda, Masato (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Subject	砂漠化の歴史を編む Compiling the history of desertification	
共同研究要旨 Summary of Joint Research	The present project aimed at compiling the history of desertification since agriculture was developed about 11,000 years ago in the fertile crescent area of West Asia. We had three meetings; 1) Public Symposium of the Japanese Association for Arid Land Studies "Compiling the History of Desertification", 2) Open Seminar of the Arid Land Research Center "Development of Mesopotamian Civilizations and Salinization", 3) 3rd Symposium "Compiling the History of Desertification" held at the 2018 Joint Research Meeting of the Arid Land Research Center. These opportunities led to an application for JSPS KAKENHI "Why has herding occupation on the Eurasian Steppe survived for several thousands of years."	

研究集会 2 Research Meeting 2	対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researchers	土本 卓 (大阪大学工学研究科) Tsuchimoto, Suguru (Graduate School of Engineering, Osaka University)	
研究課題 Research Subject	乾燥地油料作物研究会 Workshop on oil crops in arid lands	
共同研究要旨 Summary of Joint Research	As the workshop on oil crops in arid lands, International Conference "10th International Symposium" Exploring the Global Sustainability -Advances in Plant Biotechnology for Agriculture in semi-arid land – "was held from March 14 to 15 at the meeting room of Icho-kaikan in Osaka University (Yamadaoka 2-2, Suita-City, Osaka). The number of participants was 29 on 14 th , 27 on 15 th , and 32 in total. Eighteen oral presentations were performed, including two Keynote lectures on 14 th ; "Development of Next-Generation Sustainable Land Management (SLM) Framework to Combat Desertification: Our new research in Ethiopia supported by SATREPS project " by Prof. Tsunekawa of Arid Land Research Center and "Epigenome editing in plants by grafting" by Prof. Harada of Hirosaki University. Other presenters were Prof. Fujimaki of Arid Land Research Center, Prof. Wallach of The Robert H. Smith Faculty of Agriculture, Food and Environment (Israel), Prof. Kitaya and Dr. Okazawa of Osaka Prefecture University, Prof. Iwase of Teikyo University of Science, Prof. Ohmido of Kobe University, Dr. Takeuchi of Shizuoka University, Dr. Cartagena of Nagoya University, Mr. Fushimi of JIRCAS and Ms. Tanaka of Osaka College of High Technology, etc. Our group of Osaka University also had 3 presentations. Discussions were actively conducted among researchers with various backgrounds. Especially for the researchers of molecular biology, the knowledge and opinions of the field researchers were quite useful, and such impressions were actually received from the participants. We think that this meeting may contribute to development of this field.	

(6) 海外研究者招聘型共同研究/ Guest Research Associate for Joint Research Program

海外研究者招聘型共同研究 1 Guest Research Associate for Joint Research Program 1	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researchers	ティラル サイド アブデルハリム (スーダン農業研究機構白ナイル試験場) Tilal Sayed Abdelhalim Musa (White Nile Research Station, Agricultural Research Corporation, Sudan)	
研究課題 Research Subject	ソルガムの干ばつ耐性を強化する野生ソルガム遺伝子の QTL マッピング QTL mapping of wild sorghum genes to enhance drought tolerance in sorghum	

<p>共同研究要旨 Summary of Joint Research</p>	<p>Part-1: Introgression of drought and Striga tolerance gene(s) from wild sorghum into elite Sudanese sorghum cultivars</p> <p>The recurrent parent in this part was the Sorghum bicolor cultivar Arfadamek-8 (high yielding cultivar with wide adaptation in rainfed areas of Sudan). The donor parent was an accession of the presumed wild relatives of Sorghum bicolor var arundinaceum, which is well-known for its low strigolactones producing capacity and high tolerance to moisture stress. Population development was carried out during April, 2014 at the research farm of the Gezira Research Station, Agricultural Research Corporation, ARC, Wad Medani, Sudan. The program commenced with a cross between AG-8 as the female parent, and PQ-434 as the male parent. The F1 progenies were then backcrossed to the recipient parent to generate the BC1F1. The later was then backcrossed again to the recipient parent resulted in BC2F1 seeds. The seeds were then selfed to generate F2 population. Agronomic data on performance of sorghum plants including plant height, number of tillers, number of leaves, flag leaf width and length, exertion chlorophyll contents and number of days to blooming were recorded. At physiological maturity, panicle width and length, grain yield per plant and 1000 seeds weight were measured.</p> <p>A high-throughput mini- DNA extraction protocol was followed for DNA extraction from parental lines and BC2F2 populations using modified CTAB protocol. For genotyping, 280 SRR primers will be screened for polymorphisms using DNA from the parental lines. Only polymorphic SSR primers will be tested across the BC2F2 populations. Furthermore, 5 specific SSR markers related to low germination stimulant gene(s) will be screened for BC2F2 population. Genotypes from each individual are to be scored as being one of the parental genotypes or as being heterozygous. Individual genotypes and corresponding phenotypes will be entered into MapMaker 3.0 and QTL Cartographer. A QTL map and marker linkage data will be generated using segregation data.</p> <p>Part 2: Assessing genetic diversity in Sudanese wild sorghum using SNPs and DArT markers system</p> <p>The study on genetic diversity among Sudanese wild sorghum is critical to success in plant breeding, as it provides information on the quantum of genetic divergence, which serves as a platform for specific breeding objectives. With recent advances in genomics research, DNA markers assume much more significance. The objectives of this work were therefore to 1): develop a sorghum diversity array for DArT genotyping, 2): determine linkage map positions of polymorphic DArT and 3): asses useful of DArT technique in diversity studies on set of diverse Sudanese sorghum germplasm, including elite Sudanese cultivar. Seeds of 65 wild and/or weedy species of Sudanese sorghums locally called Adar, well-known for their drought tolerance and Striga resistance, were collected from the border areas between Sudan, Eriteria and Ethiopia, a place where sorghum is postulated to be domesticated for the first time, 5000 years ago. Young leaves of the seedlings from 65 wild sorghum genotypes, were collected, transferred to 2 mL Eppendorf tubes containing one stainless steel beads and immediately frozen in liquid nitrogen. Tissue was powdered using a Mini-Beadbeater™ platform and total genomic DNA was extracted using a CTAB protocol. The DNA quality and quantity was estimated on 0.8% agarose gels. DNA was stored at -20 °C and air-shipped to Australia for DArT analyses. The results will be analyzed in a consultation of specialized bioinformatician and to the best of our knowledge this is the first report on Sudanese wild sorghum genetic diversity.</p> <p>Part 3: Identifying stay-green QTL(s) among Sudanese wild sorghums using specific SSR markers</p> <p>The stay-green trait is considered as the best characterized characteristic conferring drought adaptation in sorghum. Much of research in stay-green traits in sorghum has been geared toward cultivated sorghum and researches in wild sorghum are scarce. The idea that wild sorghum naturally possesses stay-green traits which could be used to broaden the adaptability of the cultivated sorghum. Thus, the objective of this part was to identify stay-green QTL(s) associated traits among Sudanese wild sorghums. To this end, 26 SSR specific primers will be screened across 65 wild sorghum accessions. DNA extraction was done as previously mentioned with a little modification, as the Silica-gel was used instead of liquid nitrogen for drying leaves. PCR analysis is underway. Part of the DNA samples along with their respective wild sorghum seedlings were sent to Kodama sensei laboratory at the Koyama campus, Tottori University for detecting the inhabiting entophytic fungi using DNA next generation sequencing (NGS).</p> <p>Part 4: Investigation the response of Sudanese wild sorghum germplasm to phosphorus deficiency</p> <p>Wild sorghum germplasms are a treasure trove of useful genes and render rich sources of genetic variation for crop improvement. The hydroponic experiments were undertaken at the growth chamber of Arid Land Research Center (ALRC), Tottori University, Hamasaki, Tottori in order to evaluate the</p>
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differential response of Sudanese wild sorghum genotypes to phosphorus stress. Sixty four wild Sudanese sorghum genotypes including one widely cultivated sorghum cv. Arfadamek-8 which was the control, were used in this experiment. Healthy sorghum seeds were surface disinfected by soaking in 70% Ethanol for 7 mins, rinsed in tap water, and then germinated in sterilized Petri dishes (9 cm Ø) with filter paper in an incubator at 20 ± 1C. At the second leaf stage (10 days old), uniformly healthy plants were chosen and transferred into 12-l containers containing 8 l half strength Hoagland solution. The pH of the solution was brought to 5.5 ± 1 with NaOH or HCl as required. The container was covered with a polystyrol-plate with 12 evenly spaced holes (plant per hole). Two treatments were initiated on the 17th day post-transplant: (1) phosphorus stress, in which plant roots were exposed to half strength Hoagland solution knocked-out from the phosphorus; (2) control, in which the plants were maintained in the nutrient solution throughout the experiment. The experiment was laid in a completely randomized design with three replicates. The nutrient solution was continuously aerated with pumps and renewed once a week. SPAD (chlorophyll content), stomatal conductance and shoots biomass were measured. Root architectures measurements are to be done in aid of Dr. Watru Tsuiji.

海外研究者招聘型共同研究 2 Guest Research Associate for Joint Research Program 2	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searchers	封 晓辉 (中国科学院遗传及发育生物学研究所农业资源研究中心) Feng, Xiaohui (Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences)	
研究課題 Research Sub- ject	The responses of plant growth to heterogeneous salinity	
共同研究要旨 Summary of Joint Research	<p>Salts distribution in soil was highly variable in both the spatial and time scales. The soil salinity range was large even in the root zone of one single plant. The heterogeneous salinity in the soil led to the question of how plants fit into this heterogeneous salinity. It had been shown that plants could produce more fruit or obtain a larger biomass in heterogeneous salinity soil compared with uniform salinity soil. Some studies indicated that under heterogeneous salinity plant growth was determined by the root-weighted mean salinity, not by the low salinity or high salinity.</p> <p>Roots are plastic to the soil nutrients and water availability. The root will proliferate in the nutrient and water rich patch to compensate for the root reduction in the poor patch, to obtain enough nutrients and water. Regarding heterogeneous salinity, studies showed that plant roots may grow away from the high salinity zone, while, root growth in the lower salinity patch was promoted under heterogeneous salinity stress. However, how the roots compensate in different heterogeneous salinity soil and how the ions accumulate in different parts were still unknown. To answer these questions following experiments were conducted.</p> <p>(1) Split root experiments: Root system was divided into two parts, a seedling (tree species) was plant in the split root system. The root in each part were exposed to different salinity environment. There were two groups, one group for the uniform salinity and one group were for the heterogeneous salinity in the split root system.</p> <p>(2) Seedling growth character were measured after the salt stress in the root zone. After some days the leaf gas exchange parameters were measured, at last, the seedlings were harvest and the biomass of different parts (leaf, branch, roots in different parts) were measured.</p> <p>(3) Root biomass of different parts were determined and the root compensation rate were calculated.</p> <p>(4) The soluble sugar and proline in leaf were determined. The ions like Na⁺, K⁺, Cl⁻ content in each part were also determined.</p> <p>The data of the experiments will be summarized for publication.</p>	

1.4 国内外との交流 / Exchange Programs

(1) 学術交流協定 / Agreements of Academic Exchange and Cooperation

As of March 31, 2017

国名等 Country/Region	機関名	Names of Institutions
中国 China	北京林業大学	Beijing Forestry University
	北京師範大学	Beijing Normal University
	新疆農業大学	Xinjiang Agricultural University
	蘭州大学	Lanzhou University
	中国科学院水利部水土保持研究所	Institute of Soil and Water Conservation, CAS and MWR
	中国科学院遺伝及び発育生物学研究所 農業資源研究センター	Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, CAS
	中国科学院西北生態環境資源研究院	Northwest Institute of Eco-Environment and Resources, (NIEER), CAS
	中国林業科学研究院	Chinese Academy of Forestry
モンゴル Mongolia	気象水文環境情報研究所	Information and Research Institute of Meteorology, Hydrology and Environment
	モンゴル科学アカデミー一般及び実験生物学研究所	Institute of General and Experimental Biology, Mongolian Academy of Sciences
レバノン Lebanon	国際乾燥地農業研究センター	The International Center for Agricultural Research in the Dry Areas (ICARDA)
イスラエル Israel	エルサレム・ヘブライ大学ロバート H. スミス農業食料環境学部	The Robert H. Smith Faculty of Agriculture, Food and Environment, the Hebrew University of Jerusalem
スーダン Sudan	スーダン農業研究機構	Agricultural Research Corporation
	ハルツーム大学	University of Khartoum
チュニジア Tunisia	乾燥地域研究所	Arid Regions Institute
エチオピア Ethiopia	バハルダール大学	Bahir Dar University
メキシコ Mexico	国立農牧林業研究所	National Institute of Forestry, Agricultural and Animal Research (INIFAP)
イタリア Italy	バーリ地中海農学研究所	The Mediterranean Agronomic Institute of Bari (CIHEAM-Bari)
オーストラリア Australia	西オーストラリア大学	The University of Western Australia

(2) 国際共同研究

パレスチナ西岸地区におけるウォーターハーベスティングによる食料安全保障の強化

期間：2016年4月－2019年5月

代表者：藤巻晴行(鳥取大学乾燥地研究センター)

組織：ナジャハ大学・新潟大学・鳥取大学

研究費：限界地プロジェクト

課題：パレスチナ西岸地区における食料安全保障の強化のため、キャピラリーバリアとビニールシートを用いたウォーターハーベスティングの可能性を土壌水分観測と流出観測および自動灌漑実験により評価する。

作物成長の数値モデルと天気予報を利用した灌漑水量の決定

期間：2015年11月－2019年5月

代表者：藤巻晴行(鳥取大学乾燥地研究センター)

組織：ICARDA・鳥取大学

研究費：限界地プロジェクト

課題：ヨルダンとモロッコにおいて自動灌漑システムによる灌漑区と、数値予報と土壌物理シミュレーションモデルを組み合わせた灌漑水量決定(シミュレーション灌漑)に基づく灌漑区とで、仮定の価格設定による純収入を比較することにより、後者の効果を評価することを試みた。

パレスチナにおける下水処理水および脱塩処理水を利用した熱帯果樹栽培

期間：2016年4月－2019年3月

代表者：竹内真一(南九州大学)

組織：パレスチナ国立農業研究所・南九州大学・鳥取大学

研究費：国際乾燥地研究教育機構

課題：パレスチナ西岸地区における食料安全保障の強化のため、下水処理水および脱塩処理水を利用した熱帯果樹栽培の可能性を現地栽培実験により評価する。また、灌漑における適切な灌水基準サクションを探索する。

耕作限界地の環境に適応するコムギ品種開発のための近縁野生種の遺伝資源開発

期間：2015年4月－2019年3月

代表者：辻本壽(鳥取大学乾燥地研究センター)

組織：鳥取大学乾燥地研究センター(辻本壽、ヤシル・ゴラフィ、山崎裕司)・スーダン農業研究機構(イザット・タヘル)・理化学研究所(金俊植)

研究費：鳥取大学

課題：スーダンの高温、乾燥、塩害圃場において生育できるコムギを開発するために、コムギ近縁野生植物、タルホコムギの種内多様性をパンコムギに導入した系統を、これらのストレス圃場にて栽培しその評価を行った。一方で、これらの系統を多量の分子マーカーでマッピングし、ストレス耐性に関与する染色体領域を同定するための解析を行った。

環境の予測可能性と不均一性を組み込んだモンゴルの野生動物保全上の重要地域検出

期間：2015年4月－2018年3月

代表者：伊藤健彦(鳥取大学乾燥地研究センター)

組織：鳥取大学乾燥地研究センター(伊藤健彦)・モンゴル科学アカデミー一般及び実験生物学研究所

(2) International Joint Research

Enhancing food security using water harvesting in West Bank of Palestine

Period: Apr. 2016 - May 2019

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: An-Najah University, Niigata University, Tottori University

Funding: Development of crop husbandry technology in rainfed marginal regions using dryland plant resources

Subject: To enhance food security of Palestine, feasibility of new water harvesting method, capillary barrier and water harvesting using plastic sheet, is evaluated by monitoring how much water is lost due to surface runoff and deep percolation and by performing an automatic irrigation experiment.

Determination of irrigation depths using a numerical model of crop growth and quantitative weather forecast

Period: Nov. 2015 - May 2019

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: ICARDA, Tottori University

Funding: Development of crop husbandry technology in rainfed marginal regions using dryland plant resources

Subject: Field experiments were carried out in Jordan and Morocco to evaluate effectiveness of new scheme to determine irrigation depths using a numerical model of crop growth and quantitative weather forecast in terms of net income considering the price of water.

Tropical fruit tree cultivation using sewerage treatment water and desalination processing water in Palestine

Period: Apr. 2016 - Mar. 2019

Leader: S. Takeuchi (Minami-Kyushu University)

Organization: National Agricultural Research Center of Palestine, Minami-Kyushu University, Tottori University

Funding: IPDRE (Irrigation and Water Resources Management Group)

Subject: To enhance food security of Palestine, feasibility of cultivation of tropical fruit using treated waste water and desalinated water is evaluated. Also, appropriate trigger suction for irrigation is examined.

Gene mining of wild relatives to develop wheat varieties to adapt environment in agricultural marginal regions

Period: Apr. 2015 - Mar. 2019

Leader: H. Tsujimoto (ALRC, Tottori University)

Organization: Tottori University (H. Tsujimoto, Y. S. A. Gorafi, Y. Yamasaki), Agricultural Research Corporation, Sudan (Izzat S. A. Tahir), Riken (J.S. Kim)

Funding: Tottori University

Subject: In order to develop wheat lines that can grow in hot, dry, salt-damaging field in Sudan, an experimental lines were produced in which the intraspecific diversity of wheat-related wild plants, *Aegilops tauschii*, was introduced. They were cultivated in the stress fields of Sudan and the stress tolerance was evaluated. On the other hand, we mapped these strains with a large amount of molecular markers and analyzed them to identify chromosome regions involving the stress tolerance.

Detection of important areas for wildlife conservation in Mongolia considering environmental predictability and heterogeneity

Period: Apr. 2015 - Mar. 2018

Leader: T. Ito (ALRC, Tottori University)

Organization: ALRC, Tottori University (T. Ito) and Institute of General and Experimental Biology, Mongolian Academy of Sciences (B. Lhagvasuren)

Funding: JSPS Grants-in-Aid for Scientific Research

(B. Lhagvasuren)

研究費：科学研究費補助金

課題：野生哺乳類の大移動がみられるモンゴル草原では開発による生息地断断化の影響が危惧されている。環境条件の地域差を考慮した保全対策の提言を目的とし、環境の予測可能性や不均一性を解析に組み込んで、長距離移動動物の移動・生息地選択要因と、生息適地や保全上の重要地域を明らかにする。

乾燥地における不均一性土壌中の移動現象

期間：2014年5月－2018年3月

代表者：R. Berndtsson (Lund University)

組織：ルンド大学(R. Berndtsson, M. Persson)・鳥取大学乾燥地研究センター(安田裕)・ポートサイド大学(Y. Hamed)・中国科学院寒区旱区環境工学研究所(X. Wang)

研究費：Minor Field Study by Swedish International Development Authority (SIDA), the MECW project at the Center for Middle, Eastern Studies, Lund University.

課題：乾燥地の土壌は不均一性が強く移動現象をダイナミクスで評価することは困難である。本件研究にあって、エジプト北東部で浸透実験が実施され、結果をフラクタルの一種であるDiffusion limited aggregation (DLA)モデルで解析した。モデルパラメーターの最適同定には遺伝子アルゴリズムが用いられた。移動現象は著しい不均一性を呈していた。また、土壌特性により、移動現象は大きな差異を示していたので、ダイナミクスモデルでは評価不能であったが、DLAにより断面平均浸透を再現できた。2016年は外国人客員教授であった中国科学院寒区旱区環境工学研究所王新平(Xinping Wang)教授と中国Shapotou Research Stationで実験を行った。

国際河川・青ナイル川流域における土壌侵食・土壌流亡緩和のための土地管理

期間：2013年10月 - 2018年3月

代表者：恒川篤史(鳥取大学乾燥地研究センター)

組織：鳥取大学乾燥地研究センター(恒川篤史、Dagnachew Aklog、藤巻晴行)・島根大学(増永二之)・バハルダール大学(Enyew Adgo, Derege Meshesha)・南アフリカ土壌・気候・水研究所(坪充)

研究費：科学研究費 基盤研究(A) 海外学術調査

課題：エチオピアの青ナイル川流域では、土壌侵食と土壌流亡が土地生産力の低下に深刻な影響を与えている。そして、青ナイル川上流域の土壌流亡は、下流域のスーダンとエジプトのダム土砂堆積の原因であることから、国際的な環境問題でもある。青ナイル川上流域における水食問題の緩和には、住民参加による持続可能な土地管理が不可欠であるが、そのためには土地管理施策の効果・影響を解明することがまず必要である。そこで、本研究では、ナイル川流域全体に配慮する最適な土地管理対策のガイドラインを検討するために、(1) 青ナイル川上流域の持続可能な土地管理技術の効果および(2) 上流域の土地管理対策が下流域の水資源に及ぼす影響の評価を行い、(3) 持続可能な土地管理のための意思決定支援システムを開発する。

撥水性を有する灰の混入による流出率の向上

期間：2016年11月－2017年5月

代表者：藤巻晴行(鳥取大学乾燥地研究センター)

Subject: Influences of habitat fragmentation of wild mammals are concerned in Mongolia's grasslands. To propose conservation strategies for the wildlife and ecosystem, we examine factors on movements and habitat selection of long-distance movement animals and detect important areas for conservation by considering regional differences, predictability and heterogeneity of environmental conditions.

Transportation in heterogeneous soil in arid land.

Period: May 2014- Mar. 2018

Leader: R. Berndtsson (Lund University)

Organization: Lund University (R. Berndtsson, M. Persson), ALRC Tottori University (H. Yasuda), Portside University (Y. Hamed), Cold and Arid Regions Environmental and Engineering Research Institute (CAREE), Chinese Academy of Science (X. Wang).

Funding: Funding: Minor Field Study by Swedish International Development Authority (SIDA), the MECW project at the Center for Middle, Eastern Studies, Lund University.

Subject: Since heterogeneity of soil property is so predominant in arid land, transport phenomena is difficult to be evaluated by dynamic models. In this study infiltration experiments were conducted in the northeastern Egypt and results were analyzed by a Diffusion Limited Aggregation (DLA) model, one of fractal model. For the optimization of the parameters the Genetic Algorithm was applied. The transportation process indicated apparent heterogeneity. There were great different on the transportation phenomena due to soil properties. The DLA model reconstructed the infiltration in the horizontal average. Infiltration in sandy type soil is interesting. In 2016, field experiment was conducted at Shapotou Research Station in China with the visiting professor, Xinping Wang.

Land management to mitigate soil erosion in the upper Blue Nile River Basin

Period: Oct. 2013- Mar. 2018

Leader: A. Tsunekawa (ALRC, Tottori University)

Organization: Tottori University (A. Tsunekawa, D. Aklog, H. Fujimaki), Shimane University (T. Masunaga) and Bahir-Dar University (E. Adgo, D. Meshesha)

Funding: Grants-in-Aid for Scientific Research

Subject: Soil erosion by water is the largest degradation agent and makes Ethiopia major water and sediment "exporter" to downstream countries. The objectives of the research are (1) evaluation of the effects of soil erosion measures with respect to soil erosion and land productivity in the upper Blue Nile River Basin, (2) evaluation of the effects of the soil erosion measures in the upper Blue Nile River Basin on the sedimentation and water resources of Sudan and Egypt in the lower Blue Nile River Basin, and (3) identification of the most suitable technologies to mitigate soil erosion, and development of a decision support system for the optimum allocation of water resources and land management.

Enhancing runoff using a water repellent ash

Period: Nov. 2016 - May 2017

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: Jordan University of Science and Technology, ICARDA, Tottori University

Funding: IPDRE (Irrigation and Water Resources Management Group)

Subject: A water repellent ash as a by-product of burning weeds may be used for enhancing runoff by mixing it into surface layer. A field experiment was carried out in Jordan to compare runoff coefficient under actual precipitation at different mixing ratio.

組織：ヨルダン工科大学・鳥取大学
研究費：国際乾燥地研究教育機構
課題：撥水性を有する灰を表層に混入することにより、流出率がどの程度向上するかをヨルダンにおいて異なる混入率の土壌型枠からの流出率を比較する圃場実験により調べた。

乾燥および塩耐性に関する新規で独自の遺伝子の同定

期間：2012年5月－2017年4月
代表者：T. Abdel-Fatah（カタール大学）
組織：カタール大学（T. Abdel-Fatah）・鳥取大学乾燥地研究センター（田中浄、辻本壽、アミン・エリタエブ）・イリノイ大学（O. Radwan）
研究費：カタール国立研究基金
課題：カタールの農業は灌漑用水の欠乏、土壌の劣化および不適な機構条件のため大きい問題に直面している。このプロジェクトは、耐乾性の新規遺伝子の同定、解析および有用作物への導入を通じた遺伝子レベルでの研究および、生理的および分子的レベルの両面でストレス適応に関する鍵となる因子を理解することにより、ストレス環境に対抗する方法を改善することを目的としている。

中国極乾燥地民勤オアシスにおける環境保全型農業の生産性向上に関する研究

期間：2015年4月－2017年3月
代表者：柏木純一（北海道大学）
組織：北海道大学（柏木純一）・鳥取大学乾燥地研究センター（安萍）・北海道総合研究機構（岡元英樹）
研究費：鳥取大学乾燥地研究センター
課題：不適切な農業開発により、中国民勤オアシスの環境・生態系は大きく破壊され、砂漠化が加速し、オアシスは存続の危機に直面している。このプロジェクトは、民勤の問題にピンポイントで対処するため、以下の3つの実践的な研究課題を掲げ、これらの解明を通じて、民勤オアシスの環境保全と持続的農業経営を両立させることを目的とする。1) 現地環境に適した節水型作物育種のための形質の特定 2) 塩性土壌を利用した経済価値の高い耐塩性植物の栽培 3) 牧草生産を高めるための牧草の耐乾性機構の解明。

中国黄土高原半乾燥地における森林の水利用及び物質循環

期間：2014年4月－2016年12月
代表者：山中典和（鳥取大学乾燥地研究センター）・S.Du（中国科学院水土保持研究所）
組織：鳥取大学乾燥地研究センター（谷口武士）・京都大学（館野隆之輔、岩岡華恵）・九州大学（大槻恭一）・中国科学院水土保持研究所（M. Yan, Q. He, Q. Tian, R. Cheng, J. Yue）
研究費：日本・中国（JSPS - NSFC）二国間交流事業/共同研究（日本学術振興会）
課題：中国黄土高原の半乾燥地において、森林の水利用及び物質循環の解明を目指した研究を行っている。本年は黄土高原の延安地域の自然植生であるリョウトウナラ林における窒素動態と微生物動態の関係に関する調査を行った。

Isolation of new and unique genes related to drought and salinity tolerance

Period: May 2012- Apr. 2017
Leader: T. Abdel-Fatah (Qatar University)
Organization: Qatar University (T. Abdel-Fatah), ALRC, Tottori University (K. Tanaka, H. Tsujimoto, A. E. Eltayeb) and University of Illinois (O. Radwan)
Funding: Qatar National Research Fund
Subject: Agriculture in Qatar faces great challenges due to the scarcity of irrigation water, the poor quality of the soils, and adverse climatic conditions. This project aims to identify and improve strategies to cope with stressful environments at the gene levels through the discovery, characterization and integration of new genes for drought tolerance into useful food crops as well as understanding the key factors in stress adaptation at both the physiological and molecular levels.

Study for agricultural productivity improvements based on environmentally-friendly farming systems in arid oasis, Minqin in China

Period: Apr. 2015- Mar. 2017
Leader: J. Kashiwagi (Hokkaido University)
Organization: Hokkaido University (J. Kashiwagi), ALRC Tottori University (P. An), Hokkaido Research Organization (H. Okamoto) and Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Chinese Academy of Sciences (CAS) (X. Xue, C. Huang)
Funding: ALRC Tottori University
Subject: Minqin Oasis is facing serious environmental and ecological problems, which have been threatening the daily life of the local people. This project is to solve these problems in Minqin so as to establish an environmentally conserved oasis with a sustainable agriculture development. To reach the objectives, following three subjects are conducting. 1) Identification of the characteristics of local crops for breeding water-saving varieties. 2) Cultivation of high salt tolerant species with high economic value using local saline soils. 3) Investigation of drought tolerant mechanisms of local pastures for increasing pasture production.

Water Use and Nutrient Cycling in Typical Forests of the Semiarid Loess Plateau, China

Period: Apr. 2014- Dec. 2016
Leader: N.Yamanaka (ALRC, Tottori University) and S.Du (ISWC, Chinese academy of Sciences)
Organization: ALRC Tottori University (T. Taniguchi), Kyoto University (R. Tateno, T. Iwaoka), Kyushu University (K.Otsuki), ISWC Chinese Academy of Sciences (M. Yan, Q. He, Q. Tian, R. Cheng, J. Yue)
Funding: Japan-China (JSPS-NSFC) Bilateral Joint Research Projects (JSPS)
Subject: We conducted field researches on water use and nutrient cycling in typical forests of the semiarid loess plateau, china. This year, we investigated the relationship between nitrogen dynamics and microbial dynamics in the Quercus liaotungensis forest, which is a natural vegetation of Yan'an area of the Loess Plateau.

Identification of the genetic mechanism of Stay-Green trait, and its application for breeding drought tolerant sorghum

Period: Jul. 2015- Jun. 2017
Leader: Eltayeb H. Amin Elsadig (ALRC, Tottori University)
Organization: ALRC, Tottori University (Eltayeb H., Amin Elsadig), Agricultural Research Corporation, Sudan (Izzat S. A. Tahir), The University of Tokyo (Hiroyoshi Iwata).
Funding: Japan Society for the Promotion of Science (JSPS)

ステイ・グリーン遺伝的メカニズムの解析と耐乾性ソルガム育種への応用

期間：2015年7月－2017年6月

代表者：Eltayeb Amin（鳥取大学乾燥地研究センター）

組織：鳥取大学乾燥地研究センター（Eltayeb Amin）・スーダン農業研究機構（Izzat S. A. T.）・東京大学（岩田洋佳）

研究費：日本学術振興会

課題：ソルガムはスーダンの食料保障を担う主要な穀物であり、総穀物生産の75%以上を占め、その80%が天水栽培で生産されている。穀物生産のいかなる段階においても干ばつは、天水栽培において主な生産制限となる。深刻な干ばつ問題は、穀物の不作につながる。したがって、乾燥への耐性と適応性が高いソルガム品種改良が最も重要となる。穀物のステイ・グリーン特性が、乾燥への適応と気候変動からの回復への選択肢として持ち上がっている。ステイ・グリーンは遺伝的に管理された優れた形質で、乾燥ストレス下で正常な遺伝子型と比較して活動的な光合成で緑色を維持する能力を葉にもたらす。これは、水分が制限された環境下では、バイオマスの増加、より大きな粒子サイズ、およびより高い収穫量に関連する。1962年の発見以来、ステイ・グリーンの正確なメカニズムはほとんど知られていなかった。スーダン・農業研究機構との国際的研究協力により、ステイ・グリーンの遺伝的メカニズムの解析と耐乾性ソルガムの育種への応用のための共同研究および共同ワークショップを行った。

中国甘粛省の肉用牛飼育におけるエネルギー・窒素出納の観点から見たアルファルファ乾草による濃厚飼料の代替

期間：2015年5月－2016年11月

代表者：F. Hou（Lanzhou University）

組織：中国蘭州大学（F. Hou）・鳥取大学乾燥地研究センター（恒川篤史、小林伸行）

研究費：鳥取大学限界地プロジェクト、中国国家重点科学技術支援プログラム、中国国家自然科学基金、中国大学長江先端的研究プログラム

課題：中国では、牛肉消費量の急増に伴う飼料給与量の抑制のため、飼料の効率的な利用体系の構築が求められる。同国肉用牛生産の重点地域である甘粛省において一般的に播種・栽培され、タンパク質含量や耐旱性が高いアルファルファは、肉用牛飼料としての有用性が高いと考えられる。本研究では、肉用牛の飼養法改善の方策の1つとして、アルファルファ乾草で濃厚飼料を代替した際の増体成績およびエネルギー・窒素出納成績に及ぼす影響を検討する。

Subject: Sorghum is the major food security crop in Sudan and its accounts for over 75% of total cereal production, with 80% of it produced under rain fed systems. Drought that occurs at any stage of crop development, particularly in the rain-fed agriculture systems, is considered the major production constraint. Severe drought incidents often lead to a complete crop failure. Therefore, improving sorghum varieties with greater tolerance and adaptation to drought is of paramount importance. Stay-Green trait in cereals emerges as the trait of choice to drought adaptation and resilience to climate change. Stay-Green is genetically controlled superior trait that confers the leaves with ability to remain green with active photosynthesis under drought stress compared to normal genotypes. It is associated with increased biomass, bigger grain size and higher yield under water-limited environments. Since its discovery in 1962, the exact mechanism of Stay-Green trait remained largely unknown. This international open partnership with ARC of Sudan is devoted for joint-research and joint-workshops to identify the genetic mechanism of Stay-Green trait, and its possible applications for breeding drought tolerant sorghum.

Substitution of alfalfa hay for concentrate feed for Simmental beef cattle in Gansu Province, China, considering energy and nitrogen balance

Period: May 2015- Nov. 2016

Leader: F. Hou (Lanzhou University)

Organization: Lanzhou University (F. Hou) and ALRC Tottori University (A. Tsunekawa, N. Kobayashi)

Funding: Marginal Region Agriculture Project of Tottori University, National Key Project of Scientific and Technical Supporting Programs of China (2014CB138706), National Natural Science Foundation of China (No. 311172249), Program for Changjiang Scholars and Innovative Research Team in University of China (IRT13019)

Subject: In china, in order to prevent the increase of feeding amount for beef cattle caused by the increasing consumption of beef meat, the establishment of system to efficiently utilize feed is required. In Gansu Province, one of the prioritized area for beef cattle production, the 'pen feeding' is under development and the alfalfa, generally cultivated in the Province, can be utilized as the feed of beef cattle, since it is high in the protein content and the resistance against drought. This research aims to study the effect of replacement of concentrate with alfalfa hay on body weight daily gain and energy/nitrogen metabolism.

(3) 研究者・受託研究員・研究生の受入れ

研究者

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受託研究員

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ための土地・水資源の適正管理」(平成 28 年 8 月 17 日)
Zadran Mohammad Arif (アフガニスタン)、Bationo Boubie
Leonard (ブルキナファソ)、Ahmed Ghassan Lutfi (イラク)、
Ghazi Ali Faisal Ghazi (イラク)、Soba Adamou Souleymane
(ニジェール)、Abubakir Tariq Abbas (パレスチナ)、Abdi
Mohamed Mohamed (ソマリア)、Osman Sowda Mire (ソマ
リア)、Joseph Flora Joseph Loki (南スーダン)、Mikaya
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ーダン)

研究生

Itam Michael Okoi

(平成 27 年 10 月 1 日～平成 28 年 9 月 30 日) ナイジェリア
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(平成 27 年 10 月 1 日～平成 28 年 9 月 30 日) スーダン
Mesenbet Yibeltal Sebhat
(平成 28 年 10 月 1 日～平成 29 年 3 月 31 日) エチオピア

(3) Visiting Researchers, Trainees and Research Students

Visiting Researcher

Nasrein Mohamed Kamal Omer

(Apr. 1 2016—Mar. 31 2017)
Researcher, Biotechnology and Biosafety Research Center,
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Private funds

Tilal Sayed Abdelhalim

(Dec. 1 2016—Feb. 14 2017)
Senior researcher scientist, Agriculture Research Corporation,
Sudan
Funded by Guest Research Associate for Joint Research
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Stanley Chukwudozie Onuoha

(Oct. 1 2016—Mar. 31 2017)
Lecturer, Ebonyi State University, Nigeria
Funded by Matsumae International Foundation

Feng Xiaohui

(Nov. 7 2016—Jan. 7 2017)
Ph. D student, Center for Agricultural Resources Research,
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Visiting Trainees

JICA Group Training Course 2016 “Appropriate Management
of Land and Water Resource for Sustainable Agriculture in
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Zadran Mohammad Arif (Afghanistan), Bationo Boubie
Leonard (Burkina Faso), Ahmed Ghassan Lutfi (Iraq), Ghazi
Ali Faisal Ghazi (Iraq), Soba Adamou Souleymane (Niger),
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