

1. 研究活動（2017年4月～2018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。

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。平成30年2月には、スーダンの現地実証フィールドにおいて、成果発表会を開催した。

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年度新規課題に採択され、平成29年度から本格的に研究活動を開始した。

また、共同利用・共同研究拠点強化プロジェクトとして「砂漠化地域における地球温暖化への対応に関する研究（乾燥地×温暖化プロジェクト）」（平成29年度～平成33年度）を開始、平成29年12月3日には、スーダン気象庁長官などスーダンとモンゴルの研究者4名を招き、第1回国際ワークショップ「気候変動の乾燥地へのインパクト：影響評価と適応策」を開催した。

平成29年6月、乾燥地研究センターのエリタイブ・ハボラ・アミン・エリサディグ助教が、日本学術振興会の二国間交流事業により、乾燥地における持続可能な農業生産のための穀物遺伝子の改良に関する第3回国際ワークショップをスーダン農業研究機構において実施した。

平成29年9月6日から9月16日に、中国オルドスで開催された国連砂漠化対処条約第13回締約国会議（UNCCD/COP13）に、恒川教授が政府代表団の一員として参加したほか、教職員3名を現地に派遣し、中国科学院西北生態環境資源研究院と共催でサイドイベントを開催した。

平成29年10月30日、国際塩生農業研究センターの

1. Research Overview (April 2017–March 2018)

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.

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 its 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. In February 2018, ALRC's research team made presentations of the outcomes of the project at its experimental fields in Sudan.

ALRC's Professor Atsushi Tsunekawa's research project 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). Full-scale operation of the five-year project has started from FY 2017 in collaboration with Bahir Dar University, Ethiopia.

In FY 2017, ALRC launched its five-year project named "Impacts of Climate Change (ICC) on Drylands: Assessment and Adaptation" or "ICC×DRYLANDs" for short, aiming to enhance its function as a Joint Usage / Research Center. In December 2017, ALRC held the 1st International Workshop, inviting four researchers from Sudan and Mongolia including Director General of Sudan Meteorological Authority.

In June 2017, ALRC's Assistant Professor Amin E. Eltayeb Habora organized "The 3rd International Workshop on Genetic Improvement of Cereals for Sustainable Production in Arid Lands" at Agricultural Research Corporation (ARC), Sudan, in the framework of the Bilateral Programs funded by Japan Society for the Promotion of Science (JSPS).

ALRC participated in the UNCCD COP13 that was taken place in Ordos, China in September 2017, holding a side event titled "Combating Aeolian Desertification and Realization of Land Degradation Neutrality" jointly with Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences (NIEER, CAS).

Ismahane Elouafiセンター長が、乾燥地研究センターを訪問し、特別公開セミナーを実施した。

平成29年11月10日、第61回国立大学附置研究所・センター長会議第2部会（医学系・生物学系）会議を、乾燥地研究センターの当番により鳥取市で開催した。翌11日には、同会議及び乾燥地研究センターの共催により「黄砂と健康～越境汚染のいま～」と題したシンポジウムを開催した。

平成30年1月には、筑波大学つくば機能植物イノベーション研究センター、岡山大学資源植物科学研究所、琉球大学熱帯生物圏研究センター及び本センターの4拠点において、「植物研究拠点アライアンス」として連携して活動するための申し合わせを取り交わした。

また、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て行われていた本館の改修工事が平成29年9月に完了し、アクティブ・ラーニング・スペースが設置されるなど、教育研究環境が改善された。

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2名、特命助教2名、特任教授1名、国内客員4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名が配置された。事務系には職員16名（事務職員5名、事務補佐員11名）、技術系には職員11名（技術職員4名、技術補佐員7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30年3月31日時点）。

共同研究、教育、刊行物

平成29年度における共同利用研究代表者（大学教員など）は63名、指導学生数は44名（博士課程24名、修士課程13名、学部学生3名、研究生3名、特別研究学生1名、うち留学生32名（中国7名、エチオピア12名、スーダン6名、ナイジェリア2名、エジプト2名、南アフリカ1名、モンゴル1名、バングラデシュ1名））である。

共同研究に関する研究発表会は毎年開催しており、平成29年度は、12月2日～3日に本学において開催した。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、修士課程（持続性社会創生科学研究科）及び博士課程（連合農学研究科）に「国際乾燥地科学専攻」を設置し、学部一修士一博士の一貫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

Dr. Ismahane Elouafi, Director General of International Center for Biosaline Agriculture (ICBA) visited ALRC on October 30, 2017, and offered a special open seminar titled “Sustainable, Climate-smart Agriculture in Marginal Environments.”

On November 10, 2017, ALRC held a conference for the sub-committee of the Council for Research Institutes and Centers of Japanese National Universities in Tottori, at which directors from 33 research centers nationwide in the fields of medical and biology attended. In addition, ALRC co-hosted a symposium on Asian dust on the following day.

In January 2018, ALRC exchanged an agreement on “Plant Science Core Alliance” in alliance with Tsukuba-Plant Innovation Research Center of University of Tsukuba, Institute of Plant Science and Resources of Okayama University, and Tropical Biosphere Research Center of University of the Ryukyus.

In addition, ALRC had completed the renovation of its main building in September 2017, which was funded by the government’s supplementary budget for fiscal 2016.

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 March 31, 2018, four full-time professors, six associate professors, two assistant professors, two specially appointed assistant professors, one specially appointed professor, four visiting national professors and three visiting international researchers were allocated to these research divisions. In addition, seven project researchers were added to our research teams. Moreover, 16 office staff (five full-time and eleven part-time) and 11 technical staff (four full-time and seven part-time) supported ALRC’s research and education.

Joint Research, Education, Publication

In FY 2017, 63 joint-use research representatives, mainly from national and private universities, were attached to ALRC. In addition, ALRC had a total of 44 students; 24 Ph.D. students, 13 master’s students, 3 undergraduate students, 3 research students, and 1 special research student. Of them, 32 students were from overseas; 7 Chinese, 12 Ethiopian, 6 Sudanese, 2 Nigerian, 2 Egyptian, 1 South African, 1 Mongolian and 1 Bangladeshi.

ALRC holds the Joint Research Symposium every year. In FY 2017, we held the symposium on December 2 and 3 at the center. Seminars were often held by internal and external experts.

Concerning education, the course “Global Dryland Science” has been established for Master’s course (Graduate School of Sustainability Science) 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 newsletters several times a year to introduce its latest research activities, supported by the “Tottori Kanchiken Club” that was established by a local business association.

活動状況等を紹介している。

この他、平成29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.2 乾燥地の有用植物 食べる植物（鳥取大学乾燥地研究センター監修、乾燥地植物資源バンク室 辻本壽・留森寿士編、今井出版、平成30年2月出版）
- Rangeland Ecosystems of Mongolia (Editors: Jamsran, U., Tamura, K., Luvsan, N. and Yamanaka, N. Munkhiin Useg社、Ulaanbaatar、平成30年3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29年度の主な活動は以下のとおり。

- 国連砂漠化対処条約第13回締約国会議（UNCCD/COP13）においてサイドイベント「砂漠化防止と土地の劣化の中立性の達成」開催：平成29年9月9日、参加者約30名、中国・オルドス、共催：中国科学院西北生態環境資源研究院
- 平成29年度国立大学附置研究所・センター長会議第2部会シンポジウム「黄砂と健康 ～越境汚染のいま～」開催：平成29年11月11日、参加者74名、とりぎん文化会館、鳥取市
- 一般公開：平成29年7月22日、参加人数186名
- きみもなろう！砂漠博士（小学生向け実験イベント）：平成29年7月22日、参加人数21名



Director General of International Center for Biosaline Agriculture (ICBA) visited ALRC in October 2017

Moreover, ALRC issued the following publication in FY 2017.

- Photobooks of Drylands vol. 2: Useful Plants in Drylands - Edible Plants - (Supervision: Arid Land Research Center, Tottori University, H. Tsujimoto and H. Tomemori eds, Published by IMAISHUPPAN, February 2018)
- Rangeland Ecosystems of Mongolia (Editors: Jamsran, U., Tamura, K., Luvsan, N. and Yamanaka, N. Published by Munkhiin Useg Co. Ltd., Ulaanbaatar, March 2018)

Accommodation Facility

A guest house was built in August 2011, which is available for joint researchers and students who want 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 outreach activities such as facility tours and training programs to promote and publicize ALRC's activities both inside and outside Japan. In addition, ALRC has been holding a number of events such as symposia and panel exhibitions to disseminate research outcomes and achievements to public and outside researchers.

We held the following activities during FY 2017.

- UNCCD COP13 side event “Combating Aeolian Desertification and Realization of Land Degradation Neutrality”: September 9, 2017, Ordos, China. Co-organizer: Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences
- Symposium “Asian Dust and Health - Cross-Border Pollution Today -” co-hosted by the Council for Research Institutes and Centers of Japanese National Universities: November 11, 2017, Tottori Prefecture Citizens' Culture Hall
- Open House Event: July 22, 2017, ALRC
- On-site learning program for elementary students “Let's become a Dr. Desert”: July 22, 2017, ALRC



Director General of Sudan Meteorological Authority visited ALRC in December 2017

(2) 研究部門

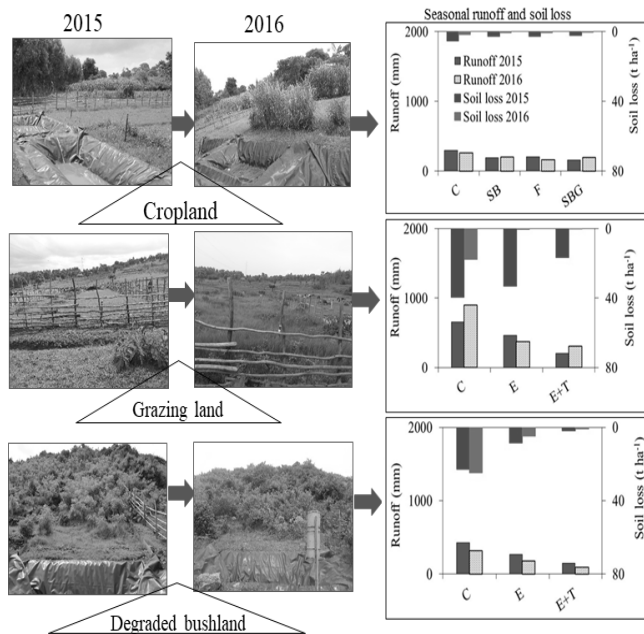
1) 総合的砂漠化対処部門

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。Aba Gerima、Guder および Dibatie の3つの小流域に設置された42の実験プロット（長さ30m×幅6m）を使用して、さまざまな持続可能な土地管理（SLM）策が各土地利用タイプにおいて季節的表面水流出および土壌流亡にどのような影響を及ぼすかを実証的に明らかにした。耕地では、十分に育ったエレファントグラスによりソイルバンドが安定化した（Aba Gerima の右上の写真）。放牧地や劣化林地では植生被覆が大幅に改善された（Aba Gerima のサイトの中央と下部の右写真）。実験の結果、2年目（2016年）には土壌流亡と表面水流出の大幅な減少が観察された。耕地では植生で被覆されたソイルバンド、放牧地ではトレンチを設置された禁牧地が水流出と土壌流亡の両方を減らす最も効果的なSLM手法であった。



(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.

Effects of different sustainable land management (SLM) measures on seasonal runoff and soil loss for crop and non-croplands use types were evaluated using 42-experimental plots (30 m long and 6 m wide) established at Aba Gerima, Guder and Dibatie watersheds in northwest Ethiopia. In croplands, soil bunds became stabilized with elephant grass (top right photo at Aba Gerima), while in grazing and degraded bush land use types, vegetation cover has improved significantly (middle and bottom right photos, respectively, at Aba Gerima site) in the second year (2016) of the experiment. As a result, significant reductions in soil loss and runoff were observed in the second year. Soil bund reinforced with grass in cropland, and exclosure with trenches in non-cropland use types were the most effective SLM practices in reducing both runoff and soil loss.

[Ebabu K, Tsunekawa A, Haregeweyn N, Adgo E, Meshesha DT, Aklog D, Masunaga T, Tsubo M, Sultan D, Fenta AA, Yibeltal M. 2018. Analyzing the variability of sediment yield: A case study from paired watersheds in the Upper Blue Nile basin, Ethiopia. *Geomorphology* 303: 446-455.]

黒崎 泰典 (ダスト気候学)

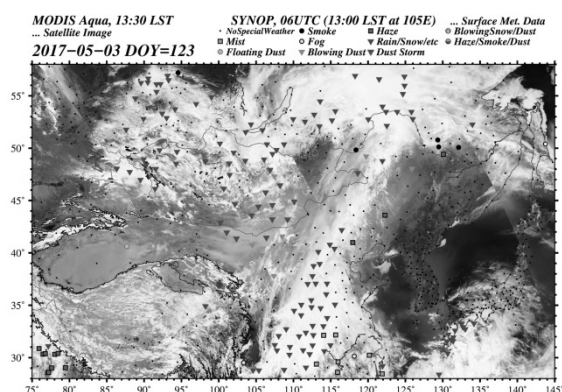
日本では黄砂として知られるダスト粒子(土壌粒子)は乾燥地や耕作地などにおいて強風によって舞い上がり、細かい粒子は自由対流圏の風によって長距離輸送される。発生域では気象災害の側面が強く、人や家畜の死亡・行方不明、建築物損壊などの被害をもたらす。発生域から遠くなるに従い、健康影響、酸性雨中和、海洋生態系への影響、放射過程・雲凝結過程を介した気候への影響といった環境影響の側面が強くなる。ダスト気候学分野では、主に(1)日々のダスト空間分布モニタリング、(2)発生原因解明とその黄砂数値モデルへの応用、(3)日本に飛来するダストの沈着量、発生源解明を課題とし、本年度は主に以下のことを実施した。

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を用いて、場所・年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。プロジェクト研究員 Wu 氏と気象台データを用いた、中国内モンゴル Abag Qi におけるダスト発生原因の解析を進めた。

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)などにおいて、Buyantogtokh 氏(M1,国際乾燥地科学専攻)等と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, 17H01616)、乾燥地×温暖化プロジェクト、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 May 3, 2017. 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 fine particles are transported over a long distance by wind in free troposphere. In emission 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), the near-real time East Asia dust monitoring system using MODIS satellite images and meteorological observatory data was operated. The images were utilized for discussion of emission places and transportation routes of dust with research colleagues.

On the subject (2), observations were carried out to quantitatively clarify a spatial and temporal difference in dust emission using the dust monitoring 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. 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. Using synoptic data, an analysis was also done with Dr. Wu (Project Researcher) to clarify the causes of dust emission at Abag Qi, Inner Mongolia, China.

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) with Mr. Buyantogtokh (M1, Department of Dryland Science).

These works were supported by JSPS KAKENHI (Grant Numbers 15H05115, 25220201 and 17H01616), by Project Impacts of Climate Change on Drylands (ICC×DRYLANDS), by International Platform for Dryland Research and Education (IPDRE), and by ALRC joint researches.



A view of observation at sub-site 14A, Tsogt-Ovoo. As a result of much rainfall in the previous summer, substantial dead leaves were found (April, 2017).

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、以下の取り組みを実施した。

1. 中国・蘭州大学との共同研究

同国肉用牛生産の重点地域である甘粛省で推奨される舎飼い飼養において、飼料としての有用性が高いアルファルファ乾草で濃厚飼料を代替した際のシンメンタル種交雑育成牛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、トウモロコシ茎葉部を基礎とした飼料設計の1案として以下を提示した。

- 1) 一定程度のアルファルファ乾草の配合 (混合割合; 温暖期 14%、冷涼期 8-21% (いずれも乾物重ベース))。これにより、温室効果ガス排出の増加を抑制しつつ、日増体量と農家収入を増加させる。
- 2) 既存飼養標準に基づく給与量にシンメンタル育成牛の高い維持代謝エネルギー量に見合う量を上乘せしての給与。
- 3) 適切な粗飼料の配合 (混合割合; 34-47% (乾物重ベース))。

2. エチオピア「次世代型・持続可能な土地管理フレームワークの開発」(JICA/JST 科学技術協力事業)

同事業の「新たな耕畜システムを通じた土地生産性の改善」において、同国青ナイル上流域で標高が異なる3小流域を対象に、過放牧による草地の劣化防止と効率的な家畜生産のため、舎飼い飼養における飼料設計の改善を図る。対象小流域の飼料資源量の把握に先立ち、既存草種の収集・同定と栄養価の分析を行なった。

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、これら国々への国際協力を行なう。国際乾燥地研究教育機構によるフィリピン「生活の質改善を目指した糖尿病予防プロジェクト」において、患者リーダーに対する糖尿病自己管理のための研修や、同リーダーから他患者への波及効果を把握するための健診を実施した。



Cattle raised in a dry season in Ethiopia. Shortage of feed in the dry season is a challenge for farmers.

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 following activities have been implemented in 2017.

1. Collaborative research in Gansu Province, China

In Gansu Province, a major beef-production area in China, the effects of substituting alfalfa hay for concentrate feed on the daily body-weight gain and the energy/nitrogen metabolism of Simmental crossbred calves, were studied. The following design for feeding corn-stover based diets was proposed.

- 1) Low-level inclusion of alfalfa hay (14% in a warm season, 8-21% in a cool season; both on a dry-matter basis), which will increase the body-weight gain and farmers' income with preventing the increase in green-house gas emissions.
- 2) Adjustment of the feed amount estimated through actual feeding standards to meet the requirements for high metabolizable energy for maintenance of Simmental calves.
- 3) Proper mixture of roughage (34-47% on a dry-matter basis).

2. Research for 'the Project for development of sustainable land management framework' funded by JICA/JST in Ethiopia

As an activity under the Project component 2, this study aims to improve feeding design for confined beef/dairy cattle to prevent the degradation of pasture land due to overgrazing and for effective animal production in the 3 watersheds of Upper Blue Nile basin. In 2017, the grass samples in the pastures of 3 watersheds were collected and identified for estimating availability of feed resources. The samples were then analyzed for nutrient concentrations.

International Cooperation:

As most technologies for drylands are applied in developing countries, the activities for development in these countries have been conducted. The Project for enhancing the preventive measures for diabetes in Philippines has undertaken training for the patients' leaders for diabetes self-management and medical check-up to monitor effects of the leaders' extension activities on the conditions of other patients.



Training for the leaders of patients on self-management of diabetes in Philippines.

2) 環境保全部門

山中 典和 (緑化学)

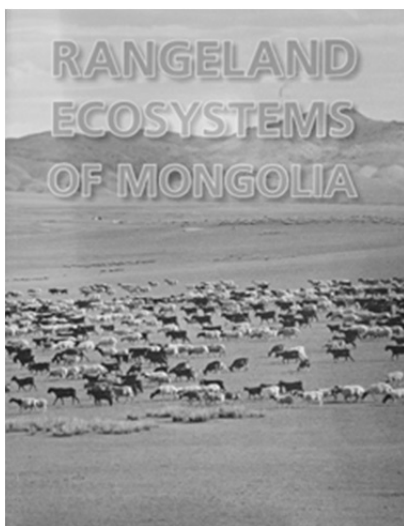
緑化学分野では植物生態学に基礎をおいた乾燥地域の緑化及び砂漠化土地の生態系修復に関する研究を行っている。主要な研究テーマは以下のとおりである。

- (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)):モンゴルの草原地帯で、乾燥及び放牧強度の変化に伴う AM 菌群集の変化とグロマリンの蓄積を調べた。結果、放牧はイネ科植物、特に *Stipa* 属の地上部バイオマスを減少させた。そして、乾燥程度の異なる3つの調査地間で AM 菌群集の違いが認められた。また、AM 菌群集の組成は、すべての試験地で、放牧強度が異なると変化した。
2. モンゴルの出版社から放牧地生態系の本を出版した (Jamsran, U., Tamura, K., Luvsan, N. and Yamanaka N. eds.: Rangeland Ecosystems of Mongolia. (ISBN 978-99978-2-567-4). Munkhiin Useg Co. Ltd., Ulaanbaatar, 528 p. (Mar., 2018) 。目次は以下のとおりである。
Ch.1 モンゴルの地形
Ch.2 モンゴルの気候
Ch.3 モンゴルの植生
Ch.4 モンゴルの野生動物
Ch.5 モンゴルの家畜
Ch.6 モンゴルの放牧地生態系タイプ
Ch.7 モンゴルの放牧地利用
Ch.8 放牧地生態系の保全と修復



Book published in Ulaanbaatar, Mongolia. (Mar., 2018)

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 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)): Mycorrhizal symbiosis and accumulation of glomalin in Mongolian grassland were characterized under gradients of grazing intensity at three sites of different aridity. With regard to floristic composition, grazing decreased the shoot biomass of Poaceae species, especially *Stipa* spp. Distinctness of the AM fungal communities was observed among the three sites. The composition of AM fungal communities differed significantly among the grazing intensities at all study sites.
2. We published a book on the Mongolian rangeland ecosystems from the publisher of Ulaanbaatar, Mongolia (Jamsran, U., Tamura, K., Luvsan, N. and Yamanaka N. eds.: Rangeland Ecosystems of Mongolia. (ISBN 978-99978-2-567-4). Munkhiin Useg Co. Ltd., Ulaanbaatar, 528 p. (Mar., 2018) .Contents are as follows
Ch.1 Geomorphology of Mongolia
Ch.2 Climate of Mongolia
Ch.3 Vegetation of Mongolia
Ch.4 Wildlife of Mongolia
Ch.5 Livestock of Mongolia
Ch.6 Rangeland Ecosystem types in Mongolia
Ch.7 Rangeland use of Mongolia
Ch.8 Restoration and conservation of rangeland ecosystems



Vegetation survey in degraded grassland of Hustai, Mongolia (Aug., 2017).

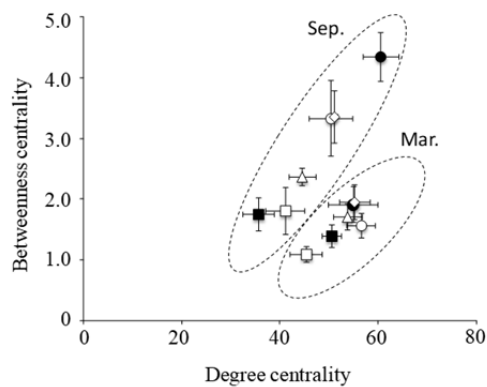
谷口 武士 (微生物生態学)

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روسケールからマクروس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とおりである。

- ・ 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。

アメリカ、カリフォルニアに位置するコロラド砂漠で生育する灌木 6 種の内部根圏微生物について調査を行った。結果として、内生細菌、内生菌、菌根菌のすべてについて、植物種によって微生物群集が異なることが明らかとなった。また、度数中心性、および媒介中心性から重要微生物を推定したところ、放線菌目、アーバスキュラー菌根菌、そして窒素固定細菌を含むリゾビウム目が微生物群集の中心的存在であることが示唆された。度数中心性と媒介中心性に基づく解析から、*Encelia farinosa* が内部根圏微生物の観点においてこの生態系の中心植物であることが示唆された。また、それぞれの微生物タイプの宿主範囲については、アーバスキュラー菌根菌 > 内生細菌 > 内生菌の順に広いことが示された。



Average value of the degree and betweenness centralities of the six plants in March and September. Open circle, filled circle, triangle, diamond, open square, and filled square show *Ambrosia dumosa*, *Encelia farinosa*, *Larrea tridentata*, *Fourquieria splendens*, *Parkinsonia florida*, and *Psoraleum schottii*, respectively.

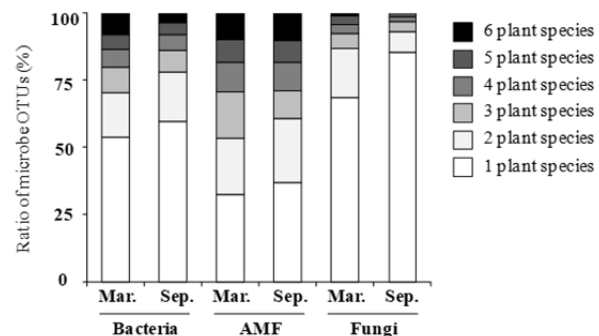
Takeshi Taniguchi (Assoc. Prof., Microbial Ecology)

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:

Endorhizosphere microbes of six shrub species were examined in the Colorado Desert, California, U.S.A. The community structures of endophytic bacteria, endophytic fungi, and arbuscular mycorrhizal fungi are different among the six plant species. Degree and betweenness centralities showed that actinobacteria, arbuscular mycorrhizal fungi, and Rhizobials were the central microbes in the ecosystem. In terms of microbes, *Encelia farinosa* was the most important plant species of the six plant species. Host range was broader at the following order, arbuscular mycorrhizal fungi > endophytic bacteria > endophytic fungi.



Ratio of the number of the bacterial, arbuscular mycorrhizal fungal, and the other fungal OTUs categorized by the number of plant species detected.

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、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。

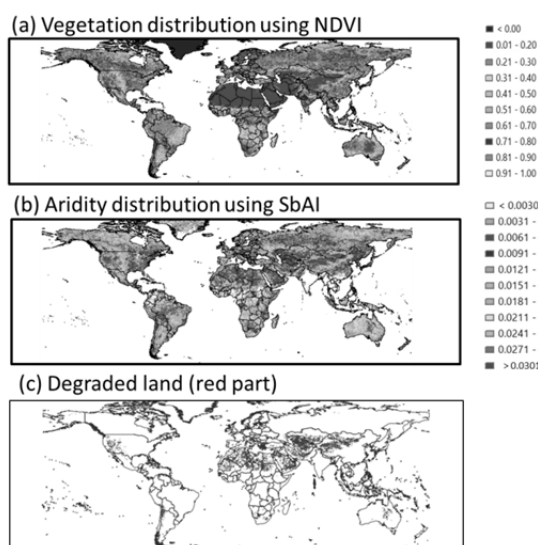
1. 劉・木村(2016)が提示した簡易な小型風洞を基に、乱流調整装置(台形スパイヤーとラフネスブロック)を用いて、比較的厚い境界層の生成、自然界に近い粗度長、水平方向の均一な風速分布、風速の安定した観測場を同時に満たす方法・手順を提案した。その結果、ラフネスブロックの並べ方や密度を変更せず、台形スパイヤーの形状や本数を工夫することにより、それらの実現が可能になった。

(劉・木村：砂丘学会誌, 64, 1-8, 2017)

2. ダストの発生しやすい場所を aeolian desertification と定義し、衛星データだけから全球レベルでの荒廃地をモニタリングする方法を提示した(Fig. 1)。過去5年間の解析結果より、荒廃地は南アメリカ、オセアニアで増加傾向、アジア、ヨーロッパ、アフリカ、北アメリカでは減少傾向にあった。全球トータルの荒廃地面積は全陸地面積の19%にあたり、UNEP が定義している極乾燥地と乾燥地の合計面積に匹敵する結果となった。本結果は、当センターのホームページでパブリック公開されている。

(Kimura, R.: *Int. J. Remote Sens.*, <https://doi.org/10.1080/01431161.2018.1444295>)

(http://rkimura.alrc.tottori-u.ac.jp/degradation_area/en2.html)



Global monitoring of degraded land (c) by combining the information of vegetation (a) and aridity (b).

Reiji Kimura (Assoc. Prof., Meteorology)

The Meteorology Subdivision conducts research mainly 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, and JAXA Global Observation Mission, especially in China, Mongolia, and Egypt.

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

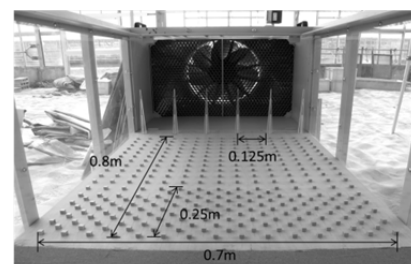
1. Based on the results of Liu and Kimura (2016), we examined to generate the boundary layer, roughness length close to the natural field, uniform distribution of wind speed toward the horizontal direction, and stable observation field of the simple type wind tunnel. Without changing the arrange of roughness block, we proposed to adjust only the shape and number of speyer. As a result, boundary layer and roughness length became 36 cm and 0.01 cm which was close to the natural condition. Additionally, it was possible to make the uniform wind speed toward the horizontal direction, and stable observation field regarding the wind speed distribution.

(Liu and Kimura: *Sand Dune Res.*, 64, 1-8, 2017)

2. Arid regions are highly vulnerable to climate change and human activity. Global warming has the potential to increase their area. In most arid regions, desertification, land degradation, and drought are frequent. An early warning and monitoring system based on numerical models, remote sensing, and weather forecasts is urgently needed to guard human well-being in those regions. This study defined degraded land area on the basis of dust erodibility determined only from satellite data, and measured seasonal variations over each continent. During the 5 years from 2012 to 2016, degraded land area showed a tendency to increase in South America and Oceania and to decrease in Asia, Europe, Africa, and North America. Degraded land area covered up to 19% of the world's total land area, almost exactly the percentage of hyper-arid (7.3%) plus arid regions (11.6%) determined by the widely used aridity index, and down to 7%.

(Kimura, R.: *Int. J. Remote Sens.*, <https://doi.org/10.1080/01431161.2018.1444295>)

(http://rkimura.alrc.tottori-u.ac.jp/degradation_area/en2.html)

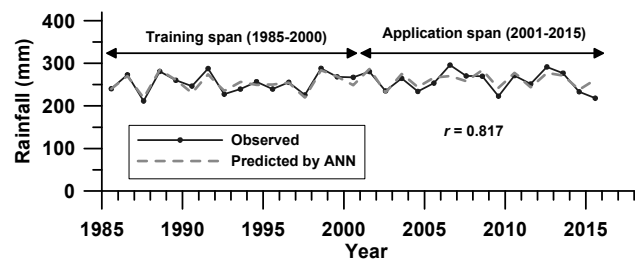


Schematic diagram of wind tunnel developed by Liu and Kimura (2017).

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. 青ナイル源流であるタナ湖流域の降雨時系列を解析した。降雨は夏季 6-9 月に集中していた。経年夏季降雨量時系列は、数か月前の太平洋の海水面温度 (Sea Surface Temperature: SST) に対して強い有意相関を示していた。この太平洋 SST とのリンクを用いて、Elman Recurrent Neural Network (NN) により予測を行った。実測値と予測値の相関はおおむね 80% ほどであった。

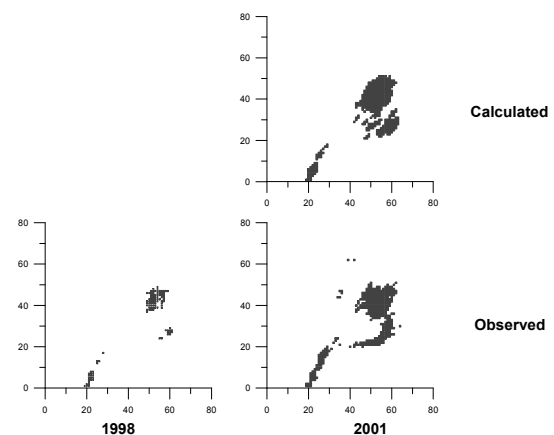


Prediction of the summer rainfall over the source region of the Blue Nile.

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. Rainfall time series over the source region of the Blue Nile, Lake Tana Basin was analyzed. Rainfall is focused in the summer (June – September). The inter-annual time series of the summer rainfall indicates strong significant correlations (link) with Sea Surface Temperature (SST) over the Pacific Ocean several months before. Using the link, prediction of the summer rainfall was performed. Correlation between the observed and predicted value was about 80 %.



Numerical simulation of spread of invasive plant, Mesquite in Kassala, Sudan.

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。特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。

本年度は特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：2015 年秋に開始したモウコガゼルの衛星追跡は 3 年目に入ったが、順調にデータが取得できている。複数の追跡個体が捕獲地点から 200–300 km 離れた冬の利用地域から、2 回の春とも捕獲地点付近に戻り、夏の間そこに滞在した。これはその地域が、夏の生息地として重要であることを示唆する。本年度秋には、過去 2 年と同じ地域でのモウコガゼル追跡個体を補充した。また、モンゴルの野生動物の保全生態に関する英文著書を 2 冊出版した。
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の複数の地域で、ユキヒョウの糞サンプル採集を実施し、糞 DNA による個体数推定および地域間の遺伝子交流に関する分析を進めた。
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の実態とその要因を示した論文を発表した。
4. 鳥取砂丘の動物研究：地上での自動撮影カメラや赤外線カメラを搭載無人航空機（ドローン）システムで、シカとイノシシの検出頭数の季節変化をモニタリングした。中大型哺乳類による種子散布の実態調査も実施した。



Capturing and collaring Mongolian gazelles, collaborating with local nomadic peoples in Mongolia

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 the 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 gazelle tracking is continuing successfully for 3 years, and several gazelles came back from the winter ranges apart 200–300 km to the same summer range in the two springs and stayed there during the summers. It suggests that the area is important as the summer range. We added more tracked gazelles in this fiscal year in the same area with the last two fiscal years. Two English books on wildlife ecology and conservation in Mongolia were published.
2. Conservation ecology on snow leopards in Mongolia: We collected snow-leopard fecal samples in the several habitats in Altay Mountains and analyzed fecal DNA to estimate population numbers and the gene flow among the habitats.
3. Behavioral study on domestic horses for *airag* production: We published a paper on horse movement and factors on it in a famous area for high-quality *airag* (fermented horse milk) in Mongolia.
4. Research on wild animals in the Tottori Sand Dunes: We monitored seasonal change of relative abundance of deer and wild boars using camera traps and an unmanned aerial vehicle (UAV, drone) with a near-infrared camera. We also studied seed dispersal by medium- and large-mammals.



A male monkey recorded by a camera trap in Arid Land Research Center in March 2018.

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、その遺伝学的情報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。



The experimental field to demonstrate the performance of MSD lines produced by the collaborative research work with ARC, Sudan (February 25, 2018, Wad Medani, Sudan)

3) Agricultural Production Division

Hisashi Tsujimoto (Prof., Molecular Breeding)

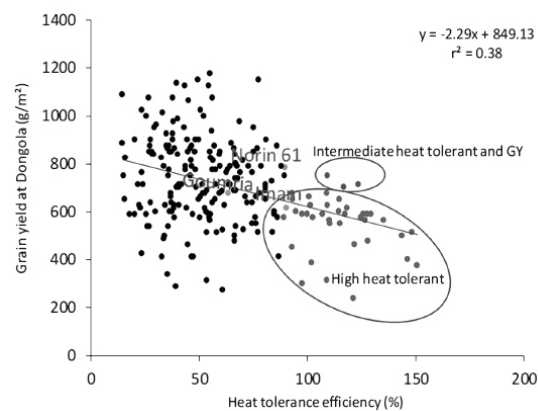
Production of foods for the increasing population under the changing climate is a big challenge for humankind. Development of crop varieties that can grow even under inadequate environments is a reliable solution to this question. We are looking for genes that provide stress-tolerance within the gene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



Relationship between grain yield at Dongola Station and heat tolerant efficiency (Elbashir et al. 2017, Breeding Science 67:483-492)

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壤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落花生を、モロッコとスーダン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) 住友ゴムとの共同研究「ラテックス遮水膜を用いた土壌の保水性向上検討」。根群域の下端まで掘って水平面を造成し、その上に多孔ラテックスゴム膜を作成し、その上に再び作土を覆土することで根群域の保水性を高める方法を考案し、その効果を検証した。

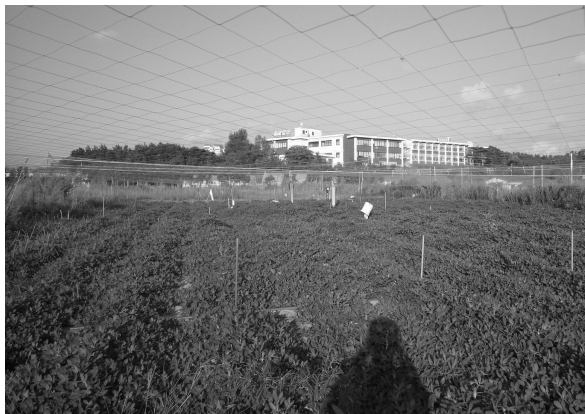
5) 限界地プロジェクト予算による「キャピラリーバリアによる砂丘圃場における保水性の向上」。傾斜した砂丘圃場にキャピラリーバリアを敷設し、落花生を無灌漑で栽培した。

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、主として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 (6回、延べ24日)
2. 限界地プロジェクトに係る灌漑実験のためのモロッコ出張 (1回、5日間)
3. 限界地プロジェクトに係る灌漑実験のためのスーダン出張 (2回、延べ9日間)



Irrigation experiment for groundnuts in ALRC

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 groundnuts was carried out in ALRC. We also carried out irrigation experiments using wheat in Sudan and Morocco. Two dimensional simulation model for determining irrigation depth of drip irrigation, WASH_2D, was applied to the experiments.
4. 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 sweetpotato was grown above capillary barrier without irrigation in ALRC.
5. Enhancing water holding capacity using a capillary barrier as an activity of husbandry group under the “Project Marginal Land”. Groundnuts was grown above inclined 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 six times for topic 1 and 2.
2. visits to Morocco for topic 3.
3. visits to Sudan twice for topic 3.



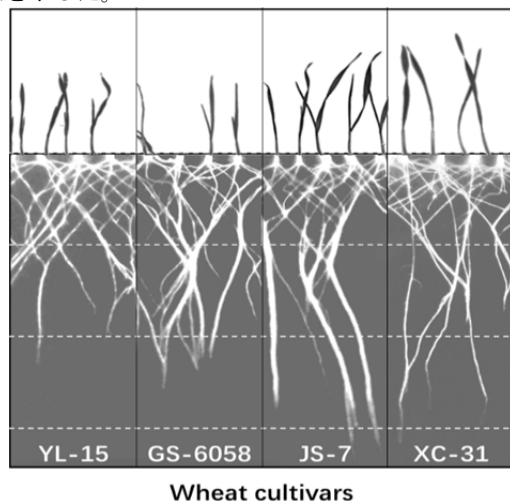
Irrigation experiment for wheat in Dongola, Sudan

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壌環境を調査し、分布の特性から植物と土壌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. ダイズ、トマト、コムギ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、日本理化学研究所環境資源科学研究センターを訪問し、共同研究として、エチレンが植物ホルモンの発生に対する影響を調査した。また、パキスタン情報技術研究所発展研究部門フサイン講師を招聘し、有機と無機肥料の施用による塩—アルカリ土壌中と作物体内のナトリウム—カリウムの変動についての研究に取り組んだ。コムギ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について本年度引き続き関連実験を行った。下の写真にその結果を示した。



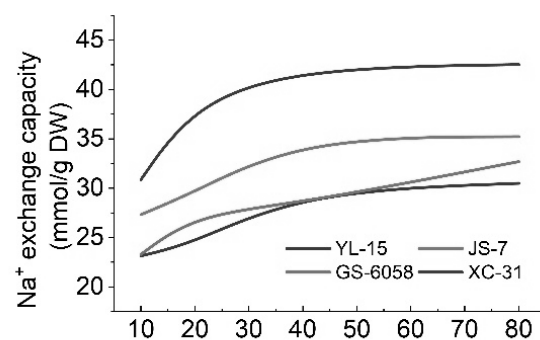
Four wheat cultivars (YL-15, GS-6058, JS-7, XC-31) showed different root growth under saline condition. Root growth of salt tolerant cultivars (JS-7, XC-31) were better than that of the sensitive ones (YL-15, GS-6058).

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 soybean, tomato, wheat 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.

The main research activities during the fiscal year 2017 include a visit to Center for Sustainable Resource Science of RIKEN. Studies on the effects of overproduced ethylene on the contents of other phytohormones in plants were conducted. Besides, a researcher from Department of Development Studies of the Institute of Information Technology of Pakistan was invited to our laboratory. Studies on sodium-potassium dynamics in wheat crop and soil under salinity and drought was conducted. Studies of the relationship between root physical and chemical characteristics and plant salt tolerance were continually carried out.



The Na⁺ exchange capacity of four wheat cultivars (YL-15, GS-6058, JS-7, XC-31) grown under saline condition was different. The Na⁺ exchange capacity of salt tolerant cultivars (JS-7, XC-31) were higher than that of the sensitive ones (YL-15, GS-6058)

エリタイブ ハボラ E. アミン (植物遺伝子工学)

乾燥地や半乾燥地における農業生産量は、干ばつ、地力の低さ、気温上昇及び自然資源の減少など、さまざまな制約に影響される。増加していく乾燥地人口の生計を維持する上で、食糧安全保障は非常に重要で喫緊の問題である。このため、農業食用作物の環境適応性や生産性の向上を目的とした先進的な植物バイオテクノロジーを利用していくことが必要である。

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 29 年度は、世界各地から収集した多数のソルガム系統種を使い、低地力および乾燥ストレス下における実験を行った。東京大学と民間企業の協力の下、高精度の点滴灌漑及びドローンを用いたリモートセンシングを利用し、ソルガム 327 系統種の低リン条件下における評価を行った。さらに、乾燥ストレス条件下でソルガム 192 系統種の評価を行った。これらの実験から、生産性の高いソルガムの育種に有用な遺伝子を持ちうる、環境適応性が高い系統種を特定した。

平成 29 年度は、東京大学とリモートセンシングを用いた作物生育状況測定の共同研究を実施したほか、山梨大学と植物の耐乾性についての共同研究も実施した。

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29年6月に、スーダン・ワドメダニに於いて第3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。



Evaluation of sorghum plants under low soil fertility on the field of the ALRC.

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

The agricultural production in arid and semi-arid regions is affected by various constraints such as drought, low soil fertility, rising temperatures and diminishing natural resources. Food security is the most critical and urgent challenge to maintain the welfare of the expanding population on these regions. This situation necessitate the use of advanced plant biotechnology as important strategy to improve both the adaptability and productivity of the agricultural food crops.

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 2017, large collection of sorghum accessions from around the world has been tested under low soil fertility and drought stress conditions. In partnership with the University of Tokyo and the private sector, we have utilized both precise drip irrigation system and remote sensing using drones, to evaluate 327 sorghum accessions under low phosphate conditions. Moreover, a total of 192 sorghum accessions were evaluated under drought stress. Highly adaptable accessions were identified, and could represent valuable genetic sources to develop highly productive sorghum.

In FY 2017, a joint-research study on plant drought tolerance was conducted with Yamagata University, while studies on the use of remote sensing for plant growth measurements was conducted with the University of Tokyo.

Internationally, the Plant Genetic Engineering Subdivision has successfully concluded the JSPS Bilateral open partnership for research/seminar (2015-2017) with the Agricultural Research Corporation of (ARC) of Sudan, and has successfully organized “The 3rd International Workshop on Genetic Improvement of Cereals for Sustainable Production in Arid Lands” on June 2017 in Wad Medani city, Sudan.



Evaluation of sorghum plants under drought condition inside the plastic house.

Yasir Mohammed (Specially-Appointed Assist. Prof., Molecular Breeding)

The research activities during April 2017 to March 2018 included:

1. Wheat salinity tolerance.
2. Identification of heat stress adaptive traits in selected wheat lines.

Two-hundred forty seven multiple synthetic derivatives lines were evaluated last season in saline soil in Sudan to identify new salt tolerant wheat germplasm to be used to develop salinity tolerant wheat cultivars. Seventeen lines showed better performance than the parent Norin 61 in term of higher 1000 seed weight and chlorophyll content (Table 1). One of the tolerant lines, sensitive line and the parent Norin 61 were grown under salinity stress in lysimeter in the Arid Land Research Center to confirm the tolerance of the selected line. The result indicated that the MSD line was more tolerant than the parent Norin 61 (Fig. 1). The field experiment was repeated this season to confirm the results obtained from the first season. Genome wide association study will be conducted to identify QTLs/markers associated with the salinity tolerance.

In our previous study, 13 multiple synthetic lines were selected as heat tolerant among 400 lines evaluated in four environments in Sudan. These lines and their parent Norin 61 were evaluated under heat stress conditions in a growth chamber at the Arid Land research Center to identify the physiological mechanism of the heat tolerance in these lines. Two lines showed better mitochondrial membrane stability under heat stress than Norin 61, one line showed higher cell membrane thermostability and higher stomatal conductance than Norin 61, and one line possessed higher cell membrane thermostability and good mitochondrial membrane activity under heat stress. These lines were crossed with their parent Norin 61 last season. Their F₁ plants were grown this season in the field and self-pollinated. The produced F₂ populations will be evaluated under heats stress and genotyped to identify the QTLs underlying the tolerance observed in these lines.

I had three publications and the overseas activities included two research visits, one to Sudan and another visit to the International Center for Biosaline Agriculture in United Arab Emirates. I participated in the 13th wheat genetics symposium.

Table 1 Characteristics of multiple synthetic derivatives wheat lines selected under salinity stress ranked based on 1000-seed weight

Genotypes	Chlorophyll content	1000 seed weight	Heading
Norin61	52.8	29.4	60.6
MSD147	54.0	70.3	59.0
MSD278	50.3	40.3	65.5
MSD361	52.6	37.7	55.8
MSD187	55.1	37.6	62.8
MSD81	50.9	37.4	55.3
MSD377	52.1	36.5	68.3
MSD307	56.2	36.1	59.9
MSD66	51.7	35.1	66.4
MSD488	52.3	35.0	67.3
MSD270	50.1	35.0	64.7
MSD337	53.3	34.9	60.3
MSD88	54.7	34.5	65.6
MSD406	52.0	34.4	60.5
MSD25	53.9	34.3	63.0
MSD17	49.9	34.3	59.7
MSD389	54.4	34.1	64.3
MSD417	54.1	34.0	65.1

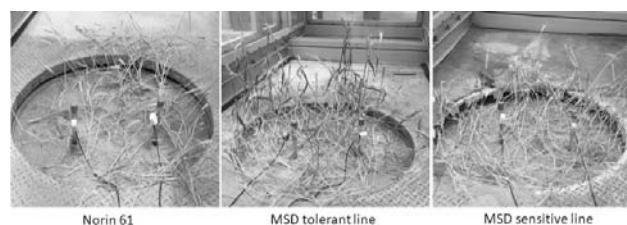


Fig.1 Performance of Norin 61, MSD tolerant and sensitive lines under salinity stress in lysimeter in Arid Land Research Center

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

Amrakh Mamedov (Prof., Soil & Water Management and Conservation)

April 2017 - March 2018

- Effective polyacrylamide (PAM) and amendments (gypsum, lime) incorporation to improve soil physical properties and quality, and prevent erosion of vulnerable.
- Effect of abiotic stress on tomato growth and yield (team member).

Amendments. In arid and semi-arid regions, land use change, intense cultivation without conservation, increase of field not covered by crops, and change in rainfall distribution associated by climate change could deteriorate decline soil structure, decline water and nutrient use efficiency, increase runoff and erosion, and lead to land degradation and biodiversity loss. Little information is available about the aggregate and stability of Ethiopian soils affected by long-term agriculture management without conservation. The objective of the study was using high energy moisture characteristics (HEMC) method to evaluate the role of soil amendments (e.g. polyacrylamide [PAM], lime and gypsum) on structure stability, and water retention parameters of 15 long-term intensively cultivated soils from three Ethiopian watersheds (Guder, Aba Gerima and Dibatie) for assessing soil conservation practices efficacy.

Stability tests showed that (i) 12 of 15 soils were more sensitive to wetting condition and had lower stability (0.14 - 0.48; max=1.0) due to various predominant breakdown mechanisms (e.g. slaking, dispersion, differential swelling). Hence, these soils are susceptible to rill and interrill erosion even under low slope level. Application of PAM and Lime considerably modified the shape of soils water retention curves at near saturation, which was closely linked to distribution of macropores (60-125, 125-250, >250 μm) and apparent aggregate size of soils and its erosion potential. PAM (200 mg/L) and Lime (1.6 g/L) treatments, improved the soil water holding capacity at saturation, volume of soil drainable pores, and thus leading to an increase in the soil aggregate and structure stability of soils more than 2-4 times, and 1.2-3 times correspondingly.

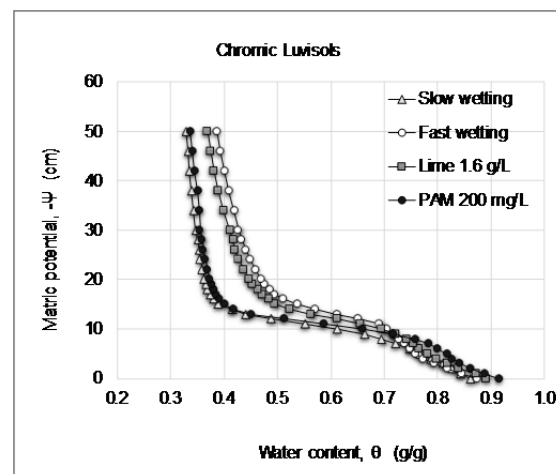
The results indicate that PAM and Lime efficiency was soil type dependent, and various site-specific PAM rate (20-80 kg/ha) and Lime rate (1-4 t/ha) could be used before rainfall in the areas when crops are small to cover and bind the soil against runoff generation, soil particles detachment and transport, and thus soil erosion. For sustaining soil and water quality and effective soil conservation and erosion control, soil type, properties and condition should be considered prior to proper rate of amendment application. Experiment on effect of

PAM concentrations, Lime rate and water quality is continued

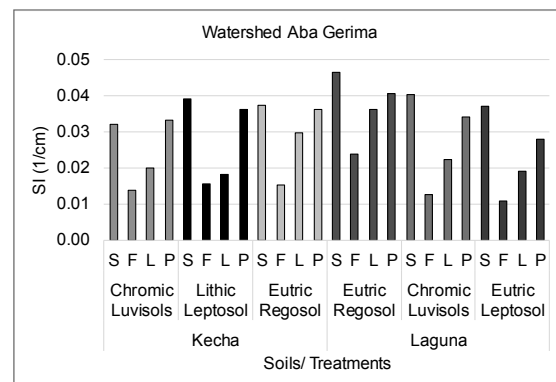
Abiotic stress. Cultivation system using more controlled sand-bed or sand ponics may have an advantage of controlling tomato crop water and nutrient requirement more economical way. To meet (i) crop water requirement, (ii) regulate abiotic stress (drought and salinity), and (iii) enhance yield quality, automatic irrigation system with capillary wetting or modified new ponics was used and effective approaches considering a) water use efficiency, b) salinity in root zone and leaching fraction, and b) net income was selected. Results would be used in macroscopic modelling of crop water use under salinity and drought stresses.

Other activities.

- Published two papers and submitted two papers for publication.
- Contribution to SATREPS project on soil conservation.
- Field survey trip to Ethiopia and laboratory experiment.
- Given seminars at Agriculture faculty and ALRC, Tottori University and Ethiopia.
- Presentation at international and national conferences.



Wetting rate, Lime and PAM application effect on (near saturation) water retention curves of Luvisols.



Soil structure stability (SI) as affected by slow wetting (S), fast wetting (F), Lime (L) and PAM (P) application.

Imad-eldin Ahmed Ali Babiker (Prof., Climate Change Adaptation)

October 2017 - March 2018

Development of Crop Production Scenarios in Sudan under Changing Climate

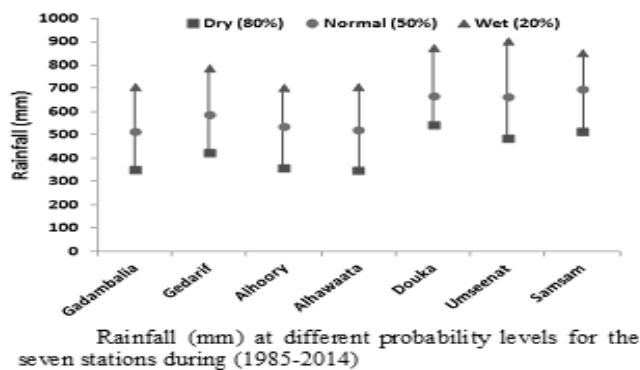
1. Rainfall Analysis and its Implications for Agricultural Production in Gedarif State, Eastern Sudan
2. Length of the Growing Season in Rainfed Farming under Arid, Semi-arid and Dry Monsoon Climates of Sudan
3. Analysis of climate factors (maximum and minimum temperatures) for wheat production areas in Sudan.

The first study focused on analyzing rainfall variability and trend using a 30-year record (1985-2014) of seven meteorological stations at the major agricultural production areas in Gedarif state Eastern Sudan. Yearly rainfall has relatively low variability compared to monthly variability. Trends of rainfall were inconsistent and the cropping season extended from June to September. Farmers in areas having high rainfall and extended growing season could grow suitable crops and varieties and their appropriate management practices should be implemented. In areas of low rainfall and short growing seasons, farmers could grow crops of short maturing varieties and water harvesting techniques.

The second study objective is to analyze historical rainfall records from seven stations in Gedarif state in Sudan to determine dependable rainfall at different rainfall probabilities wet (1-20%), normal (21-79%) and dry (80-100%) seasons, and to determine the start, end and length of the growing season.

The Results of rainfall probability at different levels grouped the stations Umseenat, Samsam and Douka same rainfall-zone (group I) rainfall range from 500 to 900 mm. On the other hand, Alhawaata, Alhoory, Gedarif and Gadambalia grouped in another rainfall-zone (group II) rainfall range 350 to 750 mm.

Generally, it could be avowed that in southern areas (group I) the season started as early as mid-June and in northern areas (group II) it started around mid-July. The growing season in dry (80%) years, ended in the third week of September in areas of group I, while it ended earlier in first week of September in areas of group II.

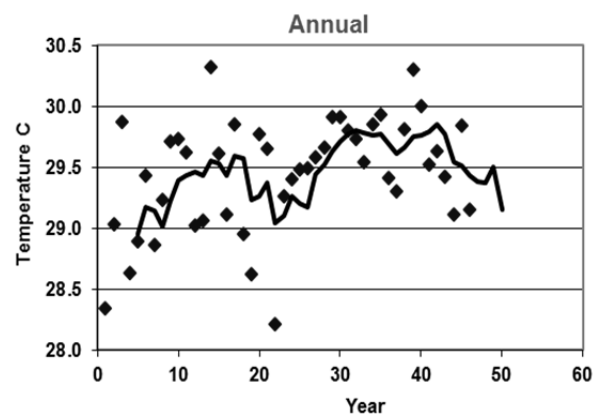


It could be stated that in southern areas (group I) the end of the growing season occurred late September and early October; while in Central-Northern areas (group II) it ended in early to mid-September. Length of the growing season (LGS) in dry years varied from 85 to 90 days in areas of group I, while it was between 45 to 65 days in areas of group II.

The general trend is the wetter the years were the longer the growing season. II areas. It is clear that areas of group I have longer growing season compared to areas of group II.

The third study objective is to determine temperature changes trends for wheat production in Sudan. The historical daily climate data of the study area such as maximum and minimum temperature, Rainfall and wind speed were collected from Sudan Metrological Authority (SMA) and wheat crop data from Agricultural Research Corporation (ARC). The climate data were quality controlled and cleaned. Checking for homogeneity and consistency were performed and adjusted. Preliminary analysis of rainfall and temperature data were performed.

Two scientific articles will be submitted for publication in peer-reviewed journals.



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

October 2016 - September 2017

Rainfall Characterization and Determination of Erosivity and Soil Erodibility in Ethiopia

I have been working on the rainfall characterization, soil erodibility and crop yield estimation, since October 2016. The rainfall data, which was collected in 2 consecutive rainfall season (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 (Fig. 2). 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 the last one year 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 environment”.

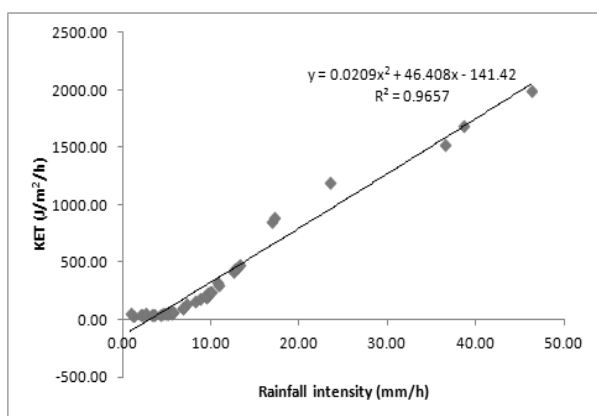


Fig. 1 Relationship between rain intensity Vs. kinetic

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.

Furthermore, I made a field survey trip to Ethiopia (May 7 to June 5, 2017) in order to contribute to the SATRPES 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. Overall, the field survey was successfully and the objectives were achieved.

Journal articles that I produced during my stay, with their status:

1. Characterizing rainfall and modeling kinetic energy of Ethiopian highland (draft completed and will be submitted soon)
2. Assessment and development of crop yield forecasting model: the case of 4 major agricultural commodities in Ethiopia (draft completed and will be submitted soon)
3. Application of optical disdrometer to characterize simulated rainfall and measure drop size distribution (after review~ hope to get acceptance soon)

Finally, I would like to thank Tottori University and Arid Land Research Center (ALRC) very much for giving me the opportunity to conduct research in Japan as foreign associate professor. I have spent a very nice research time and got a lot of experiences.



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

Mohamed Mutasim Eltayeb Elebeid (Assoc. Prof., Biochemistry and Microbiology)

April 2017 - March 2018

Screening and isolation of beneficial microorganisms with high enzymatic activity under drought conditions

Soil microorganisms contribute to a wide range of essential services to the sustainable functions of all ecosystems. These activities are governed by enzymes, which catalyze an innumerable reactions important for life process of microorganisms in soil, and it has different correlations with different biological processes such decomposition of organic matter and nutrients cycling. The main enzymes involved in the mineralization of soil organic materials are dehydrogenase, cellulases, proteases, phosphatases, and arylsulfatase. Microbial enzymes is affecting by several factors such as plants species, plant-microorganism interactions, and abiotic stress such as drought, which affect both plant and soil microbes activity. In the literature, several studies have been performed to evaluate the impact of drought stress on soil microbes and their enzymes. However, the interaction of soil microbes, enzymes and plants to their key functions under drought stress still unclear. Therefore, the main aim of our research during April 2017 to March 2018 at ALRC, Tottori University was to investigate the relationship of microbes, enzymes activity and plant to their key functions under drought stress. The soil and *Encelia farinosa* seeds used in this study were obtained from Boyd Deep Canyon Desert Research Center, California, USA. The seeds were surface sterilized and then germinated in a Petri dish for five days. The seedlings were transplanted to 15 ml tube filled with sterilized sand for 7 days. Thereafter, 12 days old plants were transplanted to the glass pot containing 220 g of soil. Two treatments were established consisting of (i) soil planted with *E. farinosa*, (ii) unplanted soil. The plants and bulk soil were placed in a glasshouse at 25°C. The water level was maintained for 50 days at 12% water content (80% of the water holding capacity). Then each treatment was subdivided among three water regimes (12%, 8%, and 5% water content w/w) for 40 days (Fig. 1). Three parameters were measured every three weeks including stomata conductance, number of leaves, thermo graphic image.

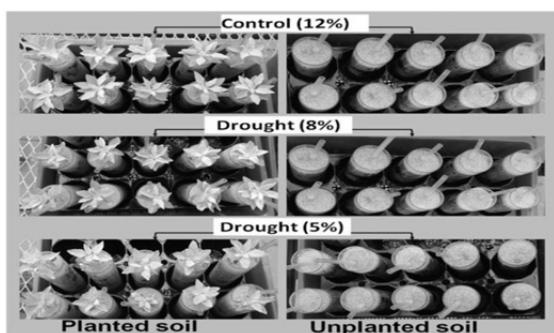


Fig. 1 Pot experiment design

Following plant harvesting, plant shoot weight and leaf area were measured. Rhizosphere soil from each treatment was stored at 4°C and -80 for enzymes assay and RNA isolation, respectively. Enzymes activities were measured using fluorogenically labeled substrates. Metagenome analysis was conducted to evaluate bacterial, fungal and AMF diversity. Thermo-graphic images, transpiration rate and phenotypic results confirmed that drought stress significantly affected *E. farinosa* seedling which might leads to changes in the root secretions and their associate microbe's functions. The results of enzymes activity revealed that induction of drought stress in unplanted soil improved most enzymes activities, whereas it showed variable effects on enzymes activities of planted soil. The activities of enzymes involved in carbon (β -Glucosidase & β -cellobiosidase) and nitrogen (Leucine- aminopeptidase) cycles were improved under drought, while it decreased for enzymes involved in phosphorous and sulfur cycles. This result indicates that drought effect was depending on the enzyme function. Analysis of bacterial, fungal, and AMF diversity and community structure revealed different responses. The results of NMDS plot showed that the microbial habitat (plant roots, rhizosphere and bulk soils) accounted for the variation in microbial diversity. However, drought stress affected the root fungal community at family level by rising relative abundance of Nectriaceae and decreasing Sebacinaceae and Thelephoraceae plus several other families (Fig. 2). This variation was decreased in bacterial community and was not observed in AMF. In conclusion, the data of the study indicates a relationship between microbial community, inducible soil enzymes, and drought stress. Drought effect on inducible enzymes were fluctuated depends on their functions. Enzymes involved in nitrogen and carbon cycles were less affected than that of phosphatase and sulfatase. Metagenome results of fungi and bacteria in different habitat and water level could be used to identify the important microbes for specific habitat under drought stress. Therefore, further covariance analysis for enzymes activity, metagenome data and ongoing research using metatranscriptomic analysis of rhizosphere and bulk soils microbes will help in a better understanding of the function of specific microbes under drought stress. The result of the study was presented in the 129th annual conference of Japanese Forest Society.

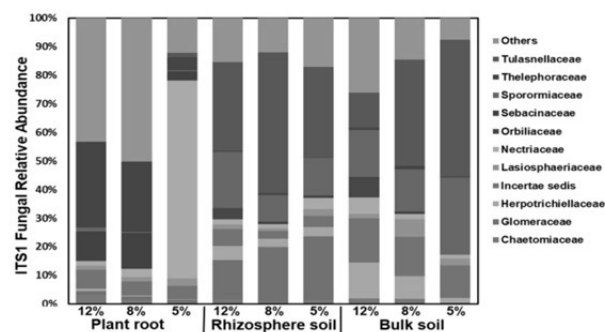


Fig. 2 Relative abundance of fungal community with ITS1 at family level

(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、「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。

- 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。
- 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。
- 明石ら (鳥取大学) と共同で、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を行った。



Breeding of *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 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 2017, we promoted the following research.

- I selected *Jatropha* plants in order to make the cold-tolerant variety.
- I evaluated environmental tolerance of sorghum.
- I preserved wheat strains.
- In collaboration with Dr. Tsuchimoto and others at Osaka University, we did research on improve productivity of oil plants in arid lands.
- In collaboration with Dr. Akashi and others at Tottori University, we did research on molecular physiology of cuticle layer fortification in the leaves of arid land plants.



Preservation and multiplication of wheat lines

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、TaPYL を過剰発現したコムギ (TaPYLox) を開発した。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. トランスクリプトーム解析および qRT-PCR の結果から、TaPYLox は ABA に対する感受性が向上しており、乾燥ストレスに対して鋭敏に反応するシステムが備わっていた (Fig. 1a)。
2. トランスクリプトーム解析において A,B,D ゲノム間の発現パターンを比較したところ、A,D は非常によく似た発現パターンを示すのに対し、B ゲノムは異なる発現パターンを示した (Fig. 1b)。

以上の結果から、TaPYLox は ABA への応答性の向上により、気孔が閉じ、水を節約できるだけでなく、ABA に対して鋭敏に反応することで、乾燥ストレスに対応していると考えられる。また、A,B,D ゲノムの発現パターンの相違から、ABA 応答および乾燥への寄与の大きいサブゲノムの同定にも成功した。

Ryosuke Mega (Project Researcher, 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. Transcriptome and qRT-PCR analyses revealed that TaPYLox improved ABA responsibility (Fig. 1a). Thus, TaPYLox was able to respond sensitively to drought stress.
2. Transcriptome analysis showed that gene expression pattern in subgenome A was similar to D although B is different from A and D (Fig. 1b).

Our research demonstrated that TaPYLox improved ABA sensitivity. This result suggests that TaPYLox adapt drought environment by highly sensitive ABA response. In addition, we succeeded to determine the subgenome which contribute to ABA and drought response according to gene expression pattern of each subgenome.

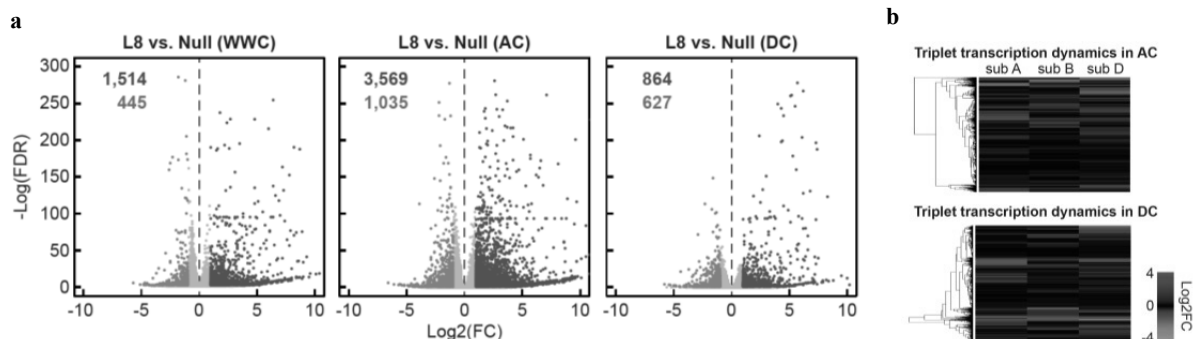


Fig. 1 (a) Gene expression pattern of subgenome A, B and D under ABA treatment and drought condition (AC and DC). (b) Different expression genes between TaPYLox L8 and null segregant (Null) under well-water condition (WWC), AC and DC.

河合 隆行 (地下水水文学)

平成 29 年度は以下の 2 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. 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)

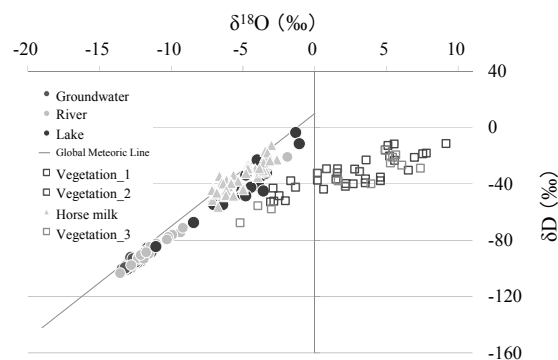
モンゴルの伝統的乳酸発酵飲料である馬乳酒において、その風味を左右する要因を自然環境因子から解析した。平成 29 年 8-9 月にかけて、馬乳酒名産地においてウマの食資源・水資源を対象に、草本の地上部 45、水 107 (湧水 56・川 29・湖 22)、馬乳 81、ホジル (集積塩) 2 サンプルの採取をおこなった。各サンプルのミネラル濃度を、乾燥地研究センターに新規導入された Agilent 8900 トリプル四重極 ICP-MS にて分析した。また、ウマの水分摂取源の割合を推定するために、ウマが摂取する水や草本地上部と馬乳の同位体比を、乾燥地研究センターのガスベンチ付き安定同位体比質量分析計にて計測した。

それらの結果、馬乳酒名産地には、①馬の育成必須ミネラル 5 種が草とホジルに十分に含まれていること、②一般的に飲量割合が少ないウマであるが、名産地では全摂取水量の約 7 割を飲水から摂取していること、③半乾燥地にもかかわらず馬乳酒名産地には豊富な湧水群が存在しており、これがウマの飲水源となっていること、等が明らかになった。

2. 地下流水音と地質探査を複合した砂地・乾燥地の地下水探査手法の確立 (学長裁量経費)、および、複合的物理解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)

モンゴル国の研究サイトにおいて地下水と地質の現地観測を実施した。水文・地質条件の異なる 3 地点 (永久凍斜面、乾燥草原地、森林斜面) にそれぞれ測線を設け、①地下流水音、②地中レーダー (GPR)、③比抵抗映像法 (電気探査) の 3 種の測定をおこなった。

探査の結果、既存技術である GPR と電気探査データから測線中に明確な断層構造が確認された。この断層構造直上では地下流水音の値が前後の地点と比較して極端に大きく、地下流水音の連続データから地下構造を推定できることが示唆された。また、GPR・電気探査により浅層地下水が確認された地点では地下流水音の曝気音を明確にとらえることができ、曝気音から推定された地下水深は GPR による探査水深とほぼ一致した。



Distribution of Oxygen and Hydrogen Stable Isotope Ratios

Takayuki Kawai (Project Researcher, Groundwater Hydrology)

We carried out the following two research subjects in 2017 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. Geographical and ecological investigation of airag (fermented mare's milk) production in Mongolia (15H02963)

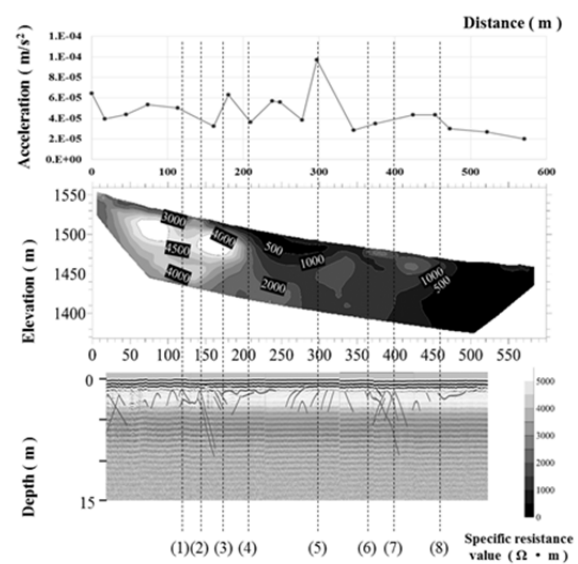
The proportion of the horse's water intake source was estimated by the following method. Mineral concentrations of food and water resources of horses were analyzed by ICP-MS. Isotopic ratios of water, grass and horse milk were measured with a stable isotope ratio mass spectrometer.

As a result, the following were clarified as the natural condition of the horse milk specialty place. As a result of that, it was revealed that horse in a airag specialty place ingests about 70% of the total water volume from drinking water. This water intake ratio is about three times that of horses in a wet place.

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

Field observation of groundwater and geology was conducted at the research site of Mongolia. Three different types of geophysical exploration were conducted at three sites with different hydrological and geological conditions. The exploration methods are estimation of shallow groundwater level by Groundwater-Aeration-Sound (GAS) and Ground-Penetrating-Radar (GPR), estimation of geological structure by GPR and 2D Resistivity image profiling (2DR).

As a result of GPR and 2DR, the fault structure, and the perched groundwater near the geological boundary are detected. In addition, discontinuities occurred in the subsurface structure as described above, the water movement sound (by GAS) became relatively large, and it became clear that a sufficient amount of liquid water was present.



Analysis results of each geophysical exploration

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 頭が生息する絶滅危惧種である。山岳生態系の頂点に位置するアンブレラ種であり、その保全は生態系の維持にとって極めて重要である。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。特にアルタイ山脈のある西部山岳地帯は、モンゴルにいるユキヒョウの大部分が生息しており、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。

モンゴル西部のユキヒョウ個体群を保全するためには、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。そのため、生息数、遺伝的多様性、集団遺伝構造を明らかにし、生息の実態や分断化の影響を評価することが求められている。

本年度はムンフン山とシルクヘム山の 2 か所でサンプリングを実施した。過去 2 年分の試料を全て乾燥地研究センターに持ち帰り、DNA 解析を実施した。個体識別は多様性の高い 8 つのマイクロサテライトマーカーを用いて実施した。個体識別の成功率は、季節にかかわらず約 80%と高く、山岳地帯の乾燥や低温環境が糞の劣化を防いでいると考えられる。

集団遺伝構造解析を実施したところ、地域間の遺伝的分化の程度は低いことが分かった。7 個体以上識別された 4 地域の間では、対立遺伝子数やヘテロ接合度に有意な差は見られなかった。クラスタリング解析では 2 つの遺伝的クラスターが検出されたが、同じ地域内に各クラスターに帰属する個体が存在しており、明瞭にクラスターが分かれることは無かった。

モンゴル西部山岳地帯では、遺伝的障壁となりうる道路が生息地を分断しているが、低い遺伝的分化や中程度の遺伝的多様性を考慮すると、生息地間で遺伝子交流が維持されていることが示唆された。しかし西部地域の道路の多くは近年舗装が進んでおり、また鉱山開発も活発になっていることから、今後も生息地の連結性を維持できるかが課題である。



Fecal sampling in Munkh mountain

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. 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.

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 due to the 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 by revealing population size and genetic structure of snow leopards in western Mongolia.

In this year, I collected fecal samples in Munkh mountain and Siilkhem mountain. After getting appropriate export and import permits, I transported samples to ALRC. Fecal DNA was extracted from all samples and then species and individual identification was conducted. Success rate of individual identification was high (about 80%), which is probably due to dry environment and low temperature.

Population genetic analyses revealed low genetic differentiation and no significant differences in genetic diversity among populations, which suggests that gene flow among populations persists in western Mongolia. Due to ongoing land development within snow leopard range, monitoring the connectivity between habitats will be needed.



Tracks of snow leopard in Siilkhem mountain

山崎 裕司 (分子育種学)

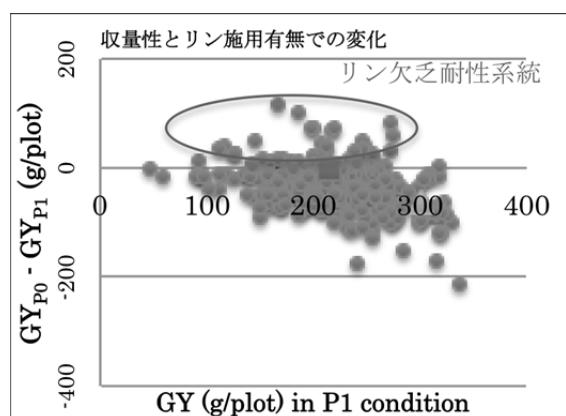
分子育種学分野では以下のような研究を行っている。

- (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) リン欠乏土壌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

これらの研究は、限界地プロジェクトの援助によって、主としてスーダン・日本で行われている。

本年度は、特に以下の研究で成果を得た。

1. リン欠乏土壌・通常土壌をスーダン（アルカリ土壌）及び鳥取砂丘（酸性土壌）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した。その結果、スーダンのリン欠乏土壌において、耐性系統を選抜できた、また2年目のデータも現在取得中である。
2. 一昨年度末に導入された ICP 質量分析システム (ICP-MS) を用い、1で栽培している多系統のコムギのリン欠乏土壌・通常土壌環境の差においての各元素の植物体への吸収・転流を含めたイオノーム解析を始めた。現在のところ、リン欠乏耐性だけでなく、種子に特徴のある系統が発見されており、再現性、有用性やメカニズムなどを確認している。
3. 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行なっている。また耐乾性のメカニズム解明のため、耐暑性同様に実験系を行なっている。



The wheat lines containing wheat wild genes grown under phosphorus deficiency in Sudan.

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

These studies are conducting under Marginal region Project especially in Sudan and Japan.

The following things are my projects, which start in the physical year 2017 as my second contract year.

1. We have obtained the first screening data for 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. Based on the analysis of data in Sudan, the tolerant lines showing better yield performance under phosphorus deficiency have been obtained. Currently, the second year's field experiments are performed.
2. In the end of physical year 2016, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was introduced into the ALRC. We have made 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. Not only phosphorus deficiency tolerant line, but also some useful genotypes have been discovered. Now we are confirming the data and trying to find mechanism of these interesting characters.
3. 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.



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 29 年度については、以下の研究を行った。

(1) アフリカ乾燥地 (ICARDA マンシュージュ、モロッコ) での節水灌漑栽培の実施。

(2) アフリカ乾燥地 (ICARDA マンシュージュ、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関連する数値解析。

(3) 天然ゴムラテックスを用いた浸透抑制膜による土壌の保水性の変化に関する実験の実施。

これらについての実施状況を、以下に示す。

(1) については、2016 年 11 月中旬に ICARDA の小麦圃場で機械播種 (現地の Durum wheat)、灌漑設備設置、モニタリングセンサの設置を行い、2017 年 3 月上旬から灌漑を開始した。その後 2017 年 4 月下旬に灌漑を停止し、5 月下旬に収穫した。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。

(2) については、(1) と同一圃場にて 2017 年 11 月中旬に、機械および手動播種、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 2018 年 3 月上旬から、実験を開始した。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。また供試作物として、Durum wheat および日本の Bread wheat を用いた。

(3) については、カラム試験として、アクリル円筒カラム (長さ 60 cm、膜あり・膜なし) に鳥取砂丘砂・膜・水分センサを充填・設置し、建物屋上での自然降雨条件下に曝してカラム内の水分動態を比較した。また圃場試験として、乾地研砂丘砂圃場に設けた実験区 (1.8 m 四方・深さ 50 cm 程度、複数の膜施工上の処理に対応) での水分動態を比較した。



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

Iwao Sakaguchi (Project Researcher, Soil conservation)

My research activities during Apr. 2017 – Mar. 2018 are described as follows:

(1) Field experiment of the water saving irrigation of wheat at ICARDA Marchouch, Morocco.

(2) Setting experimental system for the water saving irrigation scheduling at ICARDA Marchouch, Morocco, and numerical simulation of heat and mass transfers in soil for this irrigation scheduling.

(3) Column and field experiments of change in soil water content by introducing aquiclude membrane made of natural rubber latex.

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

(1) After seeding of Moroccan Durum wheat, irrigation system and monitoring sensors were installed in mid-Nov. 2016, the irrigation experiment was started from early-Mar. 2017. The irrigation period was finished in late-Apr. 2017, wheat was harvested in late-May 2017. Three different experimental treatments (Rainfed, Automated-irrigation, and Simulated-irrigation) were prepared. Income, cost, and net income of those treatments were estimated from measured yield, total amount of irrigated water etc. Net income among those treatments were compared.

(2) Seeding, settings of irrigation system and monitoring sensors were conducted in mid-Nov. 2017, the irrigation experiment was started from early-Mar. 2018. Three different treatments (Rainfed, Automated-irrigation, and Simulated-irrigation) were prepared. Moroccan Durum wheat and Japanese Bread wheat were used.

(3) As column experiment, Tottori dune sand, aquiclude membrane, and monitoring device were packed and installed into cylindrical containers (length 60 cm, with/no membrane). Those two containers were placed at roof area of building and exposed to precipitation. Changes in water content of those containers were compared. As field experiment, four experimental treatments depending on construction process of the aquiclude membrane were prepared at Tottori dune sand area of ALRC. Changes in soil water content among those four treatments were compared.



Experimental set up for column experiment



Experimental set up for field experiment

Pictures of experimental set up for column and field experiments.

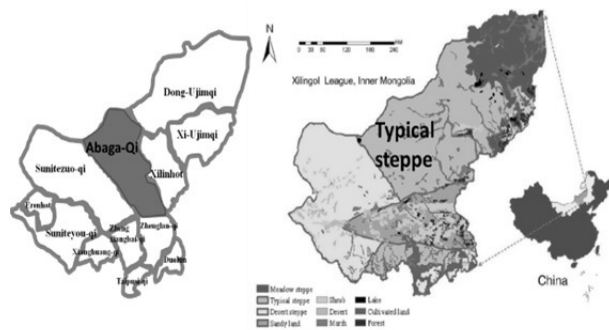
Jing Wu (Project Researcher, Wind Erosion Climatology)

The wind erosion climatological subdivision conducts research mainly as follows:

- (1) Climatological analysis of spatiotemporal characteristics of wind erosion and aeolian dust.
- (2) Characteristics of erosivity (i.e., wind velocity) and erodibility (i.e. land surface condition) by using meteorological data, remote sensing data, and statistic data.
- (3) To evaluate the relative contributions of climate change and human activities on aeolian dust and aeolian desertification in East Asia, especially in northern China and Mongolia.

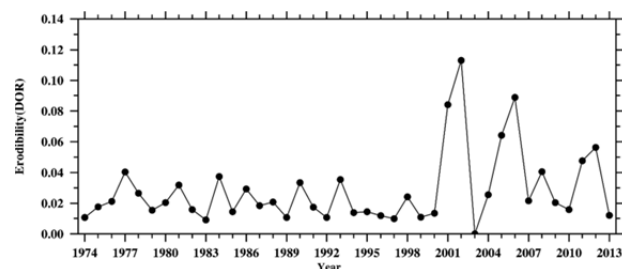
In this fiscal year, I obtained results from following researches:

1. The inter-annual variations of dust occurrence, erosivity and erodibility during the period of 1974-2013 at Abaga-Qi, Inner Mongolia. The study site is located in the Xilingol Grassland, with the vegetation cover type of typical steppe. An erodibility index (DOR), which is the ratio of the frequency of dust occurrence and strong wind, has been proposed to be used as an indicator for monitoring the status of desertification. Based on results of the year-to-year variations of DOR, the land surface has become vulnerable since 2000.
2. The inter-annual variations of precipitation and temperature during the period of 1973-2012 at Abaga-Qi indicated that the climate is becoming drier and warmer. The climate change increases the potential risk of desertification and grassland degradation, which is related to the probability of dust occurrence.
3. To combat desertification and reduce the probability of dust occurrence, a series of policies and projects have been implemented in China. For example, “returning farmland to forest or grassland” has been raised in the Grain for Green Project to control the over-reclamation. The Grazing Forbidden Project is one of the important program to remove the grazing pressure by reducing the livestock number. We proposed to objectively evaluate the effectiveness of those programs on desertification restoration.



Administrative map and vegetation map of Xilingol League, Inner Mongolia.

4. Multiple regression analysis was conducted to evaluate the relative contributions of climate change (precipitation and temperature) and human activities (livestock number) on aeolian desertification during the period of 2001-2013 at Abaga-Qi. Results from the best fitted regression model indicate that the vulnerable land surface condition is related to not only the climate change, but also the human disturbance, which is strongly controlled by the government policies. However, reduction of the livestock number relieved the grazing pressure and greatly contributed to the restoration of desertification in the recent years.
5. Field survey was conducted at Abaga-Qi. Zhang et al. (2015) identified dust hot spots from Multi-resolution remotely sensed data in Eastern China and Mongolia. They suggested that hot spots such as dry lakes, river beds and mines contribute to dust occurrence in Inner Mongolia. We went to the three identified hot spots of dry lake, which are located in Abaga-Qi to investigate the land surface condition. The land surface around hot spots are still lack of protection and management. We also collected data regarding to grazing activities and conducted interview to local herders.
6. We expected an application of the method to evaluate the climatic and anthropogenic effects on aeolian dust and desertification in a wide region of East Asia. We also expected the results can give suggestions to local people and policy makers for appropriate grassland management.



Temporal variation of DOR during the period of 1974-2013 at Abaga-Qi, Inner Mongolia.

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。

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。

平成29年度は、9月にスーダン農業研究機構から2名の研究者を乾燥地研究センターに招聘し、国際ワークショップを開催したほか、10月にはヨルダン工科大学の限界地栽培に関する国際ワークショップで藤巻教授が口頭発表を実施、また、平成30年2月には、スーダンのワドメダニとドンゴラに設けた現地実証フィールドにおいて、多数の研究者、技術者、農民、企業社員等を招き、成果発表会を実施した。

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).

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.

In FY 2017, ALRC invited two researchers from Agricultural Research Corporation (ARC), Sudan, and held a workshop in September. In October, Prof. Fujimaki gave a presentation at an international workshop on marginal region agriculture took place at Jordan University of Science and Technology. In February 2018, ALRC's research team made presentations of the outcomes of the project at its experimental fields in Wad Medani and Dongola, Sudan.

(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。

鳥取大学と相手国研究機関であるバハルダール大学は、アムハラ州農業研究センター、アンダサ研究センター等、現地研究機関の協力も得て、平成 29 年度から本格的に研究活動を開始した。

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 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.

Tottori University and its Ethiopian counterpart Bahir Dar University, in collaboration with Amhara Regional Agricultural Research Institute (ARARI), Andassa Research Center and other research institutes in Ethiopia, have started full-scale operation of the project from FY 2017.

Project Title

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

Duration

FY 2017 - FY 2021 (five years)

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.

(3) 乾燥地×温暖化プロジェクト

乾燥地研究センターでは、共同利用・共同研究拠点強化プロジェクトとして、「砂漠化地域における地球温暖化への対応に関する研究（通称：乾燥地×温暖化プロジェクト）」（平成29年度～平成33年度）を開始した。

温暖化の進行とともに極端な気象現象が増加すると指摘されている。砂漠化地域においても、地球温暖化が原因と考えられる熱波・干ばつといった気象災害が頻発し、食糧不足など生活を直撃する影響が生じている。本プロジェクトでは、①熱波・干ばつ等の将来気候の解析を行い、②これらの砂漠化・農業への影響を明らかにし、③これらのリスクに対する適応・砂漠化対処策の開発を行う。（プロジェクトリーダー：山中典和）

研究内容

本プロジェクトは、将来気候グループ、砂漠化対処グループ及び、乾燥地農業グループの3つのグループで実施する。

● 将来気候グループ（リーダー：黒崎泰典）

① 将来気候解析

主な研究対象地域：モンゴル、スーダン

- ・ GCM で計算された気候データ（CMIP5 など）を用いた乾燥度指数など将来気候の解析
- ・ 熱波や干ばつなどの気象災害の変化を予測

● 砂漠化対処グループ（リーダー：衣笠利彦）

② 影響評価及び③ 適応策・砂漠化対処策の開発

主な研究対象地域：モンゴル

- ・ 砂漠化（乾燥地における植生や土地の劣化）に対する温暖化の影響評価
- ・ 温暖化に適応した持続的な草原利用法の提案、ダスト警報システムの精度向上等

● 乾燥地農業グループ（リーダー：辻本壽）

② 影響評価及び③ 適応策・砂漠化対処策の開発

主な研究対象地域：スーダン

- ・ 熱波や干ばつによる乾燥地の農業生産等への影響を評価
- ・ 耐暑・耐乾性作物の開発、乾燥地栽培技術の発展

これらの研究は、乾燥地研究センターが国際共同研究等で構築してきた学術ネットワークを活用して、モンゴル気象水文環境情報研究所（IRIMHE）、スーダン農業研究機構（ARC）、スーダン気象局（SMA）等と連携して推進する。

平成29年度、各グループはこれらの研究機関と共同研究を開始したほか、平成29年12月3日には、スーダン気象庁長官などスーダンとモンゴルの研究者4名を招き、第1回国際ワークショップ「気候変動の乾燥地へのインパクト：影響評価と適応策」を開催した。国内の大学・研究所等を対象に、平成30年度開始の共同研究の公募を行い、3件の課題を採択した。

(3) Project ICC × DRYLANDs

ALRC has started a five-year project called “Impacts of Climate Change (ICC) on Drylands: Assessment and Adaptation,” or “Project ICC×DRYLANDs” for short in FY 2017, aiming to enhance its function as a Joint Usage/Research Center.

It is pointed out that global warming increases the frequency of extreme weather events. Disasters such as heat wave, drought etc., frequently occur in drylands as well, and they have impacts like food scarcity. In this project, ALRC’s research team will 1) conduct analyses of future climate from the viewpoint of such disasters, 2) assess their impacts on desertification and agriculture in drylands, and 3) develop adaptation technologies to mitigate their associated risks. (Project leader: Yamanaka, N.)

Contents of the project

This project consists of three research groups; Future Climate Group, Combat Desertification Group, and Dryland Agriculture Group.

● Future Climate Group (Leader: Kurosaki, Y.)

1) Analyses of Future Climate Data

Major Research Regions: Mongolia and Sudan

- ・ Analyses of future climate (e.g., Aridity Index) using GCM’s outputs such as CMIP5 etc.
- ・ Prediction of disasters such as heat wave and drought, etc.

● Combat Desertification Group (Leader: Kinugasa, T.)

2) Assessment of Climate Change Impacts & 3) Development of Adaptation Technologies

Major Research Region: Mongolia

- ・ Assessment of climate change impact on desertification (degradation of vegetation and land)
- ・ Proposal for sustainable grassland management adapted to climate change; Improvement of dust early warning system, etc.

● Dryland Agriculture Group (Leader: Tsujimoto, H.)

2) Assessment of Climate Change Impacts & 3) Development of Adaptation Technologies

Major Research Region: Sudan

- ・ Impact assessment of heat wave, drought, etc. on agriculture in drylands
- ・ Development of heat and drought tolerant crops and cultivation technologies coping with heat wave and drought

In this project, ALRC promotes collaborative researches with Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE, Mongolia), Agricultural Research Corporation (ARC, Sudan), and Sudan Meteorological Authority (SMA, Sudan).

In FY 2017, each group started collaborative researches with the institutes. ALRC held the 1st International Workshop, inviting four researchers from Sudan and Mongolia including Director General of Sudan Meteorological Authority. It publicly offered joint researches, which start from FY2018, and three subjects were adopted.

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	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Re- searcher	石山 俊 (国立民族学博物館人類文明誌研究部) Ishiyama, Shun (Department of Modern Society and Civilization, National Museum of Ethnology)	
研究課題 Research Sub- ject	ミャンマー中央乾燥地における複数生業による生計向上のための村落開発についての研究 A study on subsistence diversification and economic improvement for rural development in central dryland of Myanmar	
共同研究要旨 Summary of Joint Research	<p>Two times of field surveys had realized in 2017. The first survey in June tried to collect general data on livelihoods at three villages, in Nyaung U District, Mandalay Division. For the second, one village was selected as concentrated data collection, finding supplement data from other villages.</p> <p>Four points can be pointed out as a result of 2017's research as follow.</p> <ol style="list-style-type: none"> 1) Difficulty of rainfed cropping, because of extreme variation of rainfall, bimodal rainy season and uncorrelated precipitation between two rainy seasons. 2) Important crops are groundnut, sesame and beans under the condition of rainfed cropping excluding some area introducing water channel by international aid. 3) Groundnut is grown for self-sustenance consumption, other crops are for selling. 4) Dependency on agriculture is extremely low for household economic situation. <p>For the last point, we have classified 6 categories of household economic situations considering agricultural income.</p> <ol style="list-style-type: none"> 1) Full time farmers; 3 cases. 2) Farmers with side job possessing over than 3 acres of the land; 4 cases. 3) Main income from no agricultural activities possessing less than 3 acres of the land; 9 cases 4) Full income from no agricultural activities; 13 cases. 5) Specialized in animal feeding; 1 case (out of surveyed village). 6) Farming by irrigation introduced by international aid; 1 case (out of surveyed village). 	

特定研究 2 Specific Research 2	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searcher	大槻 恭一 (九州大学大学院農学研究院) Otsuki, Kyoichi (Faculty of Agriculture, Kyushu University)	
研究課題 Research Sub- ject	中国黄土高原における森林の水利用及び物質循環に関する研究 Studies on water use and material cycles of forests in Loess Plateau in China	
共同研究要旨 Summary of Joint Research	<p>We have been monitoring the ecohydrological dynamics of neighboring stands of an indigenous forest of <i>Quercus liaotungensis</i> and an exotic plantation <i>Robinia pseudoacacia</i> in Mt. Gonglu located in the Forest-Glassland area of Loess Plateau in China since 2002. The ecohydrological characteristics of these stands are quite different. Although the ecohydrological characteristics of the <i>Q. liaotungensis</i> stand have not changed, those of the <i>R. pseudoacacia</i> stand have greatly changed for these 15 years. Great changes are seen in the forest floor vegetation. Although the forest floor in the <i>R. pseudoacacia</i> stand was bared or sparsely covered by grasses in early 2000s, it has been densely covered by trees higher than 2 m since late 2010s and <i>R. pseudoacacia</i> seems to be decline.</p> <p>In this study, we measured the solar radiation on the forest floors and soil temperatures in addition to continuing the ecohydrological monitoring. have continued the monitoring. The results showed that the solar radiation and soil temperature in the foliation stage in spring were higher in the <i>R. pseudoacacia</i> stand than the <i>Q. liaotungensis</i> stand in the past but there are not much differences between the stands now. We also measured the transpiration of six representative tree species in this area including <i>Q. liaotungensis</i> and <i>R. pseudoacacia</i>, and found that transpiration of <i>R. pseudoacacia</i> was lower and drought resistance was weaker than the other tree species.</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 Re- searcher	土本 卓 (大阪大学薬学研究科) Tsuchimoto, Suguru (Graduate School of Pharmaceutical Sciences, Osaka University)	
研究課題 Research Sub- ject	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>A jojoba test field of 4.2 ha was set up by Osaka University (OU) Venture in the desert about 100 km northwest of Cairo in Egypt. In August, about 4,500 good female cuttings were transplanted and seeds were sown to produce 500 males. Three test plots were set up and Egyptian seeds and seeds of 12 American strains transferred from USDA were sown. We use drip irrigation with groundwater, and now they are growing steadily. We plan to evaluate traits and do marker analysis. We also do trial cultivation of the USDA strain at OU, ALRC, Ishigaki, Miyako, Okinawa, and Tokunoshima. Fruits were observed in cuttings at OU and Ishigaki, and male flowers in seedlings at Okinawa. Differences among strains were recognized on the number of fruits and resistance to typhoons. We will continue to observe traits. To examine the function of jojoba seed oil on proliferation of skin cells, proliferation test of three-dimensional epidermal model cells was carried out. We found that when jojoba oil-containing cream was given to the cells, the number of cells was about 1.5 times as high as that without treatment. On the other hand, in three commercial creams without jojoba seed oil, it was less than 1.1 times. As for Jatropha, the elite strain of Mexico was not transferred to the Japan and its research could not be done. In this fiscal year, we published a paper on Jatropha's marker analysis and another paper was accepted. We also published a report on jojoba tissue culture and another on transformation. A review book on the Jatropha genome, including six articles by foreign and Japanese members of this research, was edited and published. Laboratory of Advanced Health Science was established at OU, and research on biological resources including arid land plants such as jojoba has started. Tsuchimoto and Fukui belong to it.</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 Re- searcher	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 Sub- ject	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	<p>We started international research project to make long-term monitoring of desertification and dusts in East Asia in cooperation with Mongolian Academy of Sciences, National University of Mongolia and Tottori University. The field surveys have been done to obtain samples for long-term monitoring at lakes, ponds and marshes in Mongolia using geological and geographical methods. Our researches presumed long-range (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.</p> <p>In 2017, we surveyed at 16 lakes and marshes in the western part of Mongolia, and took 40 diatom samples and 6 drilling cores. The diatoms in the lakes and marshes distributed according to the water environment, especially electric conductivity. We found the two times of high water stages after 4500 years BP using diatom analysis of the cores. Our preliminary analysis presumed that the dry period occurred during 2340-1050 years BP. After 700 years BP the lake level has increased again. Recently the melting water from the permafrost has offered huge water resource into the lake. Those water environmental change has influenced to supply the dust materials to Gobi Desert.</p>	

一般研究 2 General Research 2	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Re- searcher	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 Sub- ject	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>The purpose of this study is to apply heat-activated retrotransposition of ONSEN that could induce mutations for crops and to promote molecular breeding. We induced retrotransposition of ONSEN in Japanese radish and adzuki beans. The callus-mediated retrotransposition of ONSEN was induced and new transpositions were found in the regenerated plant of both species. We found a heat-activated retrotransposon that was conserved in <i>Arabidopsis</i> and adzuki. The homology of DNA sequence was 82% and the transcriptional activation was detected on the heat-stressed seedlings. The heat-activation was conserved among the accession of Japanese adzuki and many of them were originated from East Japan. Extrachromosomal DNA was detected from heat-stressed adzuki indicating the possibility of retrotransposition. To increase the transposition frequency of ONSEN, we would modify the stress treatment and also try to use inhibitor of DNA methylation. In the future, we would use the transposon-inserted lines to produce stress-tolerant plants for molecular breeding.</p>	

一般研究 3 General Research 3	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Re- searcher	山中 高史 (国立研究開発法人森林研究・整備機構森林総合研究所) Yamanaka, Takashi (Forestry and Forest Products Research Institute, Forest Research and Management Organization)	
研究課題 Research Sub- ject	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>Fruit-bodies of desert truffles (<i>Picoa juniper</i>, <i>Terfezia boudieri</i>) from Tunisia were used as inoculants for infection of seedlings of <i>Helminthorum</i>, which are considered as host plants for these truffles in desert areas. 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 the fertilization, the growth of <i>Helminthorum</i> seedlings was improved when the plants inoculated with <i>Picoa</i> or <i>Terfezia</i>. The formation of Hartig net and fungal mantle were observed under a differential interference contrast (DIC) microscopy.</p>	

一般研究 4 General Research 4	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	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 Sub- ject	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>, an obligate root hemi-parasitic angiosperm, is a major biological constraint to cereal production in sub-Saharan Africa. The parasite thrives on xylem sap diverted from host through direct xylem connection. To this end the parasite maintains much higher transpiration than its respective hosts especially under drought conditions. For land plants in general, abscisic acid (ABA) plays a major role in acclimation to drought through regulation of stomatal behavior and subsequently modulates plants water relations. Recent research has advanced knowledge on ABA perception and signal transduction. The ABA receptor PYL proteins, in presence of ABA, strongly inhibit activity of PP2C type proteins phosphatases, leading to activation of the downstream component SnRK2 kinases. Stomata of <i>S. hermonthica</i> are insensitive to ABA. The anomalous stomatal behavior, in <i>S. hermonthica</i>, leads to maintenance of high transpiration, a concomitant establishment of a gradient water potential</p>	

	<p>that facilitates the translocation of water and solutes to the parasite. Accordingly, identification and functional analysis of the components of ABA signaling in <i>S. hermonthica</i> are imperative.</p> <p>Homologous genes of PYL and PP2C phosphatase in <i>Striga</i> EST databases were identified and the function of each of heterologously expressed proteins was analyzed. All of the eight ShPYLs inhibited the activity of Arabidopsis PP2C phosphatase AtABI1, thus indicating that the ShPYLs are functional ABA receptors. On the other hand, one of four PP2C phosphatases from <i>S. hermonthica</i> was not inhibited by any PYL in the presence of ABA. The mal-functional PP2C phosphatase may play a role in conferring insensitivity to ABA, maintenance of high transpiration rate in <i>S. hermonthica</i> and subsequent translocation of host-derived materials to the parasite.</p>
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一般研究 5 General Research 5	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	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 Education and Research 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 such as ectomycorrhiza fungi (EM) and Arbuscular-mycorrhiza fungi (AM) significantly affects soil microbial community structure and then soil nitrogen dynamics in forest ecosystems. We investigated the differences in soil prokaryote and fungal community structure and its functions as well as soil nitrogen dynamics between two types of forest, <i>i.e.</i> plantation forests of <i>Robinia pseudoacacia</i> (associated with AM) and natural forests of <i>Quercus liaotungensis</i> (associated with EM). We collected top soils from both types of forests and extracted soil DNA and dissolved nitrogen. We found the considerable differences in soil prokaryote community and soil fungal community between forest types. Furthermore, functional analysis using fungal community data revealed that saprotrophic fungi dominated in <i>Robinia</i> forests and symbiotic fungi dominated in <i>Quercus</i> forests. This suggests that main decomposer of soil organic matter are saprotrophic fungi and symbiotic fungi for <i>Robinia</i> forests and <i>Quercus</i> forests, respectively. Furthermore, functional composition of prokaryote community was also different between two types of forests. For amount of species of dissolved 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 6 General Research 6	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researcher	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 is an expanding field or research basically in environmental studies due to the benefits of its cost effectiveness and environmental friendliness. The use of this technology in saline and alkaline soils can be a promising approach because soil salinity inhibits crop growth and cause tremendous yield losses in many regions of the world, especially in arid and semi-arid regions of the world. However, little is known about the plants that can be applicable in the phytoremediation of saline soils and role of their rhizobacteria in the phytoremediation processes. In this study, we examined sodium (Na) uptake by the halophyte <i>Salsola grandis</i> and screened Na resistant rhizobacteria inhabiting in an extremely saline soil environment. <i>S. grandis</i> could uptake Na at the value of 15447 mg·kg⁻¹ and transported Na to stem and leaves from roots. On the other hand, we found that 50 out of the 131 strains were Na resistant and 8 out these 50 strains contributed the growth of <i>S. grandis</i>. Using 16S ribosomal RNA sequencing, we determined these eight strains to be within the genera <i>Arthrobacter</i> spp. and <i>Bacillus</i> spp. Moreover, four of the eight strains (A22, WP5, B14, AP20) showed traits of</p>	

	being both siderophore producers and indole-3-acetic acid producers. Therefore, these eight strains appear to be suitable candidates for plant growth-promoting rhizobacteria of <i>S. grandis</i> .
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一般研究 7 General Research 7	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Re-searcher	花田 耕介 (九州工業大学情報工学研究院) Hanada, Kousuke (Graduate School of Computer Science and Systems Engineering, Kyushu Institute of Technology)	
研究課題 Research Sub-ject	次世代シーケンス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 Transcribed sequences were determined by Illumina HiSEQ 2500. The determined sequences were assembled in oases software. After extracting <i>Leymus racemosus</i> specific region, we inferred more than 10,000 potential marker regions which has gap sequences between <i>Leymus racemosus</i> and wheat. The potential marker regions were validated by Tsujimoto's lab (Tottori University). Validated markers were published in a Journal (BMC Genetics).</p>	

一般研究 8 General Research 8	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re-searcher	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 Sub-ject	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>Sonneratia alba</i>, is a species of mangrove tree classified in the family Lythraceae. It occurs in the intertidal zones of estuarine areas and Iriomote island are regarded as the northern limit for its distribution. We extracted total RNA from five tissues including leaves, shoots, aerial roots and fruit in <i>Sonneratia alba</i> distributed in Iriomote island. cDNA library was constructed from various tissues and <i>Sonneratia alba</i> transcriptomes were sequenced using illumina sequencer. After quality assessment and data filtering, 7,140,000 reads were obtained resulting in 38,500,000 bp sequences. The cleaned raw reads were assembled into a total of 47,676 contigs. Of the unigenes, about 30,000 unigenes showed homology to Arabidopsis genes based on BLAST analysis against The Arabidopsis Information Resource (TAIR). About 17,000 unigenes showed no homology to TAIR database. These genes are regarded specific to <i>Sonneratia alba</i>. We have focused on 916 contigs in relation to salt tolerance by Gene Ontology (GO) information. Genes encoding Glycine-rich RNA binding protein, aquaporin TIP protein, Glutathione S-transferase, Fructose-bisphosphate aldolase, S-adenosylmethionine synthase, Chitinase Aspartic proteinase, Enolase and L-ascobate peroxidase showed higher expression level in <i>Sonneratia alba</i>. While Genes 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>. RNA-seq results showed different trend in list of genes with higher expression in <i>Sonneratia alba</i> and <i>Avicennia marina</i>.</p>	

一般研究 9 General Research 9	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Re- searcher	明石 欣也 (鳥取大学農学部) Akashi, Kinya (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	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	<p>Plants in the arid lands are often equipped with well-developed wax-rich cuticle layers, which allows efficient reflection of excess light on the leaf surface. Although this trait is considered beneficial for survival of these plants under harsh high light and water-deficit conditions, comprehensive understanding of this trait in plants, especially those in the arid regions, has been limited. In this study, properties of light reflection, chemical composition of cuticle wax layers, and morphology of arid land-derived plants were examined using a collection of genetic resource in the Arid Land Research Center, Tottori University. Investigation of the 23 representative plants showed that a maximum of 92% of incident light was reflected in these plants, which was significantly higher than that observed in a model plant <i>Arabidopsis</i>. Chemical analysis revealed that all the arid land-derived plants investigated in this study had significantly higher amount of cuticle wax in their unit surface area in comparison to <i>Arabidopsis</i>. However, their wax compositions were highly diverged, indicating the presence of distinct molecular mechanisms for the deposition of these waxes in different plant species. Analyses using surface electron microscopy suggested an array of divergent surface microstructures among the plants investigated. Significant wax fortification was observed also in the biodiesel plant <i>Jatropha</i>, as well as drought-tolerant wild watermelon from the Kalahari Desert. These observations collectively suggested that the combination of wax deposition and development of surface morphological structures may be involved in the fortification of efficient reflection of incident light, which enables the survival of these plants under severe excess light and water deficit stresses in the arid lands.</p>	

一般研究 10 General Research 10	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	長田 和雄 (名古屋大学環境学研究科) Osada, Kazuo (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Sub- ject	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	<p>Location of ALRC building has the geographical advantage to obtain various atmospheric samples such as Asian dust (Kosa) particles, PM_{2.5} and other pollutants transported from the areas where air pollution is severe. Continuous measurements of PM₁₀, PM_{2.5}, and Optical black carbon (OBC) mass concentrations were maintained at the roof of the new main building of ALRC. Results of the observation from April 2013 to December 2017 are shown below. OBC is mainly derived from diesel exhaust gas and outdoor incineration. The concentration of OBC is high in fall to spring, where the northwestern monsoon is dominant. PM_{2.5} has various sources related to air pollution, and its concentration was high during spring and early summer. PTFE tape filter papers collected with continuous size segregated mass measurements were analyzed for ionic constituents as continuous samples every 6 to 24 hours from February 2016 to October 17 2017. The results suggested that the presence of ammonium nitrate particles in coarse particles during the high PM_{2.5} concentration event. Since this phenomenon is occasionally observed from February to June, the relationship between source intensity and temperature may be an important factor.</p> <p>In order to obtain knowledge about PM_{2.5} and transboundary transport of relating gaseous substances, NH₃, SO₂, HNO₃, CO and O₃ concentrations were observed from Spring of 2016 to October 2017 with the collaboration with the group of Osaka Prefecture University. The concentrations of NH₃ and HNO₃ changed with long-range transport events and sea-land breeze. Seasonal variations of NH₃ and HNO₃, at the time of sea breeze without domestic influence, were low in the cold season and high in the warm season, suggesting the possibility of long-range transport in gas phase during the warm period. Further analysis with model simulation will be performed to reveal various interactions and mechanisms on transboundary pollution of aerosols and gaseous species.</p>	

一般研究 11 General Research 11	対応教員 Corresponding Staff	小林 伸行 Kobayashi, Nobuyuki
研究代表者 Principal Researcher	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>The Australian continent has a large difference in dryness between the inland area and the coastal area, and most of the city concentrates in the coastal area. Due to the characteristics of these natural environments, the Australian continent has restrictions on areas where it can live, and the trend towards population concentration in urban areas where water resources can be secured was seen early.</p> <p>In recent years, the major cities in Australia occupy a high rank in international ranking of re-urbable city (residential city) by EIU, Mercer, etc. and received high praise. The major cities in Australia have a population of over 1 million, and constant infrastructure development has already been done. In recent years, the population increase trend of major cities is getting stronger due to the increase of immigration from overseas. On the other hand, challenges are also attached to making urbanization in arid lands poor in water resources.</p> <p>The Goldfield in Western Australia is a large area that produces gold mines and gold mines of various sizes, large and small are scattered widely. A gold mine representing the area is a super pit, and mining is carried out by a huge open pit.</p> <p>There are many small gold mines in some areas around the gold field, some of which are still in operation, but already closed down for resource exhaustion, most of the former mining communities are ghosting.</p> <p>Compared to desert centers originating from mineral resources development in the state of Arizona in the United States of America in the state of Arizona, USA, Gold Field has a wide range of abundant resources, so even if resources are depleted, new mineral development, It is inferred that the mobility of workers is high and ghosting has progressed in many villages in a short period of time.</p>	

一般研究 12 General Research 12	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	松浦 朝奈 (東海大学農学部) Matsura, 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>Plants were cultured in Wagner pot filled soil and soil water content was regulated at 25% in wet treatment and that was adjusted at 10% in dry treatment on 30 days after sowing till harvest using two millets (foxtail millet and Japanese millet). Photosynthetic rate and water potential of leaf was measured on one day after the stress treatment was started. Stress susceptible index showed that foxtail millet was higher dehydration tolerance than Japanese millet. Grain yield of foxtail millet and Japanese millet decreased to 66% and 35%, respectively by the stress treatment. These reduction was attributable to number of grain per panicle in foxtail millet. In Japanese millet, the reduction of grain yield was attributable to number of grain per panicle and percentage of ripening. Soil water stress treatment decreased of photosynthetic rate to 94% and 87% in foxtail millet and Japanese millet, respectively. Water potential of leaf was also decreased by 0.33 MPa and 0.97 MPa in foxtail millet and Japanese millet, respectively at one day after the stress treatment was started. Water potential of leaf was also decreased by 0.34 MPa and 0.52 MPa in foxtail millet and Japanese millet, respectively when heading was started. Water potential of panicle was also decreased by 0.23 MPa and 0.33 MPa in foxtail millet and Japanese millet, respectively at heading. There was no interspecific differences of transpiration and water use efficiency (WUE). Significant interspecific difference was observed at yield WUE; yield WUE increased to 136% in fox millet, whereas that decreased to 72% in Japanese millet. Nitrate absorption of foxtail millet and Japanese millet decreased to 81% and 69%, respectively by the treatment.</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 Re- searcher	大和 政秀 (千葉大学教育学部) Yamato, Masahide (Faculty of Education, Chiba University)	
研究課題 Research Sub- ject	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>We investigated community structure of arbuscular mycorrhizal (AM) fungi in a coastal vegetation in the Arid Land Research Center at Tottori University in order to see the effect of soil depth on the AM fungal community. 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. 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). NMDS analysis based on Bray-Curtis dissimilarities of the reads of OTU and environmental variables were fitted to the ordination plots using the function envfit. Among the environmental variables, effects of distance from the sea and soil pH were significant for the distribution of AM fungi, while soil depth was not significant. Since the effect of soil depth on chemical properties was small, AM fungi may move relatively freely to deeper zone with growth of the host roots.</p>	

一般研究 14 General Research 14	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	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 caused in desert areas carry airborne microorganisms, which would influence climate changes, ecosystem dynamics and human health in downwind area of East Asia. However, the vertical transport of airborne microorganisms over desert areas has not understood in detail.</p> <p>We collected aerosols at high altitudes of hundreds meter over the Taklamakan and Gobi Deserts. High-throughput sequencing targeting 16S rRNA genes (bacterial marker) showed the vertical mixtures of airborne bacteria over the both sampling sites, which were predominantly composed of Actinobacteria, Firmicutes, Bacteroidetes, and Proteobacteria. In contrast, at the sequencing analysis of internal transcribed spacer regions (fungal marker), the fungal community structures at high altitudes over the both sites differ from those of low altitudes, increasing the relative abundances of Ascomycota sequences, which commonly included <i>Cradosporidium</i> and <i>Artenaria</i> species at the both sites. The fungal communities would be more hardly mixed vertically than those of bacterial communities and Ascomycota populations would be selected at high altitudes in dust source atmosphere.</p> <p>In addition, bioaerosol samples was collected at altitude of 1200m over Noto Peninsula and at ground levels of Gobi Desert (Tsogt-Ovoo City and Dalanzadgad City), during the Asian dust event on May 2017. Microbial strains (40 isolates) could be isolated from the air samples, and were closely related to 26 fungal species and 3 bacterial species. <i>Altermaria altermata</i> (similarity 99%) were commonly detected from the both samples of Noto Peninsula and Gobi Desert. They were relatively close to the pathogens of crops and / or human health. These results indicate the possibility of long-distance transport of pathogenic fungal cells by dust events.</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 Re- searcher	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><i>Artemisia adamsii</i> is a perennial weed in Mongolia of which palatability for livestock is low. The distribution of <i>A. adamsii</i> in the Mongolian steppe is now spreading widely, thus the control of this species is needed. We investigated the root system architecture of <i>A. adamsii</i> and tested the contribution of matter transportation through rhizome connection (physiological integration) to the regrowth of ramets after clipping. In addition, the possibility of germination control by its own phytotoxic compound was tested.</p> <p>[Exp. 1] We prepared root boxes of which inside dimensions were 45 cm wide, 2 cm deep, and 30 cm high inside. <i>A. adamsii</i> seeds were sown on the center of the boxes, and grew about 90 days. After clipping the daughter ramets farthest from mother ramets, ¹⁵N labeled NH₄NO₃ 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 ¹⁵N application, all ramets were sampled and their ¹⁵N content were measured. ¹⁵N content at 40 days after ¹⁵N application was increased from that of pre-application. Thus we concluded that the regrowth of <i>A. adamsii</i> after clipping depend in part on physiological integration among ramets. [Exp. 2] Germination test were performed for <i>A. adamsii</i>, lettuce, and radish at plastic dishes with and without <i>A. adamsii</i> residue. Germination was strongly suppressed only in <i>A. adamsii</i>, and contribution of volatile compounds on this suppression was shown.</p> <p>We concluded that it seems difficult to control <i>A. adamsii</i> by clipping because of its physiological integration, but it may be possible by applying its “autotoxicity” on germination.</p>
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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 Researcher	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 measured the changes in soil moisture, fine root dynamics and infection of ectomycorrhiza before and after the removal of Sasa dwarf bamboo (<i>Sasa senanensis</i>, hereafter called Sasa), which is the representative understory vegetation in cool-temperate forests in Japan, to investigate the effects of disappearance of Sasa on soil moisture and ectomycorrhizal dynamics. We established the plots surrounding the mature oak trees (<i>Quercus crispula</i>) in a cool-temperate forest in Nakagawa experimental Forest in northern Hokkaido and cut the above-ground part of Sasa and carried it out of plots in June, 2017. We monitored Soil volumetric Water Content (SWC), soil temperature, fine root length and fine root length production before and after Sasa removal. We also measured infection of ectomycorrhiza to oak roots and composition of mycorrhiza by stereoscopic microscope observation. We quantified the number of each type of mycorrhiza, and then conducted DNA extraction, PCR amplification (ITS 1F and ITS 4B) and DNA sequencing. Fine root length of Sasa was comparable to that of trees, suggesting the severe competition among both species against below-ground resources. Before Sasa removal, SWC was in the range of 0.35–0.45 in both Sasa-cut and control plots. On the other hand, SWC in Sasa-cut plot was higher than control plot, ranging 0.31–0.45 after Sasa removal. In Sasa-cut plot, sharp increase of SWC was observed following rain event. Increase of soil temperature in Sasa-cut plot was less than 1 °C compared with control plot. Change in evaporation from soil surface in Sasa-cut plot would not be large compared with decrease of water uptake by Sasa roots for transpiration, leading to the maintenance of soil moisture in Sasa-cut plot. Fine root length production after Sasa removal was comparable to control plot because tree root compensated the decrease of Sasa root. Infection rate of mycorrhiza did not change by Sasa removal. These results show that soil drying after Sasa removal is not probable and response of ectomycorrhiza is not evident in the cool-temperate forest.</p>	

一般研究 17 General Research 17	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	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>Our previous research demonstrated 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>Field study of the Mongolian livestock last year 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> <p>Field study of the Mongolian livestock at the same village this year showed</p> <ol style="list-style-type: none"> 1. Recovery from the iron deficiency anemia by changing the pasture for animal grazing. 2. Occurrence of coenurosis (parasitic encephalopathy) in sheep and goats; treatment by antiparasitic drug is useful for further prevention of the disease. <p>Thus, field study of the diseases affecting domestic animals in Mongolia is very important to prevent the animal loss from a variety of diseases.</p>

一般研究 18 General Research 18	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	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>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. However, it is still limited information about root coppice characteristics around moving sand dune where soil depth is variable. In this study, the following investigation was conducted to identify the environmental factors and the morphological characteristics affecting coppice development under moving sand dune condition.</p> <p>We surveyed root coppice frequency around sand dune to discuss the relationships between root coppice and root depth. We settled research plots around moving sand dune: a) top of moving sand dune; b) mid-slope of sand dune, c) bottom sand dune. Most root coppice was observed in sand-dune top site, and least root coppice was observed in flat bottom site. With investigation data, variable selection was made by generalized linear regression model using root shoot size, root diameter, root length, distance from mother tree, and mother tree size as root variables, sprouting shoot size and number of occurrences generated by the survey as dependent variables. The results suggested that the sprout size and sprouting occurrence were influenced by the size of the mother tree, root length and soil depth.</p> <p>Next, we set light shielding treatment to root system to investigate the relationship between coppice development and burial sand. At first, we tried to induce sprouts by treatment of girdling and cytokinin (BAP) treatment on root systems. Then, other treatments combined BAP/girdling and shading was set to compare the development of sprouts. As a result, leaf buds and coppice shoot development are induced by girdling and BAP and inhibited by light blocking treatment.</p> <p>Our result indicated coppice developed from the root system widely distributed in the shallow depth, and the coppice became by cytokinin dominant, but it becomes weak under dark light condition. The high coppice development is thought to be promoted by accidental exposure of the root system due to sedimentation around the moving sand dunes, but the root system developed shallow depth is indispensable.</p>	

一般研究 19 General Research 19	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	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>Orobanche 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>Orobanche corulences</i>, which is a native specie in Tottori Sand Dunes, with a goal to understand evolutionary relevance of copy number of the SL receptors in Orobanchaceae.</p> <p>I have been correcting parasitic plants from several area in Japan, and five species are corrected in this year. Unlike <i>Striga</i>, germination of these parasitic plants are autonomous, and affected by light and nutrient conditions. To survey SL response in <i>O. corulences</i>, pre-conditionined seeds in 4°C to 37°C was not effective with several SLs including a synthetic SL, GR24 and natural SLs including 5DS, 4DO, orobanchol or strigol. As <i>O. corulences</i> exhibits strong preference to <i>Artemisia capillaris</i>, which also grows in Tottori sandbank, as its hosts, the seeds may respond to atypical SLs produced in the hosts. To identify and examine the germination stimulants, I am performing next generation mRNA sequencing to clone the SL receptors and to examine their bindings to SLs or other synthetic molecules I have been identified as germination stimulants for <i>S. hermonthica</i> and other parasitic plants.</p>

一般研究 20 General Research 20	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researcher	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 sugar instead of soil organic matter, we measured NO₃⁻ concentration using batch tests and infiltration experiments. Moreover, we examined nitrous oxide with an LGR N₂O isotope analyzer.</p> <ol style="list-style-type: none"> 1. 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. 2. 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. 3. N₂O isotope analysis N₂O isotope and N₂O gas concentration were measured with the LGR N₂O isotope analyzer. <p>Results:</p> <ol style="list-style-type: none"> 1. Batch tests NO₃⁻ concentration decreased linearly using batch tests with sugar addition, although batch tests without sugar addition showed that NO₃⁻ concentration was almost constant. This suggested that nitrification occurred even in a sand field. 2. Infiltration experiments In infiltration experiments, nitrate reduction was also confirmed with analyses of drainage samples using an ion chromatography. 3. N₂O isotope analysis With regard to site preference ((SP value) = δ¹⁵N^α - δ¹⁵N^β), we were able to separate N₂O gas emission between nitrification and denitrification. N₂O gas emission occurred even when soil was saturated. 	

一般研究 21 General Research 21	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Re- searcher	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 Sub- ject	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>It is difficult to obtain fluorescence images and analyze the localizations of nucleic acid and/or protein in plant cells keeping the structure of plant organs. The purpose of our study is analyze the transgene localization in <i>Jatropha</i> genome using FISH and high-sensitive 3D imaging technique in inner tissues structures.</p> <p><i>Gypsy</i> and <i>copia</i> type retrotransposon were detected by FISH method. Specific <i>gypsy</i> retrotransposons existed in a higher amount in the heterochromatin region. Several elements represented different distribution patterns. Since 29.9% of the <i>Jatropha</i> genome is constructed from retrotransposon, then repetitive sequences analysis is important to understand <i>Jatropha</i>'s genome diversity and evolution. We could not achieve the detection of transgenic <i>GUS</i> gene by FISH.</p> <p>Roots were fixed by 4% paraformaldehyde and soaked in ClearSee solutions (Kurihara <i>et al.</i> 2015) for 4 days to extract chlorophyll autofluorescences. After ClearSee treatments, they were embedded into 7% low melting agarose gel and sliced in 10 μm by Plant Microtome (NK system, MTH-1). These slices were immunostained using antibodies against tubulin for 7 days. 3D images were obtained by a confocal laser scanning microscope (OLYMPUS, FW1000) and were constructed by ImageJ software. Based on these data, we investigated whether ClearSee solutions and longer immersing in antibody solution enabled to enhance the permeability of antibody proteins.</p> <p>Using high-sensitive 2D and 3D imaging technique makes plant inner structures more clearly. This technique will be combined the immunostaining against specific proteins and DNA- or RNA-FISH in 3D structure cells and tissues. We expect that this technique could visualize <i>in vivo</i> localization of small biomolecules and support to understand the mobility gene in transgenic plants.</p>	

一般研究 22 General Research 22	対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Re- searcher	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 Sub- ject	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>Priming is a unique physiological state that is considered to provide plants with a better strategy to cope with unfavorable or stressful conditions. This state is induced upon exposure to non-serious stress conditions or application of certain chemical agents, whether natural or synthetic origin. Plants in the primed state exhibit 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. Allantoin, a major metabolic intermediate in purine catabolism, accumulates in response to several stress conditions in various plant species. We previously showed that this metabolite can prime abiotic stress responses in <i>Arabidopsis</i>, thereby increasing the tolerance of allantoin-accumulating <i>ALLANTOINASE</i> knockout (<i>aln</i>) mutants to drought and osmotic stress. Here we examined the effect of allantoin on thermotolerance of <i>Arabidopsis</i> seedlings. We found that both <i>aln</i> mutation and exogenous allantoin resulted in increased survival after heat shock treatments, possibly through enhancing heat-shock responsive gene expression. We also found that the <i>aln</i> mutation and exogenous allantoin were able to improve the compromised thermotolerance of mutant seedlings defective in a transcription factor playing a crucial role in the heat shock response network. These results suggest that allantoin can prime the responses to heat and enhance thermotolerance in <i>Arabidopsis</i>.</p>	

一般研究 23 General Research 23	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	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 Sub- ject	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>Online database for historical Asian dust event based on Nihon Kishou Shiryou (Collection of materials for the history of Japanese weather events) has been developed. Nihon Kishou Shiryou 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>Search function are extended. A search based on each items such as date of the event type of the events has been implemented. A search through all items based on keyword is implemented. The search result can be downloaded as CSV file.</p> <p>300 articles are added to the database. The number of articles in the database is 700. The URL of the database is http://tensaichihen.info/.</p> <p>A plan for future collaboration on collection of historical record in Taiwan and China is discussed. The collections and catalogues of historical records on natural disasters are investigated at the National Taiwan University Library.</p>	

一般研究 24 General Research 24	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	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 (NIES))	
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>Transboundary air pollution has become a major environmental issue in Japan, while more serious air pollution (ozone, etc.) has been simulated around the source area and the suburbs. Because of no available data, we investigated the responses to ozone increase and/or water deficiency of plants growing in semi-arid grasslands in Northeast China.</p> <p>Seed germination and seedling growth were tested with 4 <i>Artemisia</i> and 2 <i>Caragana</i> species, and <i>A. halodendron</i> and <i>C. korshinskii</i> were selected for the present experiments. Each seedling of 2-6 weeks was 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. Growth experiments were conducted with environment-controlled growth cabinets (14/10 hrs (L/D), 25/15°C (L/D), 50/60% RH (L/D), 1,550 μmol m⁻²s⁻¹ (PPFD)) for 4 weeks. Plants were quantitatively irrigated every 2-3 days at 30, 60, 90 or 120 mm/ month corresponding to precipitation (water potential was -15.2, -6.7, -3.1, or -2.6 kPa), while plants were exposed to ozone with an average of 50 ppb (20-100 ppb) or 0 ppb.</p> <p>Height growth of both species was severely suppressed with 30 mm/ month irrigation. Better growth of <i>A. halodendron</i> was observed with increasing irrigation, showing the highest growth with 120 mm irrigation irrespective of ozone exposure, while maximum growth was confirmed with 60-90 mm irrigation in <i>C. korshinskii</i>. Height growth of both species tended to be inhibited by ozone exposure. In both species, the number of dead leaves increased with less irrigation treatment and also with ozone exposure, which seemed to enhance senescence. As compared with <i>A. halodendron</i>, impact of water deficiency on leaf senescence of <i>C. korshinskii</i> appeared clearly, and ozone impact is distinctively with 60 mm/ month irrigation in <i>C. korshinskii</i>. In both species, number of new leaves emergence was maximum with 90 mm irrigation and was extremely suppressed with 30 mm irrigation. Regarding the influence of ozone on new leaves development, the promotion tendency was observed in <i>A. halodendron</i>, while the inhibition tendency was observed in <i>C. korshinskii</i>.</p> <p>Responses to water and/ or ozone stresses differed depending on shrub species. Further precise investigations on dry matter growth and eco-physiological activities are required in order to accumulate the basic information for each species, for conservation and recovery of healthy semi-arid grasslands.</p>	

一般研究 25 General Research 25	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searcher	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>The effects which different basal fertilizer application quantity and planting density gave in the yield and glycyrrhizic acid (GL) content and its distribution in the stolons of licorice (<i>Glycyrrhiza uralensis</i> Fisher) were investigated. And the appropriate quantity of basal fertilizer application and planting density were considered to harvest higher yield of licorice stolons. The experimental field was located in Hiezu village, Tottori. There soil texture was sandy soil.</p> <p>The seedlings of licorice were transplanted to the field on July 10, 2017. There were 4 rows in a ridge, and the intervals among the rows were 25 cm. The ridge width was 100 cm and the interval of the ridge was 40 cm. The ridges were covered with silver plastic mulch. The irrigation and weeding were carried out as necessary. The cow manure (20 t/ha) was applied in May, and the dolomite (1000 kg/ha) and poultry litter pellet (N-P₂O₅-K₂O=2.6-7.1-3.3%) were applied three days before transplanting.</p> <p>The quantity of application of the poultry litter pellet assumed it 100, 200, 300 kg/ha with quantity of nitrogen. In addition, the treatments were divided into three by planting density respectively. Three different planting density were 63490 plants/ha (the interval between roots: 45 cm), 95240 plants/ ha (the interval between roots: 30 cm) and 190480 plants/ha (the interval between roots: 15 cm). The investigation was carried out on October 26th, 2017.</p> <p>As a result, it was clarify that if cow manure (20 t/ha) was applied, at least poultry litter pellet (quantity equivalent to 10 kg of nitrogen) was required for the first cultivation year of licorice. In addition, I could confirm that the GL content of the tip of the stolons decreased to around 20% of the basal part of stolons.</p>	

一般研究 26 General Research 26	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Re- searcher	依田 清胤 (石巻専修大学理工学部) Yoda, Kiyotsugu (Faculty of Science and Engineering, Ishinomaki Senshu University)	
研究課題 Research Sub- ject	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 Anatomical analysis of drought effects on internal structure of xylem conduits of trees	
共同研究要旨 Summary of Joint Research	<p>Assessment of the traits of conduits is essential to comprehend the ecological property of sap flow. We investigated the micro-structure on the inner surface of vessel walls with ESEM, and the aspects of water flow through branch segments or micro-capillary, as a model of vessel, with sucking experiments, to elucidate the relation of sap flow fluctuation and vessel features.</p> <p>Daily pattern of sap flow in a trunk of <i>Zelkova serrata</i> (ring-porous) was measured with sap flow sensors, and the distribution of temperature around the sensor was also examined with thermo-couples. Electrical signals were detected in the water flow through branch segment under sucking experiment. Aspect of water flow through micro-capillary (inner diameter: 100 um, an insertion of filter with 0.22 um pores; a model of jointed two vessels with pit membrane) was captured by far-red light sensors. Inner surfaces of vessel walls of <i>Zelkova</i> and <i>Prunus</i> (diffuse-porous) were observed comparatively with ESEM, ALRC.</p> <p>Sap flow increased in the morning, and decreased through afternoon. Temperature in the <i>Zelkova</i> trunk fluctuated in minute-scale irregularly at the downstream of the heating part of sap flow sensor. Sucking treatment induced water flow through branch segments, in which rectangular or pulse-like signal waves detected under slow or fast flow rates, respectively. In the jointed vessel model, bubbles emerged downstream of inserted filter, which segmented water column in the capillary. Slow segment flow induced rectangular signals, which changed into pulse-like with faster flow. In one-year twigs of <i>Zelkova</i>, vessels with dense pits to smooth wall (rare pits) were mixed. Whereas in four-year twigs, denser pits distributed with various patterns on vessel walls. In the twigs of <i>Prunus</i>, independent of</p>	

	age, vessels with various densities of pits were mingled. These anatomical features of vessel seem to be causal factors of fluctuating aspects of sap flow in trees.
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一般研究 27 General Research 27	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	近藤 謙介 (鳥取大学農学部) Kondo, Kensuke (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	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 'Kyoumizore' seeds were sown in urethane foam with tap water in a greenhouse on March 14th, 2017. The seedlings were transplanted to a deep flow technique system for 28 days and harvested on April 25th. The experiment involved 4 treatments, treatments intermitted all nutrient solution or all nutrient solution contained 100 mM NaCl by changing top water, all nutrient solution contained 100 mM NaCl by changing all nutrient solution (NS (100 mM)-NS), and all nutrient solution by changing all nutrient solution contained 100 mM NaCl (NS-NS (100 mM)), every 7 days. This hydroponic system treatment is called the intermitted fertilization management method. Quarter strength OAT-house-A solution was used during all cultivating periods as a control. And all nutrient solution contained 100 mM NaCl was used during all cultivating periods (NS (100 mM)). The maximum growth was in control. NS (100 mM)-NS and NS-NS (100 mM) treatments were bigger than NS (100 mM) treatment. On the other hand, quality of NS (100 mM)-NS and NS-NS (100 mM) treatments were not significant different compared with the control. These results indicated that the intermitted fertilization management method with 100 mM NaCl increased growth and no effects quality of Mizuna.</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 Re- searcher	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 Sub- ject	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 Study of the nitrogen cycle and utilization of herbaceous species in Mandal Gobi, Mongolia	
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> <p>This year, we summarized part of our data and submitted to the journal (Ecosphere). It is in the review process.</p>	

一般研究 29 General Research 29	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Re- searcher	齊藤 忠臣 (鳥取大学農学部) Saito, Tadaomi (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	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, however, this tree was severely damaged by damaged by heavy snowing in 2018. Therefore, new tree was Oak tree (<i>Cyclobalanopsis</i>) planted and used for the experiment in 2018-2019. Stem water potential was measured using a stem psychrometer (PSY-1) and a newly developed 8ch psychrometer. 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>	

一般研究 30 General Research 30	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	石塚 正秀 (香川大学工学部) Ishizuka, Masahide (Faculty of Engineering, Kagawa University)	
研究課題 Research Sub- ject	黄砂発生に関わる乾燥地における土壌表層のクラスト崩壊現象の解明 Study on soil crust destruction related to the Kosa emission in drylands	
共同研究要旨 Summary of Joint Research	<p>Sand free fall experiment:</p> <p>A sand free fall experiment was carried out in order to destruct soil crust by using a sand falling instrument. With the angle of incidence of sand to the crust surface at 30 degrees, the petri dish was tilted on the base and installed at the bottom of the instrument. For each petri dish, sand was continuously dropped for 5 minutes. In order to form soil crust, Mongol soil (Loam) was filled in a petri dish, and moisture was uniformly applied by using a spray. Experiments were conducted on three cases of 24, 72, and 120 hours for dry, respectively, with the oven temperature of the constant at 50 deg.C. The supplied water content was set in the range of 2.5 to 17.5%.</p> <p>As a result of the experiment, it was found that the mass of the eroded soil tended to decrease as the supplied moisture content increased for the all cases of drying. However, for example, when the amount of water supplied is 5%, the eroded soil mass by Exp.3 has been scaled by about 2.5 times in Exp.2. There are variations in experimental data, so the evaluation method will be considered in next fiscal year.</p> <p>Air gun experiment:</p> <p>We developed an air gun that makes one particle collide with the soil surface. In order to change the velocity of the particles to collide, the air pressure was designed to be adjustable. A soil sample was prepared at a ratio of DL clay 100% to distilled water 20%. As a result, it was found that the energy consumed on the clay surface increases as the collision speed increases, and the energy consumed increases as the incident angle increases. It was also found that the maximum collapse depth increases as the energy consumed increases. Also, the incident angle has no influence on the relationship between the energy consumed and the maximum collapse depth.</p> <p>The volume of collapse tends to increase as the energy consumed increases at any incident angle. In addition, the equation of Lu and Shao (1999) can be applied to estimate the volume of collapse by uniformly preparing the strength of the surface of the clay, determining the conditions of collision parti-</p>	

	cles, and measuring the maximum collapse depth after collision.
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一般研究 31 General Research 31	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	岩瀬 剛二 (帝京科学大学生命環境学部自然環境学科) Iwase, Koji (Department of Natural and Environmental Science, Faculty of Life and Environmental Sciences, Teikyo University of Science)	
研究課題 Research Subject	疑似乾燥地としての海岸植生におけるスナヅルーネナシカズラの重複寄生の実態解明 Characterization of hyper-parasitization between <i>Cassytha-Cuscuta</i> in coastal vegetation as a quasi-arid land	
共同研究要旨 Summary of Joint Research	<ul style="list-style-type: none"> • Field survey Field survey of stem parasitic plants, <i>Cassytha filiformis</i> and <i>Cuscuta sp.</i> was conducted in order to characterize their growth and development in the field in Southwestern Islands in Okinawa Prefecture during September in 2017 (from Sep. 3 to 9). Those Islands are Iriomote, Yonaguni, Kohama, Hateruma and Ishigaki. While <i>C. filiformis</i> were found in all of the islands, <i>C. sp.</i> was only found in Yonaguni and Kohama. In those two islands, growing area of <i>C. sp.</i> was widened than ever, and hyper-parasitization between <i>C. filiformis</i> and <i>C. sp.</i> was also found in both islands. • Sampling Sampling of parasitized tissue was all conducted in Yonaguni Islands where the growth of both parasitic plants was most vigorous of all the islands. 3 plant samples (2 in Higawa beach and 1 in Nahma beach) parasitized by <i>C. filiformis</i> were obtained, 3 samples (2 in Higawa beach and 1 in Nanta beach) parasitized by <i>Cuscuta sp.</i> were obtained, and 1 sample (in Nanta beach) of hyper-parasitization between <i>Cassytha</i> and <i>Cuscuta</i> was also obtained. Those samples were stocked in FAA and brought back to the laboratory. The parasitized tissues will be observed under a microscope. • Induction of parasitization Induction of parasitization was tried under illumination condition. Those conditions are as follows: illumination by LED lamp at ca. 70 $\mu\text{mol m}^{-2} \text{s}^{-1}$ with the cycles of 14 hours of light and 10 hours of dark. Additionally, the illumination by far-red LED light was also conducted in order to induce parasitization. <i>Leibnitzia anandria</i> was used as host plants, and parasitization of both <i>C. filiformis</i> and <i>C. sp.</i> was successful. Hyper-parasitization between <i>Cassytha</i> and <i>Cuscuta</i> will be attempted. 	

一般研究 32 General Research 32	対応教員 Corresponding Staff	エルタイブ・アミン Eltayeb Habora Amin
研究代表者 Principal Researcher	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, The University of Tokyo)	
研究課題 Research Subject	リモートセンシングを用いた植物成長の高精度計測手法の開発 Development of a high precision method for plant growth measurement using remote sensing	
共同研究要旨 Summary of Joint Research	<p>This study aims to develop a system for high-throughput phenotyping of plant growth in experimental fields by using unmanned aerial vehicle (UAV) Remote Sensing (RS). In this study, we employed sorghum, which is the fifth most important grains and a high potential biomass-energy crop, and evaluate its growth under two experimental conditions, normal and low phosphorus. Plants of 370 accessions were cultivated with two replicates for each of low and normal phosphorous treatments in an experimental field of Arid Land Research Center. The plants were transplanted on June 2 or 3 after pot culture, and harvested on Oct. 1 to 4 for manual measurements. Three models of UAVs (DJI Inspire 1, DJI Phantom 4 Pro, DJI Phantom 4 Advanced) mounted with the commercial RGB camera or the customized Near Infrared (NIR) camera were used for RS. The RS was conducted 29 times in 19 days during the growing season and collected 11441 images in total. The mosaic picture and Digital Surface Model (DSM) are generated using the 3D reconstruction software from the images taken in each time of flights and are used for extracting the phenotypic traits like plant height, canopy area, and NDVI. An image processing pipeline was also developed in this study. Plant height, culm Length, panicle node length, culm number, culm diameter, total weight, juice and brix were manually measured after harvesting. The preliminary result shows that the difference of biomass (manually measured) between the treatment is significant ($p\text{-value} < 0.01$) and the correlation between the replicates within the treatment is high (0.755 and 0.675 in -p and +p). The R squared value between the plant height estimated by the</p>	

	remote sensing method (2 days before harvesting) and the manual measured value (after harvesting) could be reach 0.3. The difference of plant height could also be observed from the remote sensing result. The technique developed in this study will enhance the screening of sorghum germplasm accessions tolerant to low phosphorus condition.
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一般研究 33 General Research 33	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	柏木 純一 (北海道大学大学院農学研究院) Kashiwagi, Junichi (Graduate School of Agriculture, Hokkaido University)	
研究課題 Research Subject	コムギの乾燥抵抗性改善のための重要形質の探索 Relevant traits for improving the wheat productivity under drought environments	
共同研究要旨 Summary of Joint Research	<p>Field trial was conducted at Hokkaido University in 2017. Four bread wheat varieties (Cham6, SW15, Haruyokoi and Sanukinoyume) were grown in two contrasting soil water conditions, viz. irrigated and non-irrigated, to evaluate their drought performances. Interesting results were obtained as below.</p> <ol style="list-style-type: none"> 1. Although significant difference was observed in the seed yield under non-irrigated condition among all varieties, the varietal difference in the final shoot dry weights under non-irrigated condition was not significant. This indicates that the varietal seed yield differences were attributed to the dry matter partitioning during the growth. 2. The superiority in terms of photosynthetic production to keep green leaves till the end of maturity observed in SW15 and Sanukinoyume seemed to be canceled due to more photosynthates consumptions required for the maintenance respirations of large biomass of leaves. This could result in no significant differences in the final shoot dry weights among the varieties. 3. In non-irrigated condition, the thermal images of ears showed cooler than those of leaves in all varieties. In addition, the dynamics of non-Structural carbohydrate (NSC) in ear parts excluded the seeds showed significant reduction during the 2 weeks after anthesis to maturity in all varieties. These indicate the importance of ear photosynthesis as the source for grain growth under drought conditions. 	

一般研究 34 General Research 34	対応教員 Corresponding Staff	伊藤 健彦 Ito, Takehiko
研究代表者 Principal Researcher	木下 こづえ (京都大学野生動物研究センター) Kinoshita, Kodzue (Wildlife Research Center, Kyoto University)	
研究課題 Research Subject	モンゴルにおける野生ユキヒョウ (<i>Panthera uncia</i>) の繁殖場所および時期推定のための糞中ホルモン濃度測定 Measurements of fecal hormone concentration for the estimation of breeding sites and season of snow leopards (<i>Panthera uncia</i>) in Mongolia	
共同研究要旨 Summary of Joint Research	<p>The place and timing for breeding have been estimated by their behaviors and the presence of offspring by infrared camera in snow leopards. However, on their reproductive physiology, it has never been estimated in wild. Analyses of fecal sex hormones enable to find the physiological state in the individual who excreted the feces, such as rut, estrus and pregnancy (or pseudopregnancy). In snow leopards, concentrations of fecal sex steroid hormones have never been measured to monitor their physiological condition in wild. In this study, we have tried to apply the measurement method of hormone concentration which we had been conducted in captive snow leopards to the wild animals. In this year, following experiments were conducted to improve the measurement method for wild animals.</p> <ol style="list-style-type: none"> 1. Hormone extraction by Field-friendly method Comparison of hormone extraction by Field-friendly method (extraction by hand in the field site) and conventional method (extraction by shaking incubator in the laboratory) was conducted. As a result, the correlation coefficients in each hormone measurement were $R^2=0.88$ (estradiol-17β), 0.51 (progesterone), and 0.74 (cortisol). Although the results were generally good, further investigation of the method was considered necessary. 2. Measurement of hormone concentration by immunochromatography method Cortisol standard concentration was tried to be measured by using an immunochromatography, which enable to measure it more rapid than the conventional method (enzyme immunoassay). As a 	

	result, it was shown that the concentration can be measured with high accuracy ($R^2=0.997$) within the range of 3.9-5,000 ng/ml. As the next step, we will use the same method to measure fecal cortisol concentrations, and try to apply it to measurements of other hormones (e.g. estradiol-17 β).
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一般研究 35 General Research 35	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	児玉 基一郎 (鳥取大学大学院連合農学研究科) Kodama, Motoichiro (The United Graduate School of Agricultural Sciences, Tottori University)	
研究課題 Research Subject	鳥取砂丘に自生する海浜植物における共生菌 (エンドファイト) の調査と活用 Investigation and utilization of symbiotic fungi (endophytes) in coast plants native to Tottori Sand Dunes	
共同研究要旨 Summary of Joint Research	<p>Seaside plants naturally growing in sand dunes etc. are exposed to various stresses such as high salt concentration and drying, and it is known that they have a high stress tolerance as compared with ordinary agricultural crops. Therefore, it is considered to be a valuable genetic resource for giving drought and salt tolerance to cultivated crops. Furthermore, in recent years, it has been reported that the stress tolerance of wild plants inhabiting these special environments is imparted by symbiotic microorganisms (endophytes) living in plants. Therefore, in this study, isolation and identification of endophytes from grass weeds and their characterization were conducted with the aim of improving stress tolerance by using endophyte in grain plants including wheat.</p> <p>This research is a joint project with Prof. H. Tsujimoto, Dr. R. D. Johnson and Dr. W. Simpson (AgResearch, New Zealand) research groups. The isolated endophyte strains were identified by culture properties, morphological observation and DNA sequence analysis. As a result, strains of <i>Epichloë</i> endophyte, which is known to impart insect resistance, drought tolerance in pasture plants, were isolated from grass weeds such as <i>Elymus tsukushiensis</i> and <i>Leymus mollis</i> distributed in the area around Tottori University, Arid Land Research Center and Tottori sand dune.</p> <p>In addition, in October 2017, we performed field survey, seed collection and endophyte separation from <i>L. mollis</i> and <i>Elymus</i> plants in Hokkaido. As a result, a large number of plant and seed samples were collected in the beach area and mountainous area of the central and eastern regions of Hokkaido. Some endophyte strains were isolated from those samples. The isolated strains are being preserved as the grass weeds endophyte collections. Characterization of those endophyte strains are now in progress.</p>	

一般研究 36 General Research 36	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	関山 剛 (気象庁気象研究所環境・応用気象研究部) Sekiyama, Tsuyoshi (Atmospheric Environment and Applied Meteorology Research Department, Meteorological Research Institute, Japan Meteorological Agency)	
研究課題 Research Subject	ゴビ砂漠における黄砂発生量の推定精度向上を目指した数値モデル研究 Numerical model study for improving the estimation of the aeolian dust emission in the Gobi Desert	
共同研究要旨 Summary of Joint Research	<p>Focusing on the dried grass effect, hollow effect, crust effect, and gravel effect, which all are supposed to have a large impact on the dust emission process, we continuously conducted a field measurement of Asian-dust-related quantities (dust flux, dust concentration, soil moisture content, ground surface wind velocity, and visibility) at the Tsogt-Ovoo dust monitoring station in the Mongolian Gobi desert. The Tsogt-Ovoo dust monitoring station is an internationally notable in-situ measurement facility for the desert dust emission process and has been maintained mainly by the Arid Land Research Center of Tottori University (Prof. Kurosaki).</p> <p>We conducted a time-series comparison of the Asian-dust-related quantities (dust flux, dust concentration, and ground surface wind velocity) between our meso-scale numerical aerosol simulation model (WRF-Chem) result and the 2015 observations from the Tsogt-Ovoo dust monitoring station to analyze the dust emission process.</p> <p>It was found that a large positive correlation does not always exist between a local dust concentration and a local dust flux. Meanwhile, depending on the weather conditions, there is a complicated connection of model estimation errors between the dust concentration and the dust flux strength. In some cases, both the model estimation errors of the dust concentration and flux have a large positive correlation. However, in other cases, only one of the two model errors (i.e., the dust concentration error</p>	

	<p>or the dust flux error) is large but the other error is small.</p> <p>These results are able to improve the Asian dust emission estimation processes of not only WRF-Chem but also the JMA (Kishou-cho) operational aerosol numerical prediction model. The dust emission estimation error is the biggest error source of the operational aerosol prediction. Therefore, its improvement will be a social contribution.</p>
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一般研究 37 General Research 37	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Re- searcher	田中 裕之 (鳥取大学農学部) Tanaka, Hiroyuki (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	高温・乾燥ストレス下でも小麦粉品質低下を起こさないコムギ遺伝資源の探索 Exploration of wheat genetic resources maintained in high quality flour under heat and drought stress	
共同研究要旨 Summary of Joint Research	<p>【Background and Purpose】</p> <p>In order to avoid the risk of wheat food due to global warming, it is necessary to develop varieties not only that have resistance to high temperature and dry stress, but also that do not degrade harvested and milled wheat flour quality.</p> <p>This year, we focused on the high-molecular-weight glutenin (HMW-GS) of the seed storage protein which greatly influences the strength of the dough which is the main factor of the quality of wheat flour, and investigated the genetic diversity of HMW-GS in the population with various chromosome subregions derived from <i>Aegilops tauschii</i> which was introduced through the cross between the practical wheat variety and the synthetic hexaploid wheat.</p> <p>【Materials and Methods】</p> <p>We used a multiple synthetic derivatives (MSD) BC₁F₅ population produced by crossing and back-crossing of the Japanese bread wheat cultivar ‘Norin 61’ with 43 synthetic hexaploid wheat lines derived from crosses between 43 accessions of <i>Ae. tauschii</i> and <i>Triticum turgidum</i> var. durum cv. ‘Langdon’ (Elbashir <i>et al.</i> 2017). For this MSD population of 392 strains, proteins were extracted from the endosperm of three mature seeds of each line and separated by SDS-PAGE to investigate the composition of HMW-GS.</p> <p>【Results and Discussion】</p> <p>The frequency of HMW-GS derived from <i>Ae. tauschii</i> was 26.3%. This result is close to the ratio of the case where self-fertilization to the F₅ generation is carried out without the selective pressure after BC₁ generation with the theoretical ratio, 1/4 of the genome from <i>Ae. tauschii</i>. Based on the molecular weight, HMW-GSs derived from <i>Ae. tauschii</i> were divided into 5 types. Two of these types belonged to TauL2 among TauL1 to 3 classified based on population structure analysis (Matsuoka <i>et al.</i> 2015) by polymorphism of DNA markers in <i>Ae. tauschii</i> parents of the MSD population.</p>	

一般研究 38 General Research 38	対応教員 Corresponding Staff	伊藤 健彦 Ito, Takehiko
研究代表者 Principal Re- searcher	中野 智子 (中央大学経済学部) Nakano, Tomoko (Faculty of Economics, Chuo University)	
研究課題 Research Sub- ject	インターバルカメラを用いた遊牧家畜の動態評価 Evaluation of nomadic livestock dynamics using time-lapse cameras	
共同研究要旨 Summary of Joint Research	<p>Recently there have been some reports about grassland degradation in Mongolia and over-grazing is considered as one of the causes of degradation. The purpose of this study is to evaluate seasonal and inter-annual dynamics of nomadic livestock in the semiarid grassland ecosystems of Mongolia. 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 2016 to mid-August 2017 and the number of animals in the images were counted.</p> <p>The results indicated that more livestock were photographed at BN than at BU during the observation period from May 2016 to August 2017, suggesting that the grazing pressure was stronger at BN</p>	

	than at BU. We also found common points between BU and BN that sheep and goat appeared more than cattle and horse throughout the period, very few livestock appeared in winter, and the number of baby animals increased in spring. However, seasonality of the total number of livestock was different between BU and BN; the number was the most in spring at BU, in the meanwhile in summer at BN.
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一般研究 39 General Research 39	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Re- searcher	永淵 修 (福岡工業大学総合研究機構環境科学研究所) Nagafuchi, Osamu (Comprehensive research center, Environmental Science research Institute, Fukuoka Institute of Technology)	
研究課題 Research Sub- ject	モンゴル高原における地下水中微量物質によるヒト健康リスク評価とその削減対策 Human health risk assessment caused from trace elements in groundwater and its reduction technology in Mongolian plateau	
共同研究要旨 Summary of Joint Research	<p>In 2017, we have conducted the water quality survey in Mongolia. Sampling survey were conducted mainly two site around Ulaanbaatar. One is large scale gold mining site and the other is the area who does the eco activities. We observed the major ion, heavy metals including mercury in pond, groundwater and river water. Now we are analyzing its water quality and risk analysis.</p> <p>This year, in addition, we have been conducted the workshop which titled the water quality level of groundwater and its human health risk in Inner Mongolia Autonomous Region (Inner Mongolia). Because of government policy, the land is clearly separated by the fence and they can understand their property. However, they cannot move as they want, depend on the season. Therefore, they became heavily rely on groundwater for daily life water. Result from the probabilistic Hazard Quotient (HQ) analysis, it revealed that the fluoride and arsenic in groundwater may human health risk concern level.</p> <p>In order to show the option to reduce human health risk caused from the groundwater intake, scenario analysis has been conducted. We set four scenarios, (1) they use river water instead of groundwater whole year, (2) they use both river water and groundwater in half of the year each, (3) In summer vacation season, they use tap water in city side and the other season, they use groundwater, (4) They basically use groundwater however, in winter season, they use snow as drinking water. The scenario analysis showed the scenario (4) may reduce human health risk concern. This analysis has some uncertainty, however, we can show the way to reduce human health risk concern (in prep. Chemosphere).</p>	

一般研究 40 General Research 40	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	馬場 貴志 (鳥取大学農学部) Baba, Takashi (Faculty of Agriculture, Tottori University)	
研究課題 Research Sub- ject	好塩性植物を用いた塩類集積土壌のファイトレメディエーション Phytoremediation of Saline and Sodic Soil by Salt-loving plant species	
共同研究要旨 Summary of Joint Research	Clarifying the differences in response in salt-loving plant species to sodium will be valuable for agriculture in salt-affected soils. At the germination stage, the maximum germination rate of all plant species was observed in the absence of NaCl and these rates decreased in the presence of NaCl, except for quinoa. The behavior at the germination stage in response to NaCl differed with plant species and did not match that at the later growth stages. These results suggested that the responses of salt-loving plant species to sodium differ with the growth stage.	

一般研究 41 General Research 41	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	増本 年男 (鳥取大学医学部) Masumoto, Toshio (Faculty of Medicine, Tottori University)	
研究課題 Research Sub- ject	ASPECT/AFS による黄砂飛来状況監視とその成分分析 Monitoring and componential analysis of transboundary air pollution such as Asian dust from Eurasia using ASPECT/AFS	
共同研究要旨 Summary of Joint Research	<u>Subjects</u> Recent studies indicate that Asian dust contains air pollutant such as PM2.5 and metal ions from	

	<p>Korea and China. These air pollutant studies indicate that Asian dust event causes the negative effect on human health (Otani et al, 2011; Onishi et al, 2012; Kanatani et al, 2014). Thus, it is important to make the alert system for the Asian dust with air pollutant and bioaerosols. To construct this, we analyze the ASPECT/AFS data of Asian dust day in 2017.</p> <p><u>Materials and Methods</u></p> <p>ASPECT/AFS data was obtained at Tottori University. Sampling started from 2017/05/02 and ended at 2017/08/30. For statistical analysis, we calculated Student's t-test. $p < 0.05$ was considered statistically significant. For calculation Aerosol Fluorescence Sensor, raw data was conducted low-path filter and high-path filter. After that we calculated overall mean value and standard deviation. Threshold was determined mean value + 3 sd value. We used MATLAB (Mathworks, Natick, Massachusetts, USA) for all calculation and graph construction.</p> <p><u>Results</u></p> <p>In total, three Asian dust days were identified during the survey period. Particle amount per one hour was increased after Asian dust arrival by northwest wind compared with non-Asian dust day. Particle shape was also changed from ball like shape to bar like shape. Particle size was also increased. The bioaerosol arrival did not increased in Asian dust day compared with non-Asian dust day.</p> <p><u>Discussion</u></p> <p>In this study, we found that particle amount, size, shape of Asian dust day was changed compared with non-Asian dust day. These results indicate that the particle content was changed by Asian dust. Although we can detect the particle amount, size and shape, the component of the particles was unknown. To elucidate this question, we will perform the filter sampling with ASPECT/AFS sampling.</p>
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一般研究 42 General Research 42	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	松浦 秀幸 (大阪大学大学院薬学研究科) Matsuura, Hideyuki (Graduate School of Pharmaceutical Sciences, Osaka University)	
研究課題 Research Subject	プロリン生合成酵素 GPR の新規機能に関する研究 Study of novel functions of a proline biosynthetic enzyme GPR	
共同研究要旨 Summary of Joint Research	<p>We previously expressed the recombinant proteins of CrGPR (glutamyl phosphate reductase in <i>Chlamydomonas reinhardtii</i>) in <i>Escherichia coli</i> and partially purified using His-tag. The recombinant CrGPR proteins showed catalytic activity for the reaction from γ-GP (gamma-glutamyl phosphate) to GSA (glutamic-gamma-semialdehyde) in an in vitro reaction containing GK (gamma-glutamyl kinase) protein, glutamic acid, and NADPH. EcGPR (GPR in <i>E. coli</i>) has been shown to induce γ-EC (gamma-glutamyl cysteine) synthesis from γ-GP, the product of GK, when NADPH was removed from the in vitro reaction. Therefore, we also investigated the corresponding properties of CrGPR, and found that, in contrast to EcGPR, CrGPR had much lower inductive activity for γ-EC synthesis, suggesting that γ-EC synthesis from γ-GP is dependent on the properties of GPR proteins. We further investigated amino acid residues important for the difference between CrGPR and EcGPR in the aspect of γ-EC synthesis using multiple-alignment analysis and comparative analysis of the predicted protein structures. We focused on the two positions of amino acid residues and investigated the effects of point mutations for the positions. As a result, we succeeded to find a critical amino acid residue for GPR-dependent γ-EC synthesis. Our results might provide a molecular basis for bifurcation control of biosynthesis of important stress-related metabolites, proline and glutathione.</p>	

一般研究 43 General Research 43	対応教員 Corresponding Staff	木村 玲二 Kimura, Reiji
研究代表者 Principal Researcher	松岡 延浩 (千葉大学大学院園芸学研究科) Matsuoka, Nobuhiro (Graduate School of Horticulture, Chiba University)	
研究課題 Research Subject	機械学習を用いた土壌表面画像からのダスト発生危険度の推定 Assessment of dust events risk by soil surface images with machine learning	
共同研究要旨 Summary of Joint Research	<p>The purpose of this research is to combine the visible image of soil surface taken by an interval camera and critical wind speed for dust emission using mechanical learning so that this system may</p>	

	<p>predict dust emission. Since the shooting conditions such as brightness, color, shade, solar altitude, etc. of the soil surface is different, we develop methods of correcting the difference in shooting conditions between images as preprocessing to perform machine learning. At the same time, in order to lower the cost of the system, we developed a system which are assembled by a visible / near-infrared camera module (Raspberry Pi Camera V2, Raspberry Pi NoIR Camera V 2, respectively), instead of using a commercially available multispectral camera.</p> <p>As a result, correction of luminance and color as preprocessing became possible. Moreover, in addition to being able to capture images in the near infrared wavelength range, the cost of the camera system has been reduced to less than 1/10 of that of commercial products. We estimated the surface soil moisture content using the green band of this camera. It becomes possible to acquire an image for estimating the risk of dust generation using the camera developed in this research.</p> <p>It was suggested that images are more easily used for machine learning after shadows are removed which are formed on the soil surface due to irregularities of soil surface. In order to solve this problem, introduction of SfM (Structure from Motion) algorithm and detection of shadows by thermal infrared images are necessary.</p>
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一般研究 44 General Research 44	対応教員 Corresponding Staff	辻本 壽 Tsuji moto, Hisashi
研究代表者 Principal Re- searcher	松岡 由浩 (福井県立大学生物資源学部) Matsuoka, Yoshihiro (Department of Bioscience, Fukui Prefecutral University)	
研究課題 Research Sub- ject	合成 6 倍体コムギさび病抵抗性の調査 Leaf rust resistance of synthetic hexaploid wheat	
共同研究要旨 Summary of Joint Research	<p>Synthetic hexaploid wheat lines, i.e., artificial lines produced by crossing the ancestors of common wheat, <i>Triticum turgidum</i> L. and <i>Aegiolops tauschii</i> Coss., are good source of alleles that can be used to improve various agronomic traits in breeding programs. We examined yellow rust resistance of 55 synthetic hexaploid wheat lines that were derived from crosses made between <i>T. turgidum</i> subspecies <i>durum</i> cv. ‘Langdon’ (LDN) and a diverse array of <i>Ae. tauschii</i> accessions, <i>Ae. tauschii</i> accessions (105 accessions in total, including 23 accessions that were parent to the synthetic lines), and LDN. All the synthetic lines were found susceptible to yellow rust under field conditions. In the seedling stage, most synthetic lines were susceptible, whereas five lines showed weak resistance. Similarly, LDN was susceptible under field conditions and in the seedling stage. In contrast, 42 <i>Ae. tauschii</i> accessions (40%, mostly originated from Iran) showed strong or modestly strong resistance under field conditions. Interestingly, most of the parental <i>Ae. tauschii</i> accessions (18 accessions) showed strong or modestly strong field resistance. Therefore, yellow rust field resistance appeared not expressed in the synthetic lines, despite that their parental <i>Ae. tauschii</i> accessions were resistant. Our findings may suggest that LDN has genes that suppress the action of <i>Ae. tauschii</i>’s resistant genes when the genomes of these two species are merged.</p>	

一般研究 45 General Research 45	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	松添 直隆 (熊本県立大学環境共生学部) Matsuzoe, Naotaka (Faculty of Environmental and Symbiotic Sciences, Prefectural University of Ku- mamoto)	
研究課題 Research Sub- ject	塩生植物 <i>Suaeda salsa</i> の飼料作物としての利用の可能性 Possibility of using halophyte <i>Suaeda salsa</i> as a forage crop	
共同研究要旨 Summary of Joint Research	<p>In this study, our focus is on the effects of the calcium addition on the absorption of inorganic components in <i>S. salsa</i> under NaCl treatments (250 mM and 500 mM) in hydroponics culture and sand culture respectively. 5 mM or 15 mM CaCl₂ was added to the culture solution in hydroponics, and calcium material (Ca concentration: 29%) was mixed at the rate of 12.5 g/L (S plot) or 25.0 g/L (2S plot) in sand culture. The growth of <i>S. salsa</i> under the 500 mM NaCl treatment was inhibited more than under the 250 mM NaCl treatment in the both culture systems. In hydroponics culture, the growth of <i>S. salsa</i> was ameliorated, and the Na content in underground part of the plant decreased by adding of 15 mM CaCl₂ to the 500 mM NaCl treatment. Moreover, the Cl, Ca, and K contents in aboveground part</p>	

	of the plant tended to increase with CaCl ₂ addition. In sand culture, while the Na content tended to decrease, K and Ca contents tended to increase in aboveground part of the plant, and the growth of <i>S. salsa</i> was ameliorated in only S plot of calcium addition under the 500 mM NaCl treatment. These results suggest that calcium addition improves the growth because it can enhance the absorption of inorganic components such as K and Ca, and ameliorated the excessive Na absorption in plants of <i>S.salsa</i> .
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一般研究 46 General Research 46	対応教員 Corresponding Staff	エルタイプ・アミン Eltayeb Habora Amin
研究代表者 Principal Re- searcher	三橋 渉 (山形大学農学部) Mitsuhashi, Wataru (Faculty of Agriculture, University of Yamagata)	
研究課題 Research Sub- ject	植物への乾燥耐性付与を目指したアブシジン酸シグナル伝達系の解明 Study on abscisic acid signal transduction pathway for increasing of drought tolerance in plant	
共同研究要旨 Summary of Joint Research	<p>Plant growth is 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>.</p> <p>We isolated an ABA-related protein 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 showed that GST-ABA related protein is able to co-precipitate with MBP-KRP. 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 in protoplast prepared from <i>Arabidopsis</i> rosette leaves.</p> <p>In 2017, we introduced new protoplasts from <i>Arabidopsis</i> T87 cultured cells to observe clear nucleus, because these cells have not much chloroplasts. It was observed that very clear localization of reconstructed eYFP at nucleus.</p> <p>We also checked ABA responsibilities for selected homo-lines as <i>KRP</i> over expresser, <i>KRP</i>-knockout mutant (<i>krp</i>) and <i>krp</i> x <i>ABA related protein</i>-knockout double mutant. In the case of cotyledon opening and greening, existence of KRP might correlate with ABA-responsibility. We are continuously observing other ABA-responsibilities.</p>	

一般研究 47 General Research 47	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searcher	咏 梅 (名古屋大学大学院環境学研究科) Mei, Yong (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Sub- ject	「退牧還草」が黄砂発生を抑制したか? Did “return grazing land to grassland” suppressed dust occurrence?	
共同研究要旨 Summary of Joint Research	<p>We used process-based ecosystem DAYCENT model and statistical models, and dust event observations during March–June 1981-2017 to identify critical land surface factors that control dust emission (including soil moisture and vegetation components: live grasses, standing dead grasses and litter) in Inner Mongolian steppe (Xilinhot) and desert steppe (Erliahot) sites, and to estimate impacts of the controlled land-use by the grassland protection law (returning grazing land to grassland) on dust events. In general, the DAYCENT model realistically simulated seasonal and interannual variations of the vegetation components and soil moisture that were captured by field observations during 2005-2017. Results showed that at both the sites, the number of spring dust events had a similar amplitude of significant correlation with wind speed and a combination of all the surface factors that retained anomalies (memory) of the preceding year. Importantly, in the desert steppe, the standing dead grasses had the strongest memory and simultaneous significant correlation with the dust events. Moreover, simulations of dust events with the controlled land-use (light grazing) and without such a control (heavy grazing) showed that since 2003, the grassland protection law (returning grazing land to grassland) resulted in reduced dust events by 20% and 40% in the steppe and desert steppe, respectively.</p>	

一般研究 48 General Research 48	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	李 偉強 (国立研究開発法人理化学研究所横浜研究所環境資源研究センター発現調節研究ユニット) Li, Weiqiang (Signaling Pathway Research Unit, Center for Sustainable Resource Science, RIKEN, Yokohama Institute)	
研究課題 Research Sub- ject	Effect of ethylene on hormone homeostasis and contribution to drought tolerance in Arabidopsis	
共同研究要旨 Summary of Joint Research	Ethylene is involved in regulation of various aspects of plant growth and development. Physiological and genetic analyses have indicated the existence of a crosstalk between ethylene and other phytohormones, such as auxin, cytokinin (CK), abscisic acid (ABA), gibberellin (GA), salicylic acid (SA), jasmonic acid (JA) and strigolactone (SL), in regulation of different developmental processes. However, the effects of ethylene on the biosynthesis and contents of these hormones are not fully understood. Here, we investigated how overproduction of ethylene may affect the contents of other plant hormones using the ethylene-overproducing mutant ethylene-overproducer 1 (eto1-1). The contents of various hormones and transcript levels of the associated biosynthetic genes in the 10-day-old Arabidopsis eto1-1 mutant and wild-type (WT) plants were determined and compared. Higher levels of CK and ABA, while lower levels of auxin, SA and GA were observed in eto1-1 plants in comparison with WT, which was supported by the up-regulation of their biosynthetic genes. Although we could not quantify the SL contents in Arabidopsis, we observed that transcript level of the potential rate-limiting SL biosynthetic gene more axially growth 4 was increased in the eto1-1 versus WT plants, suggesting that SL level might be enhanced by ethylene overproduction. JA level was not affected by overproduction of ethylene, which might be explained by unaltered expression level of the proposed rate-limiting JA biosynthetic gene allene oxide synthase. Taken together, our results suggest that ET affects the levels of CK, ABA, auxin, SA, GA, and potentially SL, by influencing the expression of genes involved in the rate-limiting steps of their biosynthesis.	

一般研究 49 General Research 49	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Re- searcher	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 Science, Okayama University)	
研究課題 Research Sub- ject	中国乾燥地域の緑化植物 <i>Juniperus sabina</i> の通水阻害に関わる乾燥抵抗性機構 Drought resistance mechanism of revegetation plant, <i>Juniperus sabina</i> in dryland of China	
共同研究要旨 Summary of Joint Research	In coniferous trees, the loss of water transport from cavitation in tracheid caused by drying has been considered irreversible. On the other hand, it is also pointed out that the reversible change in the hydraulic resistance of bordered pit due to the movement of the pit membrane in tracheid may effect on the water transport function without cavitation, however, it has not been revealed yet. Coniferous trees in regions with low water availability may reduce the xylem water transport in a state where the tracheid filled with water due to an increase in hydraulic resistance of the pit under drying condition and may suppress water loss from the leaves; it may contribute to prompt restart of production after rainfall event. We investigated the influence of increase of the hydraulic resistance of pit due to the movement of the pit membrane in addition to cavitation in tracheid in response to the decline of the water transport function with the progress of drying in <i>Juniperus sabina</i> , dominated coniferous species in semi-arid area of China. As a result, the percentage of tracheid filled with water in xylem and hydraulic conductivity (Ks) decreased with the progress of drying. In individuals with Ks of almost 0, the percentage of tracheid filled with water in xylem varied from 0% to about 40%. In these individuals, the percentage of the stained cross-sectional area and the percentage of the pit, which are not completely closed and can become the water conduit pathway, were confirmed. Moreover, we confirmed the pit not completely closed between tracheid filled with water. In addition, <i>J. sabina</i> showed relatively high margo flexibility index of pit membrane as compared with the various species of previous studies. These results suggested that the decrease in water transport function under the progress of drying was caused by not only cavitation of tracheid but also the increase in hydraulic resistance due to the movement of pit membrane between tracheid without cavitation. The high flexibility of pit membrane causes an increase in hydraulic resistance of pit during drying, closing pit closely to prevent expansion of cav-	

	itation, even when cavitation occurs, implying that it minimize water loss and cavitation under drying and contribute to prompt restart of production after rainfall event.
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一般研究 50 General Research 50	対応教員 Corresponding Staff	木村 玲二 Kimura, Reiji
研究代表者 Principal Re- searcher	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 Sub- ject	ダスト発生臨界風速に影響する地形・土壌条件の類型化 Categorizing topographical and soil conditions affecting the critical speed of dust emissions	
共同研究要旨 Summary of Joint Research	<p>The threshold wind speed of dust emission is determined according to the surface soil moisture and the above-ground vegetation. The land surface conditions surrounding an observatory are not usually homogeneous, and it is considered that the threshold wind speed changes according to wind direction. Then, this study aimed clarification of the relationship between topography and above-ground vegetation using satellite data with high spatial resolution, targeted at five locations in Mongolia (Tsogtovoov, Dalanzadgad, Arvaiheer, Bayanhongor, and Mandalgobi).</p> <p>Routine meteorological data were used for finding dust emission occurrences. Topography analysis was based on the digital elevation data observed by a space shuttle (SRTM-1arc second ver.3). The above-ground vegetation (NDVI) is based on the data from ALOS/AVNIR-2. A footprint model developed by Kormann and Meixner (2001) was used for estimating the source area of dust emissions. Based on the above data and model, the principal component analysis (PCA) was applied. Variables selected for the PCA were NDVI, elevation, gradient, and the azimuth of gradient direction.</p> <p>The outline of the results was as follows: (1) High NDVI corresponded low elevation and low gradient, i.e. the valley bottom; (2) In Tsogtovoov, the threshold wind speed did not decrease as the soil moisture decreased only in the directions of NDVI being high; In contrast in Dalanzadgad, such significant difference was not found according to wind direction possibly due to the valley bottom in the vicinity of the observatory not being as near as that of Tsogtovoov.</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	安 萍 An, Ping
研究代表者 Principal Re- searcher	中道 範人 (名古屋大学トランスフォーメティブ生命分子研究所) Nakamichi, Norihito (Institute of Transformative Bio-molecules (ITbM), Nagoya University)	
研究課題 Research Sub- ject	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. In last year, we found that one clock modulator molecule gives water-stress tolerance to <i>Arabidopsis thaliana</i>.</p> <p>In this fiscal year, we tried to understand action mechanism of this molecule for clock control and water-stress tolerance. At first we performed structure-activity relationship study of the molecule, and found that a moiety of the molecule is changerable to lengthen the period. We generated a molecule possessing an alkyl substituent at the moiety position to conjugate to agalose bead. Resulting molecule-conjugated agalose beads were incubated with Arabidopsis lysate and bead-binding proteins were analyzed by LC-MS/MS. The analysis identified a protein kinase as beads-binding protein. To examine whether the kinase is involved in the clock, we mutated a gene encoding the kinase, and analyzed clock phenotype of the mutant. The mutant showed long period phenotype. However, the effect by the gene mutation was not so strong compared to that by treatment of the original molecule, suggesting that the molecule control via the kinase-dependent and independent pathways. Since substrate of the kinase was already known, we examined whether the substrate is also involved in the clock. Different small molecules targeting the substrate function were treated to Arabidopsis, and circadin rhythm was measured.</p>	

	As result, the small molecules lengthend circadian period, suggesting that the kinase-substrate are involved in the clock.
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若手奨励研究 2 Incentive Research by Young Scientists 2	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	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	
共同研究要旨 Summary of Joint Research	<p>We mainly conducted an additional analysis regarding the degradation mapping of vegetation in Mongolian steppe based on species richness. In particular, we constructed a statistical model to explain plant species richness including both environmental factors and grazing as the explanatory variables to identify the areas where increased livestock grazing may have caused the loss of plant species richness. As the additional analysis, we primarily improved the statistical model by considering the indicator of grazing. Secondary, we translated the works conducted by A. D. Simukov (1902~1942), and improved the discussion part from a viewpoint of grazing pattern. As a result, we conclude that the negative effects of livestock grazing on plant species richness are weak throughout the Mongolian rangelands.</p> <p>We submitted a following paper regarding the above to Grassland Science on December 19, 2017. Kohei Suzuki, Radnaakhand Tungalag, Tsagaanbandi Tsendeekhuu, Narantsetegiin Amartuvshin, Iku-taro Tsuyama, Yuki Konagaya, Ayumi Hotta, Takashi Kamijo, Norikazu Yamanaka and Masato Shinoda. Patterns and predictors of fine-scale plant species richness in the Mongolian rangelands: Evaluation of impacts of livestock grazing.</p> <p>We are preparing the resubmission based on the decision letter.</p> <p>We are planning to submit a paper to Folia Geobotanica using the vegetation data collected from western Mongolia in 2016. Furthermore, we started a preparation of manuscript to Senri Ethnological Reports regarding the overview of works conducted by A. D. Simukov.</p>	

若手奨励研究 3 Incentive Research by Young Scientists 3	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	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 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. Our previous studies on tetraploid wheat core-collection lines have shown that tetraploid wheat is rich in diversity of ABA sensitivity.</p> <p>In this study, we conducted QTL-seq analyses for ABA sensitivity with two F₂ populations which were derived from cross between standard line (<i>Triticum turgidum</i> ssp. <i>durum</i> cv. Langdon) and ABA hyper-sensitive line (4x033: <i>T. t.</i> ssp. <i>dicoccoides</i>), ABA hyper-insensitive line (6x062: <i>T. t.</i> ssp. <i>dicoc-cum</i>). ABA sensitivity was evaluated by the shoot length with ABA treatment (0.25 μM). We selected ca. 20 individuals with high and low ABA sensitivity from each F₂ population and obtained genotype (SNPs) data by RAD-seq method for these selected individuals. We searched SNPs which closely linked to ABA sensitivity based on RAD-seq data and ABA sensitivity data.</p> <p>As the results of QTL-seq analyses, no regions closely linked with ABA sensitivity were detected. It is considered that these negative results may not able to accurately evaluate ABA sensitivity of F₂ individuals. We therefore retested ABA sensitivity using multiple individuals in each line for the F₃ generation obtained from each F₂ individual and found lines that showed difference in ABA sensitivity between F₂ generation and F₃ generation. These results strongly suggested that ABA sensitivity could not be accurately evaluated in the F₂ generation in which only one individual can be used per line. Now, we are pursuing linkage analyses by SSR markers for all F₂ individuals.</p>	

若手奨励研究 4 Incentive Research by Young Scientists 4	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Re- searcher	徳本 家康 (佐賀大学農学部) Tokumoto, Ieyasu (Faculty of Agriculture, Saga University)	
研究課題 Research Sub- ject	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>Objectives:</p> <p>To develop recycling-based arid land agriculture due to extrication from dependence on oil, we evaluated the effect of our own produced liquid fertilizer on plant growth. Additionally, water flow and root distribution were investigated for developing the spot drilling method (shaft tillage method) with an artificial macropore.</p> <p>Results:</p> <p>a. Evaluation of our developed liquid fertilizer:</p> <p>We were able to produce liquid fertilizer from residues of crops with underwater sparks. To evaluate the effects of fertilizer on plant growth, we chose medallion flower and applied the different diluted fertilizer (10%, 50%, 100%, and 1000% diluted liquid fertilizer of original one) to the flowers. As a result, more flowers with the fertilizer grew up than that without fertilizer did. Comparison of flowers growth with our produced fertilizer to flowers with commercial fertilizer indicated that our fertilizer was successful.</p> <p>b. Shaft tillage method:</p> <p>As transpiration increased, root growth into the artificial macropore was confirmed. Upward water flow was investigated due to pressure gradient. During irrigation periods, however, we found preferential flow through the macropore wall and high density of roots in macropore.</p> <p>To understand mechanism of root water uptake and water retention for roots having high density in the macropore, pressure measurements of the roots is needed. Then, relevant determination of the amount of irrigation could work through numerical modeling.</p>	

若手奨励研究 5 Incentive Research by Young Scientists 5	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Re- searcher	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, Uni- versity of Yamanashi)	
研究課題 Research Sub- ject	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.</p> <p>Additionally, we evaluated health effect of Asian dust exposure to children. In the analysis using quartile categories, a significant linear association of Asian dust with an endpoint determined by a re-</p>	

	ported score of two or more in ocular symptoms was observed (SPM-PM2.5: Ptrend < 0.001, odds ratio [OR] of the highest quartile [Q4] vs. the lowest [Q1] = 2.20, 95% confidence interval [CI] = 1.21 to 3.98, PM2.5: Ptrend < 0.001, odds ratio [OR] of the highest quartile [Q4] vs. the lowest [Q1] = 2.08, 95% confidence interval [CI] = 1.15 to 3.77). Skin symptoms was also observed SPM-PM2.5: Ptrend < 0.001, odds ratio [OR] of the highest quartile [Q4] vs. the lowest [Q1] = 1.57, 95% confidence interval [CI] = 1.12 to 2.20.
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若手奨励研究 6 Incentive Research by Young Scientists 6		対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Re- searcher	辻 渉 (鳥取大学農学部) Tsuji, Wataru (Faculty of Agriculture, Tottori University)		
研究課題 Research Sub- ject	“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 through “Hardening”, and the elucidation of its mechanism		
共同研究要旨 Summary of Joint Research	<p>The most susceptible growth stages for drought stress in crops are germination/emergence and seedling stages. Mitigation of the stress in these stages may contribute to minimizing of the yield reduction under drought condition. In the present study, “Seed hardening (SH, enhancement of germination/emergence under dry soil by the treatment of seed imbibition in water and re-drying before sowing)” and “Drought hardening (DH, enhancement of the resistance for severe drought stress in late growth stage by exposing the plants to moderate stress in early-middle growth stages)” are focused as countermeasures for the drought-susceptible stages.</p> <p>It has been reported that SH enhances germination rate under drought in several crops. However, optimum treatments of SH has not well understood so far. Synthetic wheat lines with different response to SH were examined to clarify the most effective water temperature of seed imbibition in SH which shows the best performance in germination. It was found that the optimum temperature was relatively higher in both wheat lines. However, the temperature during seed re-drying didn't influence on SH effects. As the results of isozyme and mRNA expression analysis, the mechanism of germination enhancement under drought by SH involved α-amylase activity in seed germination.</p> <p>On the other hand, DH has been reported in wooden plant species so far. In this study, it was examined the application of DH to annual herbaceous crops such as upland rice (NERICA4), tomato, cucumber, cabbage. We found that DH can enhance drought resistance in all tested crops, in particular, increment of survival rate and RGR (relative growth rate) was remarkable in rice. This attributed that not only increase of water uptake via larger root system development but also osmotic adjustment (OA). OA was induced by increment of total amino acid contents, especially Asn, Gln, Glu and GABA. In addition, we found that the effect of DH is different in timing (growth stage) and duration of DH treatment.</p>		

若手奨励研究 7 Incentive Research by Young Scientists 7		対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Re- searcher	金 俊植 (理化学研究所環境資源科学研究センター) Kim, June-Sik (Center for Sustainable Resource Science, RIKEN)		
研究課題 Research Sub- ject	NGS を活用した野生ゲノム導入による環境耐性型コムギの原因遺伝子探索 Gene mining for acquired abiotic stress tolerance in synthetic hexaploid wheat employing NGS strategy		
共同研究要旨 Summary of Joint Research	<p>Diversity Arrays Technology (DArT) evaluates hundreds of thousands of unique DNA markers (DArT-markers) on wheat genome. This commercial service provides immense genotype data sufficient to identify the genomic characterization of the submitted germplasm, even without the sequenced genome, having been largely helpful to wheat breeding. However, with the sequenced reference genome of wheat recently reported, the absence of the physical positional information of DArT-markers on chromosomes comes obstacle to applying the basepair-based molecular biology on wheat. In this study, I attempted to locate the DArT-markers on the recently reported wheat reference genome (IWGSC, 2014), by aligning the marker sequences to the genome through NGS data analysis pipelines. The physical positions of 4,315 markers were revealed, occupied 27.6% of the subjected DArT markers. Six known heat tolerant wheat lines (MNH) were analyzed by DArT-seq and genotypes of the DArT-makers were aligned on wheat chromosomes in the revealed the physical orders, and compared</p>		

	to that from the control cultivar Norin 61 (N61). Visualized view of genotypes presented genomic cross-over on MNH genomes. There was no common non-N61 genomic region was discovered across six MNH genomes, suggested the heat tolerance of MNH wheats was acquired by independent pathways. These results are published on an international scientific journal <i>Breeding Science</i> in 2017. [Reference] IWGSC (2014) Science 345: 1251788.
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若手奨励研究 8 Incentive Research by Young Scientists 8	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	松本 一穂 (琉球大学農学部) Matsumoto, Kazuho (Faculty of Agriculture, University of the Ryukyus)	
研究課題 Research Subject	立地環境の変化がマングローブ植物の生理生態に及ぼす影響の解明 Effects of change in stand environments on ecophysiology of mangrove plants	
共同研究要旨 Summary of Joint Research	To clarify the effects of changes in stand environment on the ecophysiology of mangrove plants, we studied mangrove trees (<i>Bruguiera gymnorrhiza</i>) at the mouth of the Okukubi River on Okinawa Island, Japan. Recently, a decrease in seedlings and decline in the vigor of trees were found in some plots in this mangrove forest. Takemura et al. (2012) postulated that construction of a dam upstream of the river and subsequent changes in erosion and sediment deposition in the river bed were the cause. In the current study, we measured ecophysiological traits of living mangrove trees in a “decline” plot and a “still healthy” (control) plot. The ground height and soil salinity were higher in the decline plot than in the healthy plot. There were also fewer knee roots (respiratory roots) and more dead mangrove trees in the decline plot. However, there were no significant differences in the maximum photosynthetic ability (maximum electron transfer and carboxylation rates) of living mangrove trees in both areas. Moreover, the transpiration rate was greater in the decline plot. These results suggest that mangrove plants are dying in the decline plot because of paralysis of the controlling function of transpiration and excessive suction caused by very salty water. The inhibition of root respiration due to sediment deposition and changes in soil properties contribute to this. To verify these hypotheses, we will conduct surveys focusing on the regulatory function of leaf gas exchange in mangrove trees and salinity within the tree body in 2018.	

若手奨励研究 9 Incentive Research by Young Scientists 9	対応教員 Corresponding Staff	伊藤 健彦 Ito, Takehiko
研究代表者 Principal Researcher	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	モンゴルにおける雪害が家畜のエネルギー収支に及ぼす影響 The effects of snow on energy balance of Mongolian livestock	
共同研究要旨 Summary of Joint Research	The average bite size of grazing sheep was estimated as 67.04 mg. The average bite times of grazing sheep was estimated as 12093 times / day. The metabolic energy of main forage plants were estimated as from 1.01 to 2.32 Mcal/kg DM. From these results, we estimated the energy intake of Mongolian grazing sheep as 0.92 Mcal/ day.	

(5) 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	安 萍 An, Ping
研究代表者 Principal Researcher	ホサイン ザヒード (COMSATS 情報技術研究所発展研究部門) Hussain, Zahid (Department of Development Studies, COMSATS Institute of Information Technology)	
研究課題 Research Subject	有機と無機肥料の施用による塩—アルカリ土壌中と作物体内のナトリウム—カリウムの変動 Sodium-Potassium Dynamics in Crops and Saline-sodic Soils Supplemented with Organic and Inorganic Amendments	

<p>共同研究要旨 Summary of Joint Research</p>	<p>The experiment, to study K adsorption and Na-K exchange in sand dune soil under K and manure treatments, was conducted and the data will be fitted to the known sorption equations. At first the sand dune soil (sandy soil) and loam soil (with >30% clay content) was made saline-sodic by adding different salts to make the EC of 6 dS m⁻¹ and SAR>15. A 10 g of soil samples was taken in 50 ml plastic bottles and equilibrated for 72 h after adding 10 mL of 0, 20, 40, 60, 80 and 100 mg K L⁻¹ solution and two levels (0 and 50 tons ha⁻¹) of FYM (cattle manure) with five replications 3-factorial RCB (6Kx2FYMx2Sx5R) design.</p> <p>K₂SO₄ (0, and 150 mg K ha⁻¹) and saline water with EC of 6 dS m⁻¹ was applied to sand dune soils in 1 kg pots with two drought levels in such a way that normal irrigation was provided at 80% of field capacity to pots in control treatments, while the drought level was maintained by decreasing the field capacity level by 20 % at every irrigation. 15 seeds of wheat per pot were grown, which were thinned to 6 plants per pot after the plant height was 2-3 cm. The basal doses of urea and di-ammonium phosphate was uniformly applied to all pots in the beginning. After thinning of plants, the saline and drought treatments were started. The experiment was terminated when the drought treatment reached 0% of field capacity. The experiment was arranged in a 3-factorial completely randomized design with 5 replications (2K x 2Salinity x 2Drought x 5R) with total of 40 pots in a greenhouse at ALRC. The data on plant physiological parameters (photosynthesis rate, stomatal conductance, transpiration) was recorded before the termination of the experiment. The fresh root and shoot weight and leaf length and root length was recorded. The soil samples from each pot were dried and exchangeable Na, K, Ca, Mg, EC and pH was determined to know the treatment effects on soils. Similarly, the root and shoot samples were oven-dried and after wet-digestion, the Na, K, Ca and Mg in roots and shoots were determined.</p>
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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, 2018

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發育生物学研究所 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
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 (S. Shadeed) ・新潟大学
(森井俊廣) ・鳥取大学 (藤巻晴行)

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および貯水槽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。

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 (Z. Fadda) ・南九州大学 (竹内真一) ・鳥取大学 (藤巻晴行)

研究費：鳥取大学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。

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－2018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 (V. Nangia) ・鳥取大学 (藤巻晴行)

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。

乾燥および塩耐性に関係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 (田中淨、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。

(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 (S. Shadeed), Niigata University (T. Morii), Tottori University (H. Fujimaki)

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 and a reservoir, is evaluated by monitoring how much water is lost due to surface runoff and deep percolation and by performing an automatic irrigation experiment.

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 (Z. Fadda), Minami-Kyushu University (S. Takeuchi), Tottori University (H. Fujimaki)

Funding: IPDRE (Irrigation and Water Resources Management Group), Tottori University

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.

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

Period: Nov. 2015 - May 2018

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: ICARDA (V. Nangia), Tottori University (H. Fujimaki)

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.

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.

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

Period: Apr. 2015-Mar. 2019

Leader: H. Tsujimoto (Tottori University)

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

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

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）・金俊植（理化学研究所）

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。

アルファルファ乾草による濃厚飼料の代替を通じた中国乾燥地での肉用牛飼養法の改善

期間：2015年5月－2018年9月

代表者：侯扶江（中国蘭州大学）

組織：中国蘭州大学（侯扶江、陳先江）・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の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として、アルファルファ乾草にて濃厚飼料を代替する際の適切な配合割合を提示する。

ゴビ砂漠の詳細観測に基づく黄砂－地表面過程モデルの構築

期間：2015年4月－2019年3月

代表者：黒崎泰典（鳥取大学乾燥地研究センター）

組織：鳥取大学（黒崎泰典、西原英治、中村公一、B. Buyantogtokh）・気象庁気象研究所（関山剛、眞木貴史）・モンゴル気象水文環境情報研究所（D. Jugder、B. Gantsetseg）

研究費：科学研究費補助金（課題番号15H05115）

課題：地表面－黄砂発生過程の多くを組み込むことができていないため、既存の黄砂数値モデルは精度不足の問題を抱えている。これまでの観測から、(1)クラスト形成・崩壊、(2)レキの量、(3)窪地、(4)植生量を考慮していないことが原因で、黄砂数値モデルが現実の黄砂を再現出来ていないことが定性的に明らかになっている。本研究では設置済みの観測資源を活用して、クラスト、レキ、窪地、植生といった地表面条件を定量化し、この結果に基づいた黄砂－地表面過程モデルの構築を行っている。

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－2019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（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

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.

Improvement of feeding regimens for beef cattle through the substitution of alfalfa hay for concentrate feed in dryland China

Period: May 2015- Sep. 2018

Leader: F. Hou (Lanzhou University)

Organization: Lanzhou University (F. Hou), 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. Alfalfa, generally cultivated in the Province, can be utilized as the feed of beef cattle, because it is high in the protein content and the resistance against drought. This research aims to propose measures for improved feeding regimens of beef cattle through the substitution of alfalfa hay for concentrate feed.

Building a model of processes between land surface and dust emission based on detailed observations in the Gobi Desert

Period: Apr. 2015 - Mar. 2019

Leader: Y. Kurosaki (ALRC, Tottori University)

Organization: Tottori University (Y. Kurosaki, E. Nishihara, K. Nakamura, B. Buyantogtokh), Meteorological Research Institute, Japan Meteorological Agency (T. T. Sekiyama, T. Maki), Information and Research Institute of Meteorology, Hydrology and Environment (D. Jugder, B. Gantsetseg)

Funding: JSPS Grants-in-Aid for Scientific Research (15H05115)

Subject: Existing dust numerical models have an accuracy problem because it still cannot include many processes between land surface and dust emission. From our observations, we have qualitatively clarified that key factors in aeolian erodibility are (1) formation and breakdown of soil crust, (2) amount of gravels, (3) topographic depression, and (4) vegetation amount. In this research, we are conducting quantitative observations regarding the effect of land surface conditions on dust emission such as soil crust, gravel, topographic depression and vegetation by utilizing our dust observation system already installed in the Gobi Desert, and we are also developing a numerical model installing these processes.

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

Period: Oct. 2013- Mar. 2019

Leader: A. Tsunekawa (ALRC, Tottori University)

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

(Enyew Adgo, Derege Meshesha) ・南アフリカ土壤・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。

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

期間：2017年4月-2022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 (恒川篤史、藤巻晴行、Nigussie Haregeweyn AYEHU、谷口武士、小林伸行他)・島根大学 (増永二之他)・東京大学 (大黒俊哉他)・バハルダール大学 (Enyew Adgo, Derege Meshesha他)

研究費：地球規模課題対応国際科学技術協力プログラム (SATREPS)

課題：エチオピアを対象に、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のフレームワークを提案する。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。土壌侵食の削減、土地生産力の向上、住民の生計向上に貢献。「持続可能な土地管理」は、すでに砂漠化対処に向けて世界的に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。本プロジェクトでは、開発された個別要素技術とそれらが普及していくための取り組み・手法を定式化し、青ナイル川流域および世界の乾燥地への展開を目指す。

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 (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分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。

University (E. Adgo, D. Meshesha), Agricultural Research Council (M. Tsubo)

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.

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

Period: Apr. 2017- Mar. 2022

Leader: A. Tsunekawa (ALRC, Tottori University)

Organization: Tottori University (A. Tsunekawa, H. Fujimaki, N. Haregeweyn, T. Taniguchi, N. Kobayashi and others), Shimane University (T. Masunaga and others), University of Tokyo (T. Okuro and others), Bahir Dar University (E. Adgo, D. Meshesha and others)

Funding: Science and Technology Research Partnership for Sustainable Development (SATREPS)

Subject: Proposing a framework for next-generation sustainable land management (SLM)

The project will propose a framework for next-generation SLM in Ethiopia, incorporating effects such as enhanced prevention of soil erosion, improvement of land productivity and increasing local residents' income. Research sites will be set up in three different areas (highland, midland and lowland) in the Upper Blue Nile Basin, which suffers from serious soil erosion caused by rainfall so as to develop practices and technologies for improving land productivity by reducing soil erosion and introducing crop-livestock production systems as well as linking such efforts to improving the livelihoods of local residents. Contribution to reduction of soil erosion, improvement of land productivity and local residents' livelihoods

Various SLM practices targeted to fight desertification have been implemented in many areas of the world, but their sustainability and effectiveness are being questioned. Hence this project aims to develop improved SLM technologies and approach that could address the major limitations of the currently implemented SLM practices and then to propose them to be used in the study sites and beyond such as to the entire Blue Nile Basin and other arid regions of the world that are experiencing similar problems.

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

Funding: JSPS Grants-in-Aid for Scientific Research

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, predicta-

モンゴル全土降雨量時系列の予測モデル

期間：2014年4月－2018年3月

代表者：安田裕（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（安田裕）・モンゴル気象水文研究所（G. Amgalan, B. Nandintsetseg）・スウェーデンルンド大学水資源工学科（Prof. Ronny Berndtsson）

研究費：鳥取大学

課題：モンゴル全土の降雨量時系列につき、全球海面温度（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。このような相関によるテレコネクション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。

ミャンマー中央乾燥地における複数生業による生計向上のための村落開発についての研究

期間：2017年4月 - 2019年3月

代表者：石山俊（国立民族学博物館）

組織：国立民族学博物館（石山俊、宮崎秀樹）・鳥取大学乾燥地研究センター（安田裕）・乾燥帯緑化部（U Zaw Win, Aung Zaw Latt）

研究費：鳥取大学

課題：多雨地帯が国土の大半を占めるミャンマーの中央部には、平均年雨量が600mm内外の中央乾燥帯が存在する。ここでは、天水農業による油脂作物、豆科作物の栽培が中心に行われてきた。しかし、中央乾燥帯の降雨の特徴は、少雨だけにとどまらず、雨季が2つに分かれるバイモダル（前・後雨季）、かつ激しい経年変動のため、安定的な農業生産を継続することは非常に困難である。本研究の目的は、上記の状況を踏まえたうえで、ミャンマー中央乾燥帯を対象とした、人文社会学系-農学系研究者による学際的共同研究による、地域住民の生計向上のための、複数の生業の導入可能性と農業改善を検討することにある。

乾燥地における非均一性土壌中の移動現象

期間：2014年5月 - 2019年3月

代表者：R. Berndtsson（ルンド大学）

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）・中国科学院西北生態環境資源研究院（王新平）

研究費：スウェーデン国際開発局（SIDA）小規模現地調査、スウェーデン・ルンド大学中東研究センター・現代世界における中東研究経費

課題：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。

有機と無機肥料の施用による塩-アルカリ土壌中と作物体内のナトリウム-カリウムの変動

期間：2017年8月 - 2018年2月

bility and heterogeneity of environmental conditions.

Prediction model for rainfall time series over Mongolia

Period: Apr. 2014- Mar. 2018

Leader: H. Yasuda, Arid Land Research Center.

Organization: Tottori University (H. Yasuda, T. Kawai), Lund University (R. Berndtsson), Information and Research Institute of Meteorology, Hydrology and Environment, Mongolia (G. Amgalan, B. Nandintsetseg)

Funding: Tottori University

Subject: Tele-connection of rainfall time series all over Mongolia with Global Sea Surface Temperature: GSST was analyzed. The rainfall time series inland Mongolia indicates significant correlations with SST of regions over the Pacific Ocean. Teleconnection due to the significant correlations was applied to the Neural Network Model and the prediction model was developed.

Study on village development for living improvement by the plural occupation in Myanmar central drylands

Period: Apr. 2017 - Mar. 2019

Leader: S. Ishiyama (The National Museum of Ethnology)

Organization: The National Museum of Ethnology (S. Ishiyama, H. Miyazaki), ALRC Tottori University (H. Yasuda), Dry Zone Greening Department (U Zaw Win, Aung Zaw Latt)

Funding: Tottori University

Subject: In the central dry zone in Myanmar, farmers depend on rainfed agriculture. The annual mean rainfall is about 600 mm and there is a big fluctuation of the rainfall time series. Agricultural productivity is not stable there. The life standard of habitants in the central dry zone is not high level. To improve such a misery condition, the optimum management of plural occupations is studied by the humanities sociology system - agriculture system researcher.

Transportation in heterogeneous soil in arid land

Period: May 2014- Mar. 2019

Leader: R. Berndtsson (Lund University)

Organization: Lund University (R. Berndtsson, M. Persson), ALRC Tottori University (H. Yasuda), Portside University (Y. Hamed), Northwest Institute of Eco-Environment and Resources (NIEER), Chinese Academy of Sciences (X. Wang)

Funding: Minor Field Study by Swedish International Development Authority (SIDA), the Middle East in the Contemporary World (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 Shpotou Research Station in China with the visiting professor, Xinping Wang.

Sodium-Potassium Dynamics in Wheat Crop and Soil under Salinity and Drought

Period: Aug. 2017- Feb. 2018

Leader: Z. Hussain (Institute of Information Technology, Pakistan)

代表者：ザヒード フサイン (パキスタン情報技術研究所)

組織：パキスタン情報技術研究所(ザヒード フサイン)・鳥取大学乾燥地研究センター (安萍、邵揚)

研究費：鳥取大学

課題：土壌の塩類集積は世界的な問題になっている。塩類集積土壌での農業生産の向上は急務である。本研究は、塩-アルカリ土壌における硫酸カリウム (K) と有機肥料の同時施用が土壌中のナトリウム (Na) の交換性、植物に対するKの吸収性および作物の根のNa-K選択性に対する影響を解明することが目的である。有機肥料と硫酸カリウムを培土に施用し、作物を栽培する。栽培前後の土壌と作物個体について、作物の生長に影響する土壌パラメーター、植物の生理指標および栄養素を測定し、数値モデルを利用して土壌のNa-K交換性と根のNa-K選択性を計算する。最終的には塩-アルカリ土壌における有機と無機肥料の施用によるNa-Kの土壌中と作物体内の変動を解析する。

ステイ・グリーン特性の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：エリタイプ ハボラ E. アミン (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 (エリタイプ ハボラ E. アミン)・スーダン農業研究機構 (イザット・S. A. タヘル)・東京大学 (岩田洋佳)

研究費：日本学術振興協会 (JSPS)

課題：ソルガムはスーダンの食料安全保障において重要な作物である。ソルガム生産において、乾燥は非常に大きな制約要因であり、厳しい干ばつはソルガムの不作の原因となることもしばしばである。乾燥地研究センターとスーダン農業研究機構との協力関係は、ソルガムの耐乾性における遺伝的機構の研究を目的とした共同研究及び、共同ワークショップを開催することに特化したものである。特に、ステイ・グリーン特性や、その耐乾性ソルガム育種への応用についての研究を重点的に行っている。

Organization: Institute of Information Technology, Pakistan (Z. Hussain), ALRC Tottori University (P. An, Y. Shao)

Funding: ALRC Tottori University

Subject: Salinity is a global problem. Reclamation of saline soils is necessary for improving agricultural production in drylands. The present study focused on the Na-K exchange within the soil solid phase as well as root selectivity and translocation in plant at different K, drought and salinity levels. Objectives of the research study were to investigate the role of potassium sulphate and organic manure on the exchangeability of Na and adsorption of K in loam and sandy soils and to study root selectivity and transport of Na-K and other physiological parameters of crops as influenced by K and salinity treatments under drought conditions.

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 (H. Iwata).

Funding: Japan Society for the Promotion of Science (JSPS)

Subject: Sorghum is the major food security crop in Sudan. Drought is considered the major production constraint. Severe drought incidents often lead to a complete crop failure. This international open partnership with ARC of Sudan was devoted for joint-research and joint-workshops to study the genetic mechanism for drought tolerance in sorghum. Particularly, investigating the Stay-Green trait, and its possible applications for breeding drought tolerant sorghum.

(3) 研究者・受託研究員・研究生の受入れ

研究者

Nasrein Mohamed Kamal Omer

(平成 29 年 4 月 1 日～平成 30 年 3 月 31 日)

スーダン農業研究機構バイオテクノロジー・バイオセーフティ研究センター・研究員

私費

Zahid Hussain

(平成 29 年 8 月 31 日～平成 30 年 1 月 18 日)

COMSATS 情報技術研究所・発展研究部門・助教
鳥取大学乾燥地研究センター・海外研究者招聘型共同研究経費

Matthias Vanmaercke

(平成 29 年 7 月 18 日～平成 29 年 9 月 28 日)

リエージュ大学・講師

日本学術振興会外国人特別研究員（欧米短期）経費

受託研究員

2017 年度 JICA 課題別研修「乾燥地における持続的農業のための土地・水資源の適正管理」（平成 29 年 8 月 17 日）
イラク 3 名、パレスチナ 2 名、ケニア 1 名、ニジェール 1 名、南スーダン 1 名、ソマリア 1 名

2017 年度 JICA 課題別研修「サブサハラアフリカ 気候変動に対するレジリエンス強化のための砂漠化対処」（平成 29 年 11 月 27 日～平成 29 年 11 月 28 日）
ケニア 5 名、エチオピア 1 名、ボツワナ 1 名、ニジェール 1 名、セネガル 1 名

研究生

Fekremariam Asargew Mihretie

(平成 29 年 10 月 1 日～平成 30 年 9 月 30 日) エチオピア

Gamila Mohamed Idris Elhadi

(平成 29 年 10 月 1 日～平成 30 年 9 月 30 日) スーダン

Mohammad Intekhab Alam

(平成 29 年 12 月 1 日～平成 30 年 3 月 31 日) バングラデシュ

(3) Visiting Researchers, Trainees and Research Students

Visiting Researchers

Nasrein Mohamed Kamal Omer

(Apr. 1, 2017—Mar. 31, 2018)

Researcher, Biotechnology and Biosafety Research Center, Agriculture Research Corporation, Sudan

Private funds

Zahid Hussain

(Aug. 31, 2017—Jan. 18, 2018)

Assistant Professor, Department of Development Studies, COMSATS Institute of Information Technology

Funded by Guest Research Associate for Joint Research Program, Arid Land Research Center, Tottori University

Matthias Vanmaercke

(Jul. 18, 2017—Sept. 28, 2017)

Lecturer, Department of Geography, the University of Liege

Funded by JSPS Postdoctoral Fellowship for Research in Japan (Short-Term)

Visiting Trainees

JICA Group Training Course 2017 “Appropriate Management of Land and Water Resources for Sustainable Agriculture in Arid & Semi-Arid Regions”

3 Iraqis, 2 Palestinians, 1 Kenyan, 1 Nigerian, 1 South Sudanese, 1 Somalian

JICA Group Training Course 2017 “Combating Desertification to Strengthen Resilience to Climate Change in Sub-Saharan Africa”

5 Kenyans, 1 Ethiopian, 1 Botswanan, 1 Nigerian, 1 Senegalese

Research Students

Fekremariam Asargew Mihretie

(Oct. 1, 2017— Sep. 30, 2018) Ethiopia

Gamila Mohamed Idris Elhadi

(Oct. 1, 2017— Sep. 30, 2018) Sudan

Mohammad Intekhab Alam

(Dec. 1, 2017— Mar. 31, 2018) Bangladesh