

1. 研究活動（2018年4月～2019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。

乾燥地研究センターは、国立大学の共同利用・共同研究拠点に係る中間評価において、文部科学省からA評価を受けた。

本センターでは、文部科学省特別経費事業「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－（限界地プロジェクト）」を平成27年度から4年間実施した。最終年度の平成30年度には、開発した耐暑性コムギ系統および節水灌漑管理の実証を海外共同研究機関の研究者と行うとともに、「乾燥地の有用植物 使う植物」を今井出版より刊行した。

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～令和3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年度から相手国エチオピアにおいて研究活動を展開している。

また、共同利用・共同研究拠点強化プロジェクト「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～令和3年度）においては、将来気候グループ、砂漠化対処グループ、乾燥地農業グループの3つのグループで研究活動を推進している。

さらに、乾燥地研究センターの辻本壽教授を研究代表者とする研究課題『スーダンおよびサブサハラアフリカの乾燥・高温農業生態系において持続的にコムギを生産するための革新的な気候変動耐性技術の開発』（令和元年度～令和5年度）が、JSTのSATREPS平成30年度新規課題に採択された。

平成30年6月、乾燥地研究センターはライブニッツ植物遺伝作物学研究所（IPK、ドイツ）と研究協力に関する覚書を締結した。石井孝佳講師を中心に、IPKとの共

1. Research Overview (April 2018–March 2019)

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 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 was graded A by MEXT in the interim assessment of National University's Joint Usage/ Research Centers.

ALRC had implemented the Project Marginal Region Agriculture "Development of crop husbandry technology in marginal rainfed environment using dryland plant resources - Toward sustainable improvement in global marginal regions" funded by MEXT for four years from FY2015 through FY2018. In FY2018, ALRC's research team, in collaboration with overseas research institutions, conducted demonstration experiments with heat-tolerant wheat lines developed and water-saving irrigation control. In addition, ALRC published "Useful Plants in Drylands - Plants for Human Life" by IMAISHUPPAN.

ALRC's Professor Atsushi Tsunekawa's research project entitled "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 FY2017 in partnership with Bahir Dar University, Ethiopia.

ALRC has launched its five-year project entitled "Impacts of Climate Change on Drylands: Assessment and Adaptation (Project ICC×DRYLANDS)" since FY2017, aiming to enhance its function as a Joint Usage / Research Center. This project has been actively promoted by our three research groups; Future Climate Group, Combat Desertification Group, and Dryland Agriculture Group.

Furthermore, ALRC's professor Hisashi Tsujimoto's five-year research project entitled "Development of Climate Change Resilient Innovative Technologies for Sustainable Wheat Production in the Dry and Heat Prone Agro-Ecologies of Sudan and Sub-Saharan Africa" was selected as one of the FY2018 SATREPS programs by JST. The research team will launch full-fledged operations from FY2019 jointly with Agricultural Research Corporation and Metrological Authority, Sudan.

In June, 2018, ALRC and Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany, signed a mem-

同研究を開始した。

平成30年8月、乾燥地研究センターの安萍准教授が、日本砂丘学会第64回全国大会において、日本砂丘学会論文賞を受賞した。

平成30年9月、乾燥地研究センターの藤巻晴行教授が、第67回農業農村工学会大会において、優秀報文賞を受賞した。また、山本福壽元特任教授が、日・オマーン関係の促進に貢献した功績により、在オマーン日本国大使から在外公館長表彰を受賞した。

平成30年11月、乾燥地研究センターが中心部局となり、鳥取大学と国際塩生農業研究センター（ICBA、本部アラブ首長国連邦）との間で学術交流協定を締結した。

平成31年1月、乾燥地研究センターの辻本壽教授が、乾燥・高温耐性コムギ系統の系統選抜に関する研究を高く評価され、鳥取大学長表彰を受賞した。

平成31年2月8日、乾燥地研究センターの妻鹿良亮プロジェクト研究員と宇都宮大学の岡本昌憲助教らによる国際共同研究が英国科学雑誌『Nature Plants』のオンライン版に掲載された。本研究では、節水型耐乾性をもつコムギの開発に世界で初めて成功した。

平成31年2月11日から14日に、乾燥地研究センターと国際乾燥地研究教育機構は、海外研究機関を含む6機関と共催で、インド・ジョドプールにおいて第13回乾燥地開発国際会議（ICDD）を開催した。鳥取大学からは教職員12名が参加し、口頭発表やポスター発表を行った。

平成31年3月、乾燥地研究センターと独立行政法人国際協力機構中国センター（JICA中国）との間で、乾燥地や開発途上国への国際貢献や人材育成の分野で連携を強化していくための覚書を締結した。

また、アリドトロン管理実験棟の改修（平成30年10月完了）が行われ、乾燥地植物資源バンク室の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5名、准教授6名、講師1名、助教1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8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8名（技術職員4名、技術補佐員4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31年3月31日時点）。

共同研究、教育、刊行物

平成30年度における共同利用研究代表者（大学教員など）は61名、指導学生数は38名（博士課程24名、修士課程11名、学部学生1名、研究生1名、特別研究学生1名、うち留学生30名（中国7名、エチオピア11名、スーダン4名、ナイジェリア2名、エジプト2名、南アフリカ1名、モン

orandum of scientific cooperation, and ALRC's Junior Associate Professor Takayoshi Ishii has begun joint research with IPK.

In August 2018, ALRC's Associate Professor Ping An received the Japanese Society of Sand Dune Research Award at the society's 64th national convention.

In September 2018, ALRC's Professor Haruyuki Fujimaki received the Technical Paper Award for Excellence at the 67th convention of the Japanese Society of Irrigation, Drainage and Rural Engineering. In addition, ALRC's former Specially-Appointed Professor Fukuju Yamamoto was awarded a prize from ambassador of Japan to Oman for his outstanding contribution in promoting relationship between Oman and Japan.

In November 2018, ALRC, Tottori University entered into an academic exchange and cooperation agreement with International Center for Biosaline Agriculture (ICBA, headquarters in UAE).

In January 2019, ALRC's Professor Hisashi Tsujimoto received the Tottori University President's Award for his highly-evaluated research achievements on dry and heat tolerant wheat selection.

Moreover, ALRC's Project Researcher Ryosuke Mega succeeded in developing a water-saving type drought tolerant wheat line for the first time in the world in an international joint research with Assistant Professor Masanori Okamoto of Utsunomiya University. It was published in an online edition of Nature Plants on February 8, 2019.

From February 11 to 14, 2019, ALRC, jointly with IP-DRE, co-hosted the 13th International Conference on Development of Drylands (ICDD) with six institutions including international research institutions in Jodhpur, India. 11 researchers and a staff from Tottori University participated in the conference and gave oral and poster presentations.

In March 2019, ALRC and JICA Chugoku Center signed a memorandum to strengthen cooperation in the fields of international contribution and human resource development in arid regions and developing countries.

In addition, renovation of Arid-tron Control and Experiment Building of ALRC was completed in October 2018, and research environment of the Laboratory of Arid Land Plant Resources was improved.

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 into a department in FY2012, 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, 2019, five full-time professors, six associate professors, one junior associate professor, one 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, eight project researchers were added to our research teams. Moreover, 16 office staff (five full-time and eleven part-time) and eight technical staff (four full-time and four part-time) supported ALRC's research and education.

Joint Research, Education, Publication

In FY2018, 61 joint-use research representatives, mainly from national and private universities, were attached to ALRC. In addition, ALRC had a total of 38 students; 24 Ph.D. students, 11 master's students, one undergraduate

ゴル1名、バングラデシュ1名、ケニア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30年度は、12月1日～2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、博士前期課程(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行以来毎年刊行し、センターの研究教育活動の紹介を行っている。また、センターの活動を地域で支え、その研究活動と成果を広く情報発信することを通じて地域の発展を図る組織として設立された「とっとり乾地研倶楽部」の支援により、広報誌を年数回発行し、最新の活動状況等を紹介している。

この他、平成30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.3 乾燥地の有用植物 使う植物(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・山中典和編、今井出版、平成30年9月出版)
- 持続可能な乾燥地農業のためにー土壌塩類化防止と塩類土壌修復ー(鳥取大学乾燥地研究センター監修、藤山英保 編、技報堂出版、平成31年2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30年度の主な活動は以下のとおり。

- 鳥取大学サイエンスアカデミーにおける講演「モンゴルをフィールドとする乾燥地研究」：平成30年8月25日、9月22日、10月27日、鳥取県立図書館
- 「乾燥地の食べる植物・使う植物」パネル展：平成30年5月19日～6月18日、鳥取大学附属図書館、平成30年11月19日～12月14日、鳥取大学広報センター
- 平成30年度日本学術会議中国・四国地区会議主催の学術講演会における基調講演「鳥取砂丘から世界の乾燥地研究へー乾燥地におけるSDGs達成への挑戦ー」：平成30年11月17日、とりぎん文化会館、鳥取市
- 第13回乾燥地開発国際会議(ICDD)を共催。基調講演、口頭発表、ポスター発表を実施：平成31年2月11日～14日、鳥取大学・ICARDA共催シンポジウム(平成31年2月12日)への参加者人数約60名、インド・ジョドプー
- 一般公開：平成30年7月21日、参加人数120名
- きみもなろう！砂漠博士(小学生向け実験イベント)：平成30年7月21日、参加人数20名

student, one research student, and one special research student. Of them, 30 students were from overseas; 7 Chinese, 11 Ethiopian, 4 Sudanese, 2 Nigerian, 2 Egyptian, 1 South African, 1 Mongolian, 1 Bangladeshi and 1 Kenyan.

ALRC holds the Joint Research Symposium every year. In FY2018, we held the symposium on December 1 and 2 at the main campus of Tottori University. 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 Kan-chiken Club” established by a local business association.

Moreover, ALRC issued the following publication in FY 2018.

- Photobooks of Drylands vol. 3: Useful Plants in Drylands - Plants for Human Life - (Supervision: ALRC, Tsujimoto, H., Tomemori, H. and Yamanaka, N., eds. Published by IMAISHUPPAN, September 2018)
- Toward Sustainable Dryland Agriculture - Preventing Salt Accumulation in Soil and Remediating Salt-affected Soil- (Supervision: ALRC, Fujiyama, H., ed. Published by Gihodo Shuppan Co. Ltd., February 2019)

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 FY2018.

- Giving lectures in a series entitled “Dryland Field Researches in Mongolia” at Tottori University’s Science Academy: August 25, September 22, and October 27, 2018, Tottori Prefectural Library
- Panel exhibition “Edible plants and plants for human life in drylands”: May 19 - June 18, 2018, Tottori University’s Library and November 19 - December 14, 2018, Tottori University’s Public Relation’s Center
- Giving a keynote speech entitled “From Tottori Sand Dune to the study of the world’s drylands - Challenge to achieve SDGs in drylands” at the FY2018 Science Council of Japan’s Chugoku/Shikoku Regional Conference: November 17, 2018, Tottori Prefectural Cultural Hall
- ALRC co-hosted the 13th International Conference on Development of Drylands (ICDD), giving a keynote speech, oral and poster presentations: February 11 - 14, 2019, Jodhpur, India
- Open House Event: July 21, 2018, ALRC
- On-site learning program for elementary school students “Let’s become a Dr. Desert”: July 21, 2018, ALRC

(2) 研究部門

1) 総合的砂漠化対処部門

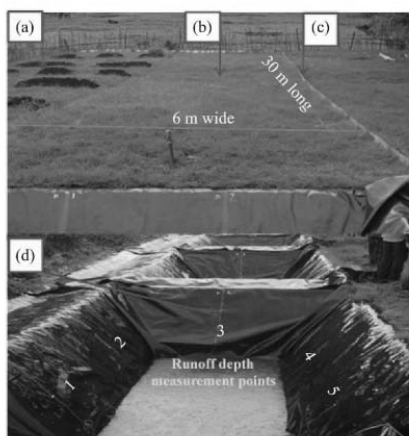
恒川 篤史 (保全情報学)

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

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

本年度は、エチオピアの青ナイル川上流域における異なる農業生態学的環境における土壌・水保全対策の効果に関して以下の研究結果を得た。

高地地域の湿潤亜熱帯サイトでは、土壌・水保全対策は潜在的に浸水を引き起こすのに十分なほど土壌水分を増加させたが、同様の事象は雨量の少ないサイトでは見られなかった。耕作地では *Vetiveria zizanioides* 草とソイルバンドの組み合わせが、また草地では短いトレンチが最も多くの表面流去を保全した（それぞれ 51%と 55%）。流出応答は土地利用タイプ内および土地利用タイプ間で高い空間的変動を示し、土壌・水保全効率に大きな変動を引き起こした。我々の結果は、流出と水文学を制御するための土壌と水の保全対策の成功における農業生態学的環境の役割を理解する必要性を強調している。本研究成果は、同様の土壌、気候、地形条件を持つ他の場所で検証可能な適切な手法の採用を促進するための政策策定を支援すると期待される。



Layout of the runoff plots established in grazing land in the Guder watershed. (a) plots with soil and water conservation measures; (b) plots without conservation measures; (c) corrugated iron sheets inserted in the ground to a depth of 15 cm to establish the plot boundaries; (d) runoff collection pit lined with impermeable geomembrane plastic.

(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 efficiency of soil and water conservation practices in different agro-ecological environments in the Upper Blue Nile Basin of Ethiopia.

At the moist subtropical site in a highland region, soil and water conservation increased soil moisture enough to potentially cause waterlogging, which was absent at the lowrainfall sites. Soil bunds combined with *Vetiveria zizanioides* grass in cultivated land and short trenches in grassland conserved the most runoff (51% and 55%, respectively). Runoff responses showed high spatial variation within and between land use types, causing high variation in soil and water conservation efficiency. Our results highlight the need to understand the role of the agro-ecological environment in the success of soil and water conservation measures to control runoff and hydrological dynamics. This understanding will support policy development to promote the adoption of suitable techniques that can be tested at other locations with similar soil, climatic, and topographic conditions.

[Sultan, D., Tsunekawa, A., Haregeweyn, N., Adgo, E., Tsubo, M., Meshesha, D.T., Masunaga, T., Aklog, D., Fenta, A.A., Ebabu, K. 2018. Efficiency of soil and water conservation practices in different agro-ecological environments in the Upper Blue Nile Basin of Ethiopia. *Journal of Arid Land*, 10(2): 249-263.]

坪 充 (気候リスク管理学)

気候リスク管理学分野では、農業気象、微気象および作物モデルに関する研究を進め、特に以下について活動している。

- (1) 農業干ばつモニタリング
- (2) 乾燥地農業モデリング
- (3) 農業気象情報システムの開発

平成 30 年度は、次の研究を行った。

南アフリカにおける日射

南アフリカの沿岸と内陸で観測された全日射量と散乱日射量の関係を明らかにした。1 時間ごとの気象データを用いて、全日射に対する散乱日射の割合 (K) を分析した結果、 K は大気飽差に反比例することが示された。また、晴天指数 (K_T) から K を推定するモデルを開発した。 K_T - K モデルは、研究対象地における午後の散乱日射を約 10% 過小に見積もったが、午前については、誤差が小さかった。

南アフリカにおける牧草生産

衛星リモートセンシング技術は、草地の生産性のモニタリングに用いられるが、枯れた植物の現存量に関する研究は少ない。本研究では、牧草の緑色部分と非緑色部分を区別することができる衛星リモートセンシング手法を提案した。MODIS 衛星データを用いて、南アフリカの乾燥草地における緑色現存量と正規化差植生指数 (NDVI) の関係および非緑色現存量と正規化差水指数 (NDWI) の関係を明らかにした。これにより、牧草生産の過小評価を最小限にすることができる。

作物モデリング

エチオピアの青ナイル川上流域で栽培されているテフ作物およびスーダンの高温乾燥下で栽培されているコムギのモデル開発を開始した。



A teff crop field in Ethiopia (Nov. 2018)

Mitsuru Tsubo (Prof., Climate Risk Management)

The Climate Risk Management subdivision conducts research in agrometeorology, micrometeorology and crop modelling, particularly the following.

- (1) Agricultural drought monitoring
- (2) Dryland agricultural modelling
- (3) Development of agrometeorological information systems

Research activities in this fiscal year were as follows.

Solar radiation in South Africa

Relationships between global radiation and diffuse radiation observed at both coastal and inland locations in South Africa, were investigated. Analysis of the fraction of diffuse to global radiation (K) using long-term hourly meteorological data shows that K is inversely related to atmospheric water vapour pressure deficit. In addition, A model that estimate K from clearness index (K_T) was developed. The K_T - K model underestimated afternoon irradiances by about 10% in the study area, but errors for morning irradiances was small.

Pasture production in South Africa

Satellite remote sensing technology has been successfully used to monitor grassland productivity, but senescent standing plant biomass has not been widely studied. This study proposed a satellite remote sensing method that can distinguish between green and non-green herbage. MODIS satellite data were used to develop relationships between green aboveground biomass and Normalized Difference Vegetation Index (NDVI) and between non-green aboveground biomass and Normalized Difference Water Index (NDWI) in South African semi-arid grasslands. This in turn can minimize underestimations of pasture availability in the semi-arid grasslands.

Crop modelling

Model development has begun for teff grown in the Upper Blue Nile basin, Ethiopia and wheat grown under hot and dry conditions in Sudan.



A wheat crop field in Sudan (Jan. 2019)

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ている。また、ダスト研究の他に、(4)乾燥地×温暖化プロジェクトを推進している。本年度は主に以下のことを実施した。

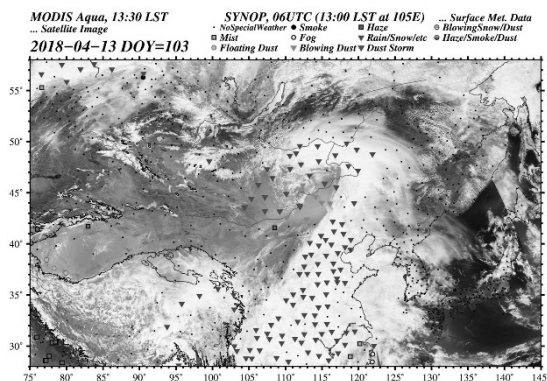
課題(1)では、気象台データと MODIS 衛星画像を用いた東アジア準リアルタイムダストモニタリングシステムの維持更新を行い、ダスト発生・輸送経路の議論に用いた。

課題(2)では、2012年3月にゴビ砂漠北部のツォクトオボー (モンゴル) に設置した観測設備を用いて、黄砂発生メカニズム解明のための観測を実施した。乾地研共同研究 (代表: 土塚正秀・香川大) などにおいて、土壌水分と土壌クラスト強度の関係を定量評価するための室内実験を実施した。Buyantogtokh 氏 (M2, 国際乾燥地科学専攻) と地形とレキ被覆の関係及びレキの飛砂への影響の研究を現地調査および数値実験で推進した。

課題(3)では、乾地研共同研究 (長田和雄・名古屋大) において、PM_{2.5} 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。

課題(4)では、気候変動とその草原生態系への影響 (モンゴル) 及びコムギ生産への影響 (スーダン) の研究を進めている。

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 April 13, 2018. 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 missing of human and its livestock, 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. In addition, (4) Project Impacts of Climate Change on Drylands (ICCxDRYLANDS) is promoted. Major works 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 elucidate dust emission mechanisms utilizing the dust monitoring system, which was installed at Tsogt-Ovoo, Mongolia located in a northern part of the Gobi Desert. Laboratory experiments were carried out to measure a hardness of soil crust under ALRC joint research (PI: Prof. Ishizuka, Kagawa Univ.) etc. Field surveys and numerical simulations were conducted to elucidate a relation between topography and stone coverage and an effect of stone on sand saltation with Mr. Buyantogtokh (M2, Department of Dryland Science).

On the subject (3), observations of PM_{2.5} 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.

On the subject (4), researches of climate change and its effect on grassland ecosystems in Mongolia and its effect on wheat production in Sudan were proceeded.

These works were supported by JSPS KAKENHI (Grant Numbers 15H05115, 25220201 and 17H01616), by Project ICCxDRYLANDS, by International Platform for Dryland Research and Education (IPDRE), and by ALRC joint researches.



A view of field survey for stone coverage at a mountain area, Tsogt-Ovoo (May, 2018).

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する飼料設計の一例を提示した。

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。飼料設計の前提となる放牧牛の飼料摂取量(現採食量)の妥当な計測手法を把握するための放牧試験や3小流域での植物生産量の計測を行なうとともに、飼料分析に必要な機材や試薬を整備し、その使用方法を関係者に指導した。

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、これら研修で得た知識が一般患者に伝播した効果を把握するための健診を実施した。その結果、患者リーダーの知識レベルの向上に伴って一般患者の知識や自信、生活の質が向上するとともに、こうした生活の質の向上には、血中HbA1c値(糖尿病の進行度を表す指標の1つ)の低下(改善)とともに自己管理活動(運動等)の励行度が影響していることが明らかになった。



Preparation of cage to measure the biomass production in a free-grazing land. (in Ethiopia)

Kobayashi Nobuyuki (Associate 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 2018.

1. Collaborative research with Lanzhou University in China

In Gansu Province, a key 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. A preferable formulation for corn-stover based diets was demonstrated.

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

As an activity of the component 2 for the Project, 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 2018, we carried out the trials to identify proper methods to measure the forage intake of grazing cattle, which is used for recommended dietary design, and the survey to measure the biomass production in each watershed. Moreover, we instructed how to use the equipment for feed analysis provided by the Project, for those concerned.

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 general patients. We recognized the enhancement of knowledge and quality of life (QOL) for the general patients, along with the increase of leaders' knowledge level. We further demonstrated that such increase of QOL was affected by the improvement in blood HbA1c level (an indicator to monitor the stage of diabetes) and the active self-management for diabetes (e.g., frequent exercise).



Participatory workshop by a patient leader for other diabetic patients. (in Philippines)

Zerihun Nigussie Gebresilasie (Specially-Appointed Assist. Prof., Socio-economics of Sustainable Land Management)

The Socio-economics of Sustainable Land Management Subdivision undertakes research mainly as follows:

- (1) To understand the mechanism behind successful adoption of few sustainable land management technologies by small-scale farmers while significant others still lagging behind,
- (2) To examine small-scale farmers' livelihoods, livelihood diversification and its probable link with sustainable land management,
- (3) To clarify mechanisms to enhance participation of less privileged segment of the society (landless youth and women) in land management through income generating activities, and
- (4) To understand ways to engage local stakeholders into continual experiential learning for sustainable watershed management.

These research activities have been continuing under the support of the project "Development of Next Generation Sustainable Land Management Framework to Combat Desertification-SATREPS", Grant Number JPMJSA1601, funded by JST/JICA.

In this fiscal year, I have obtained the following results:

1. Among the many factors that have been contributing to successful spread of a few sustainable land management technologies in the rural landscapes of the Upper Blue Nile Basin, Ethiopia, in this study, one factor has been explored in detail using an economic valuation technique, cost-benefit analysis. Data has been collected from small-scale farmers that represent various segments of the society in terms of wealth, education, gender and primary job, and also agricultural experts in the region. The analysis takes into account different land management systems and scenarios, like changes in prices and discount rate, which affect the net present values of the systems under consideration. Accordingly, I clarified that, inter alia, financial sustainability is an important factor for successful uptake of land management options by small-scale farmers, and, yet equitable distribution of benefits among society from such land management technologies is still a big concern.

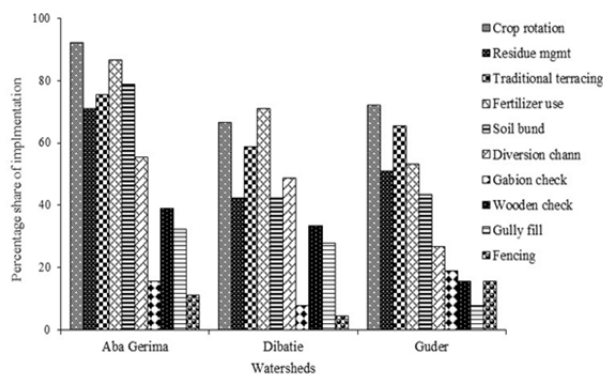


Farmers participating in experiential learning for sustainable land management

While the very technology may be beneficial, in general, it may particularly disadvantage a certain segment of the society (e.g., Poor landless farmers, youth, women), further fueling the wider distributional inequalities within the local community's. In order to redress such a problem, inter alia, facilitating rural financial facilities for those resource constrained farmers and broadening livelihood options would help to narrow the gaps.

2. Land degradation, among others, poses a major threat to agricultural production and food security situation in Sub-Saharan Africa, in general, and Ethiopia, in particular. In order to solve the daunting problem of land degradation, the implementation of sustainable land management by smallholder farmers is key in dealing with, or else at least minimizing, its adverse impacts, as unsustainable land management by smallholder farmers is reported to be among its major causes. Using a household-level cross-sectional data obtained from three study sites (Aba Gerima, Guder and Dibatie watersheds), I have tried to investigate the rural livelihood diversification among smallholder farmers and its probable effect on uptake of a portfolio of sustainable land management technologies in the Upper Blue Nile Basin, Ethiopia.

Accordingly, I found that a greater extent of livelihood diversification had a significant negative effect on adopting a greater number of SLM practices, i.e., the more diversified the livelihoods of rural households, the less number of sustainable land management practices applied on their farmlands, whereas it had a positive effect on lower SLM adoption intensity. Overall, I found evidence that having greater livelihood diversification could prompt households not to apply more sustainable land management technologies. Therefore, livelihood initiatives that focus on increasing shock resilience of rural households, facilitating access to financial support mechanisms, improving traditional livestock production system, and providing quality agricultural extension services, while also considering agro-ecological differences, are needed in order to promote the wider implementation of land management practices among smallholder farmers. In addition, development planners in the region should take into account the existing livelihood portfolios of rural households when trying to implement sustainable land management related policies and programs.



Sustainable land management practices implemented by farmers across study watersheds.

2) 環境保全部門

山中 典和 (緑化学)

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

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

これらの研究は、中国、モンゴル、スーダン等にある研究機関、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. 岡山大学、京都大学、東京大学、三重大学、鳥取大学そしてモンゴル生命科学大学で行ってきた、共同研究の成果として、Ayumi Tanaka-Oda et al, (2018) A water-acquisition strategy may regulate the biomass and spatial distribution of essential winter forage species in cold Asian grasslands. ECOSPHERE 9(12) Article e02511 を出版した。この研究では、砂による埋没が、モンゴルの重要な冬の飼料植物であるアクナテルム・スプレンドンの水獲得戦略と大きなバイオマスの維持に影響を与えることを明らかにした。
2. オマーン国において、乳香の生産促進に関する共同研究をオマーン、スルタンカブース大学の Ahmed Al-Busaidi 博士と行った。乳香はアラブ諸国で用いられる神聖な香料であるが、スルタンカブース大学の圃場に生育する乳香樹を用いて実験を行った結果から、乳香の生産促進には 3 種のシグナル伝達に関わる化学物質が有効であることが明らかとなった。



Acnatherm splendens growing in Mandal gobi, Mongolia. (Aug., 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. As a result of the joint research of Okayama University, Kyoto University, The University of Tokyo, Mie University, Tottori University, Mongolian University of Life Science etc., a paper of “Ayumi Tanaka-Oda et al, (2018) A water-acquisition strategy Winter forage species in cold Asian grasslands. ECOSPHERE 9 (12) Article e02511” has been published. In this study, it was clarified that sand burial affect the water acquisition strategy and maintenance of large biomasses of *Acnatherm splendens* that act as important winter forage in Mongolia.
2. In Oman, we conducted joint research with Dr. Ahmed Al-Busaidi of Sultan Qaboos University to promote the production of frankincense. Frankincense is a sacred incense used in Arab countries, and as the results of experiments using *Boswellia sacra* trees grown in the fields of Sultan Qaboos University showed that three types of signal transduction substances were effective in promoting the production of frankincense.



Field experiment on frankincense production in Sultan Qaboos University, Muscat, Oman (Sep., 2018).

谷口 武士 (微生物生態学)

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

- ・ 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
- ・ スーダンにおけるソルガムに有用な微生物の探索

これらのテーマについて、アメリカ、スーダン、エチオピアを中心に共同研究を行っている。本年度は主に以下の研究で成果を得た。

スーダンの主要作物であるソルガムの内部根圏微生物のメタゲノムデータを用いて、微生物間相互作用における中心的な微生物、およびソルガムの成長と相関のある微生物を検出し、有用微生物の推定を行った。また、この推定の妥当性を検討するため、ソルガムの根から分離培養した内生菌および内生細菌をソルガム苗に無菌的に接種し、その成長への影響を評価した。結果として、窒素固定細菌、およびバチルス属菌で有用と予想された微生物による成長促進効果が確認された。このことから、メタゲノムデータによる有用微生物の推定が可能であることが示唆された。

Endophytic bacteria	
B2	<i>Nocardioides</i> sp. (16S_49)
B12	<i>Rhizobium</i> sp.3 (16S_31)
B14	<i>Bacillus</i> sp.1 (16S_5)
B20	<i>Variovorax</i> sp. (16S_108)
B21	Unknown bacterium (16S_28)
B22	<i>Rhizobium</i> sp.1 (16S_9)
B23	<i>Rhizobium</i> sp.2 (16S_46)
B25	<i>Promicromonospora</i> sp.1 (16S_20)
B26	<i>Pseudoxanthomonas</i> sp.2 (16S_24)
B31	<i>Lysobacter</i> sp. (16S_25)

■ Growth-associated endophytes
□ Central endophytes

Bacterial isolates used for the inoculation test.
Growth-associated endophytes and central endophytes were determined using metagenome data

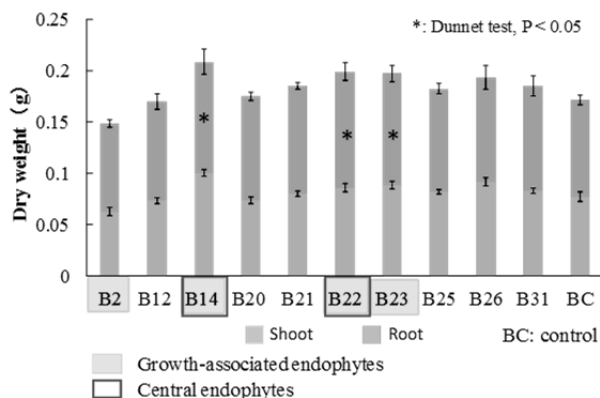
Takeshi Taniguchi (Assoc. Prof., Microbial Ecology)

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
- ・ Search for the effective microbes of sorghum in Sudan

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

The useful root endophytic microbes on sorghum had been determined based on the metagenome data by detecting the central microbes in the microbe network and plant growth promoting microbes that had the significant correlation with plant growth. Then, inoculation test of the endophytic microbes isolated from roots were conducted to check the validity of the estimation by metagenome data. The result showed that *Bacillus* (B14) and *Rhizobium* (B22) species, that were central and plant growth associated endophytes, enhanced the sorghum growth, indicating that the estimation by metagenome analysis would be possible.



Effect of bacterial inoculation on plant biomass.

木村 玲二 (気象学)

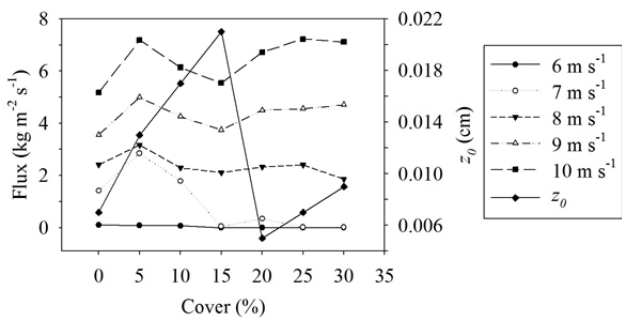
気象学分野では以下のような研究を行っている。

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

これらの研究は、日本学術振興会による科学研究費（課題番号 17H04634, 17H01626, 18K05877）、宇宙航空研究開発機構(JAXA)の Global Change Observation Mission の援助 (RA1C127)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。以下に研究の要旨を示す。

1. レキの被覆率が粗度長や飛砂のフラックスに与える影響について、乱流発生装置を備えた簡易風洞とピエゾエレクトリック飛砂計測器を併用して観測を行った。被覆率が 5%から 15%の範囲では、粗度長は被覆率の増加とともに大きくなった。しかしながら、20%以上になると粗度長の値は 0%のときの値に近くなった。風速が弱い場合 (6 m/s)、飛砂は被覆率が 15%以上になると完全に捕捉された。しかしながら、風速が 8 m/s~9 m/s の場合、被覆率の影響は少なくなり、風速が 10 m/s になると被覆率の効果はなくなった。被覆率が 5%~15%のとき、粗度長の増加は高さ 8 cm 以上の飛砂の減少に対応した。しかしながら、高さ 8 cm における飛砂量の増加は、被覆率が 20%~30%の範囲における粗度長の減少に対応していた。要因として、被覆率が大きくなると空気力学的な滑らかさが表面に形成されることが考えられた。
(Liu, J. and Kimura, R., 2018: Wind speed characteristics and blown sand flux over a gravel surface in a compact wind tunnel. *Aeolian Research*, 35, 39-46).

2. GCOM-C 衛星にマウントされている SGLI センサーによって取得された可視画像および放射温度を用いて SbAI (Satellite based Aridity Index)を計算することを試みた。従来の MODIS に比べて、解像度が格段に向上しており、細かな精度で乾燥地における干ばつや荒廃の状況が監視できることが示唆された。
(Kimura, R. and Moriyama, M., 2019: Development of global desertification map. The Joint PI Meeting of JAXA Earth Observation Missions FY2018, Tokyo, Japan)



Comparison of roughness length (right axis) and blown sand flux (left axis) at 8 cm height at seven different gravel coverages.

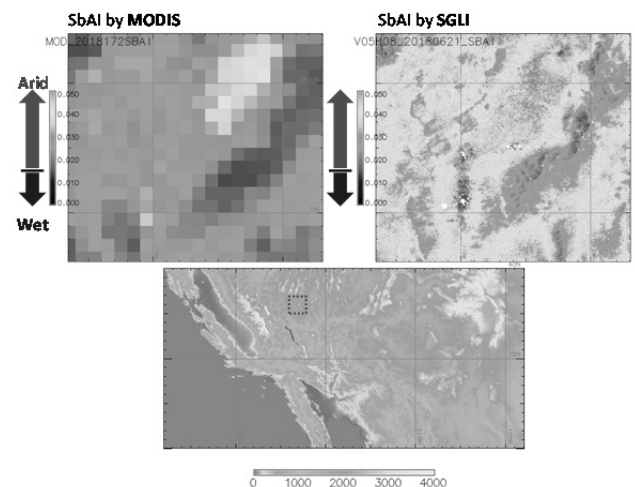
Reiji Kimura (Assoc. Prof., Meteorology)

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 (KAKENHI 17H04634, 17H01626, 18K05877), and JAXA Global Observation Mission (RA1C127), especially in China, Mongolia, and Egypt. I obtained results from following researches:

1. Liu and Kimura (2018) investigated the influence of gravel coverage on roughness length and blown sand flux in a compact wind tunnel equipped with a turbulence generator and a piezoelectric blown sand meter. At gravel coverages from 5% to 15%, roughness length increased with increasing coverage. However, at coverages of 20% or greater, roughness length reverted to its value at 0% coverage. At the lowest wind speed of 6m/s, blown sand was fully trapped at gravel coverages of 15% or greater; however, coverage affected sand flux little at wind speeds of 8 and 9m/s and had no effect at a wind speed of 10ms⁻¹. The increase in roughness length with gravel coverages from 5% to 15% corresponded to a decreased blown sand flux at heights less than 8 cm. However, at 8 cm height, a greatly decreased roughness length at higher gravel coverages (20%–30%) corresponded to a notable increase in blown sand flux, a change we attribute to aerodynamic smoothing.
(Liu, J. and Kimura, R., 2018: Wind speed characteristics and blown sand flux over a gravel surface in a compact wind tunnel. *Aeolian Research*, 35, 39-46).
2. Calculation of SbAI (Satellite based Aridity Index) was examined using the data of visible band and radiative temperature obtained by SGLI mounted on GCOM-C satellite. Its resolution was improved considerably compared to those of MODIS.

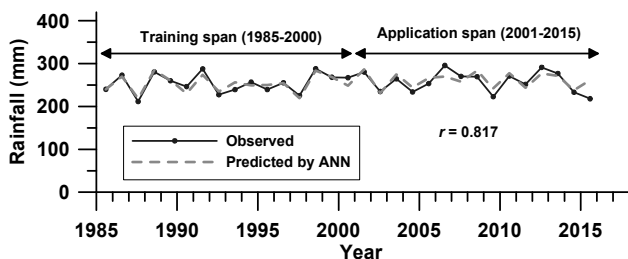


Comparison of SbAIs between MODIS and SGLI in Nevada, U.S.A.

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た。

1. ミャンマー中部乾燥地域の月平均降雨量分布は、前雨季、後雨季のダブルピークを示す。それぞれの雨季降雨量の経年時系列は全球海面温度(SST)とリンクを持ち、数ヶ月前の SST と雨季降雨量の相関は 0.6 以上であった。SST からの雨季降雨量の予測モデルの開発が示唆されている。また、日雨量データから雨季の期間を同定したところ、年ごとの大きな変動が検証された。また、灌漑期の連続干天の出現を得た。現地の農村開発に貢献するために、降雨量予測に基づく最適営農法策定が期待される。
2. 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。
3. 青ナイル源流であるタナ湖の水位の変動を解析し、予測の方法論につき考察した。2-3 ヶ月までの短いラグでは、流域内の降水量、蒸発量などの気象指標と有意な高相関がみられた。数か月のラグでは、遠方の海面温度と有意な高相関がみられた。
4. エチオピア全土の降雨量を解析した。Web data base から得られた降雨量データを用いて、年・月の時系列の基本的特性を掌握した。全球海面温度との相互相関を求めて、いくつかの海域と有意なテレコネクションがあることを明らかとした。

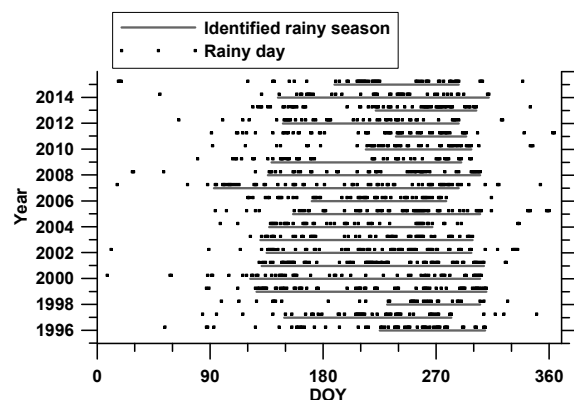


Prediction of the summer rainfall over Lake Tana, the source region of the Blue Nile.

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. 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 Global Sea Surface Temperature (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. Occurrence of sequent dry day was also identified. Planning of the optimum farming is expected.
2. 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 SSTs over the Pacific Ocean several months before. Using the link, prediction of the summer rainfall was performed by the Elman Recurrent Neural Network (NN). Correlation between the observed and predicted value was about 80 %.
3. Water level of Lake Tana, the source region of Blue Nile was analyzed and the methodology of prediction was considered. For short lag up to few months, there are significant strong correlations of the level with the meteorological index such as rainfall and evaporation were shown. For long lag of several months, there are significant strong correlations with far SST.
4. Precipitation all over Ethiopia was analyzed. The basic characteristics of the annual and monthly rainfall time series were clarified using data of the web site. Cross-correlations with global sea surface temperature were obtained and significant teleconnections with some sea regions were shown.



Identification of the rainy season in the central dry zone of Myanmar.

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。

高温耐性の遺伝的機構を明らかにするために、選抜した高温耐性系統に正常系統を交配して、遺伝的に分離する集団を作っている。また、乾燥に対しても耐性になる系統を選抜した。これらの分子生物学的メカニズムを知るために、ストレスを与えた後の植物体をサンプリングし、それが作る代謝物の網羅的解析をしている。これらの研究により、耐性コムギを分子指標によって確実な選抜を可能にする。



Field test of drought stress tolerance at the experimental field of Agricultural Research Corporation, Wad Medani, Sudan

3) Agricultural Production Division

Hisashi Tsujimoto (Prof., Molecular Breeding)

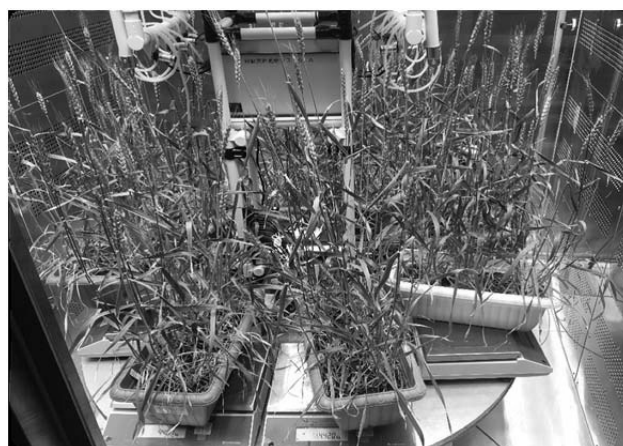
Production of foods for the increasing population under the changing climate is a big challenge for humankind. Development of crop varieties that can grow even under inadequate environments is a reliable solution to this question. We are looking for genes that provide stress-tolerance within the gene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

To know the genetic behavior of heat tolerance, we have crossed the tolerant line and normal line, and are making genetically segregating populations. Also, we have selected drought-tolerant genotypes. To reveal the molecular mechanism of these tolerant lines, we have sampled tissues after stress treatments and analyzed the dynamics of the metabolites in the cells. These studies will be the base for detailed selection of stress tolerant genotype by molecular indicators.



Detailed analysis of stress response using growth chamber in Arid Land Research Center

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ナツメヤシの最適灌水基準サクションの探索」。パレスチナ農業研究所ジェリコ支所内の実験圃場にて灌漑実験を行った。

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。スーダンで小麦を供試作物とする灌漑実験を行った。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) エチオピア SATREPS における「青ナイル川流域の斜面における遮水シートを用いた天水田栽培」

5) 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。

6) 「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 (4回、延べ27日)
2. 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 (3回、延べ18日間)
3. エチオピア SATREPS (2回、延べ12日間)



Experimental rain-fed paddy field in Aba-Grima, Ethiopia

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. “Optimizing trigger suction for automated irrigation system for Date Palm in Palestine”, as an activity under IPDRE, being carried out in Jericho station of National Agricultural Research Center.
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 experiment was carried out using wheat in Sudan. Two dimensional simulation model for determining irrigation depth of drip irrigation, WASH_2D, was applied to the experiment.
4. “Rain-fed rice cultivation using a geo-membrane on a hill site in Blue Nile Basin” as an activity of the SATREPS in Ethiopia.
5. Enhancing water holding capacity using a low permeable layer made from latex as a cooperative research with Sumitomo Rubber Industry. Low permeable layer was formed at the depth of 30 cm in the experimental field of ALRC and soil moisture above the layer was observed.
6. Water and salinity management for a sand-ponics and an upward irrigation system. Irrigation experiments using Tomato were carried out in ALRC.

Overseas research activities during the fiscal year were:

1. visits to Palestine four times for topic 1 and 2.
2. visits to Sudan three times for topic 3
3. visits to Ethiopia topic 4.



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壤環境を調査し、分布の特性から植物と土壤との相関関係を解明する研究も重点的に取り組んでいる。この研究は、砂漠及び砂漠化地域の植生回復に相応しい緑化用樹種・草種の選定、栽培方法の確立などの策定に役立ち、さらに、生態系の環境維持に重要な役割を果たす植物や経済的に価値の高い植物を発見した場合、これらの植物の生態生理特性を解明し、農業利用に適切な栽培技術を開発している。具体的には、以下の課題について進めている。

1. 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、中国科学院遺伝及び発育生物学研究所農業資源研究センターを訪問し、共同研究として中国渤海湾周辺の塩類集積土壌における植生の生理生態調査の結果および塩生植物栽培実験の結果について、現地研究者と検討した。また、同院の西北生態環境資源研究院を訪問し、野生種の塩生植物の人工栽培実験を見学した。中国河北省林業科学院も訪問し、共同研究である乾燥砂地植林に用いられる長根苗の成長に関する生理学的反応を調査した。根の細胞壁の化学性・物理性と植物の耐塩性の関係の解明について、本年度コムギ実験に引き続きホウレンソウと *Suaeda salsa* に関しても実験を行った。

下の写真に調査地の様子を示した。



Halophyte of *Suaeda salsa* grown in saline soils along Bohai Bay in China

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 2018 include a visit to Center for Agricultural Resources Research of the Chinese Academy of Science (CAS). Results of the field investigation of the ecology and physiology of halophytes around Bohai Bay and halophytes cultivation experiments were discussed with local researchers. A visit to Northwest Institute of Eco-Environment and Resources of CAS. Halophytes cultivation conducted by the local researchers were studied. A visit to Hebei Academy of Forestry. Responses of long-root trees used for sandy lands greening were investigated. Studies of the relationship between root physical and chemical characteristics and plant salt tolerance were continually carried out.



Cotton cultivation in saline soils in Nanpi County, China

石井 孝佳 (植物細胞遺伝学)

植物細胞遺伝学分野では以下のような研究を行っている。

(1) ササゲの CENH3 遺伝子改変による半数体誘導系統の作成

(2) CRISPR/Cas9 システムの細胞遺伝学的な応用法の開発

これらの研究は、ライプニッツ植物遺伝学研究所 (アンドレアス・フウベン)・オーストラリア連邦科学産業研究機関 (アンナ・コルツノフ) との共同研究で行われている。

本年度は、特に以下の研究で成果を得た。

1. ササゲ (*Vigna unguiculata*, $2n = 2x = 22$) は、アフリカでは重要なマメ科作物であり、干ばつや熱ストレスに対して強い耐性を持っている。半数体 (倍加半数体) は、植物育種を促進するのに非常に強力な手法である。セントロメア特異的ヒストン H3 (CENH3) の操作によるササゲの半数体生産法を確立する事を目標にした。ササゲは、二倍体ゲノム中に 2 種類の CENH3 をコードしていることが分かった。ササゲ半数体誘導系統の作成のための CENH3 の改変は現在進行中である。
2. CRISPR/Cas9 によるゲノム編集技術を応用することで、核および染色体の任意ゲノム領域を可視化する新しい技術を開発した。RNA-guided endonuclease - *in situ* labelling (RGEN-ISL) 法と命名した。RGEN-ISL 法は、従来から用いられている FISH 法に比べて、ゲノム DNA を変性させる必要がなく、ゲノム構造の時空間的な理解を促進し、染色体生物学の分野における知識を向上させるための有望な新技術となる。RGEN-ISL 法は、植物およびヒトの染色体で有効性が示されており、おそらくすべての生物で利用する事が可能と考えられる。DNA 配列を染色体 (ゲノム) レベルで可視化する一般的な方法としては、過去 30 年間、蛍光 *in situ* ハイブリダイゼーション法 (FISH 法) が幅広く使用されてきた。RGEN-ISL 法は FISH 法、免疫染織法と組み合わせ可能でサンプルの調整法が簡便であり、比較的安い。RGEN-ISL 法は様々な生物種に適応可能であり、細胞生物学の基盤技術になる可能性を秘めている。

本研究成果は New Phytologist に掲載された。



Cowpea cultivation in Arid Land Research Center field in 2018 summer.

Takayoshi Ishii (Junior Assoc. Prof., Plant Cytogenetics)

The Plant Cytogenetics Subdivision conducts research mainly as follows:

(1) Generation of haploid inducer lines with modification of CENH3 gene of cowpea

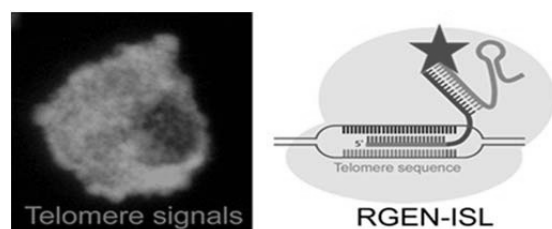
(2) Development of new cytogenetic tool with CRISPR / Cas9 system

The international collaboration project was made possible through a grant to CSIRO (Australia) by the Bill & Melinda Gates Foundation (USA) as well as through funding by the German Research Foundation DFG (Germany).

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

1. Cowpea (*Vigna unguiculata*, $2n=2x=22$) is an important legume crop in Africa, and has a pronounced tolerance to drought and heat stress. Haploids (doubled haploids) are very instrumental to accelerate the plant breeding process. We intend to establish a haploid production method for cowpea via manipulation of the centromere-specific histone H3 (CENH3) variant. Cowpea encodes two types of CENH3s in the diploid genome. Manipulation of cowpea CENH3s is in progress.
2. Development of a new molecular visualization method, RNA-guided endonuclease - *in situ* labelling (RGEN-ISL) for the CRISPR/Cas9-mediated labelling of genomic sequences in nuclei and chromosomes. RGEN-ISL leaves the chromatin intact, as denaturation is not required, and therefore facilitates the investigation of spatio-temporal structure of the sample. RGEN-ISL has been tested in plant and human chromosomes and can likely be utilised in all organisms. For the last 30 years, Fluorescence *in situ* hybridization (FISH) has been the established and commonly used method for visualising *in situ* DNA sequences at chromosomal level. However, this method requires denaturation of the investigated DNA, thus often damaging the structure of the sample. Further experimentation showed that RGEN-ISL outperforms conventional method combinations, such as FISH and immunohistochemistry, requiring less preparation and being comparatively quicker and cheaper. RGEN-ISL method is applicable to various species. Thus, has the potential to be a basic technology of cell biology.

Published in New Phytologist.



The nucleus of cowpea exhibiting telomere-specific signals (in red). The CRISPR/Cas9-based REGN-ISL method was used for the detection of telomeres.

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

Food security in the arid and semi-arid regions is challenged by several environmental stresses such as increases in drought incidents and severity, degrading soil fertility, rising temperatures and diminishing natural resources. Increasing agriculture productivity by developing new superior food crop varieties that can withstand these environmental stresses is the most critical and urgent challenge to maintain food security and the welfare of the expanding population of these regions. Plant genetic engineering and biotechnology are considered as important approaches to improve both the adaptability and productivity of the agricultural food crops.

The Plant Genetic Engineering Subdivision is conducting an in-depth research on:

- (1) Identification and utilization of novel genes that contribute to the plant tolerance and adaptation to unfavorable growth conditions.
- (2) Clarification of the genetic mechanism of the plant's tolerance to major environmental stresses such as drought and salinity.
- (3) Identification of superior crop genetic diversity that could be utilized in crop breeding programs

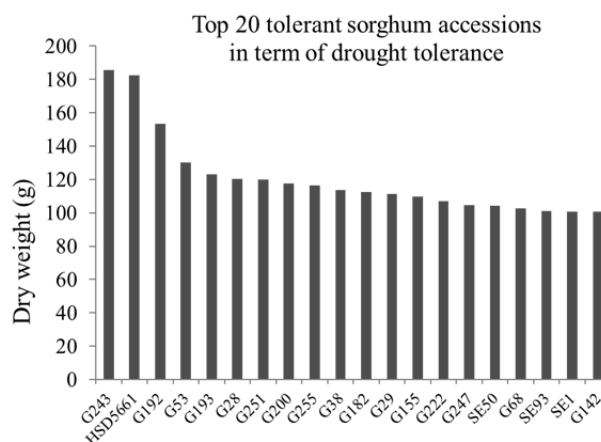
I carry research on important cultivated crops such as sorghum (*Sorghum bicolor*) and rice (*Oryza sativa*), as well as model plants such as Tobacco (*Nicotiana tabacum*) and Arabidopsis (*Arabidopsis thaliana*).

During the fiscal year 2018, data analysis was continued to identify and clarify the responses of large collections of sorghum accessions to low soil fertility and terminal drought stress conditions. These sorghum accessions represent a great genetic diversity that were collected from all sorghum growing regions and various climatic zones. The analyses revealed the highly adaptable accessions, which represent valuable genetic sources to develop highly productive sorghum.

International activities during FY 2018 included scientific exchange visits to the Agricultural Research Corporation of Sudan, and the Ethiopian Institute of Agricultural Research (EIAR), Ethiopia.



Sorghum seedlings and transplantation to sandy beds in the plastic house.



The top 20 superior sorghum genotype that showed high tolerance to drought stress identified from a collection of 192 sorghum accessions.

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

The research activities during April 2018 to March 2019 included the study of wheat tolerance to a combined heat-salinity stress.

In arid and semi-arid regions, huge agricultural lands are affected by salinity, and the influence of salt is aggravated by high temperature. The previous studies considered heat and salinity as isolated stress elements, and to the best of our knowledge, no reports elucidated the wheat response to the combined heat and salinity stress.

Two-hundred forty-seven multiple synthetic derivatives lines were evaluated under a combined heat-salinity stress in Sudan to identify new tolerant wheat germplasm to be used to develop new tolerant wheat cultivars, and to identify QTLs/genes associated with the tolerance to the combined stress.

The genotypes, seasons and their interaction were significant for most of the traits. The heritability of the traits varied from low in chlorophyll content (≤ 0.5), to high (≥ 0.7) in grain yield in the first season and days to heading in the second season.

Tiller number, grain per spike, biomass and harvest index were the most contributing traits to grain yield under the combined stress and could be good selection criteria.

We identified 46 tolerant lines, of which five were stable and could be used as parents in breeding as well as in further studies to uncover the physiological and genetic mechanisms of the combined heat -salinity stress tolerance (Fig. 1).

GWAS was performed using 14356 SNP and silico-DArT markers. The results revealed 146 significant marker-trait associations, out of which, 23 were stable across the seasons (Fig. 2). We identified two heat stress transcription factors putative genes *Traes_2AS_CF07F4EC2* and *Traes_2DS_B6872CB84* on chromosomes 2AS and 2DS, respectively. Incorporation of the favorable alleles identified after validation would improve wheat yield under the combined stress condition.

I had five publications and the overseas activities included two research visits, one to Sudan and another visit to the International Cenetr for Biosaline Agriculture in United Arab Emirates.

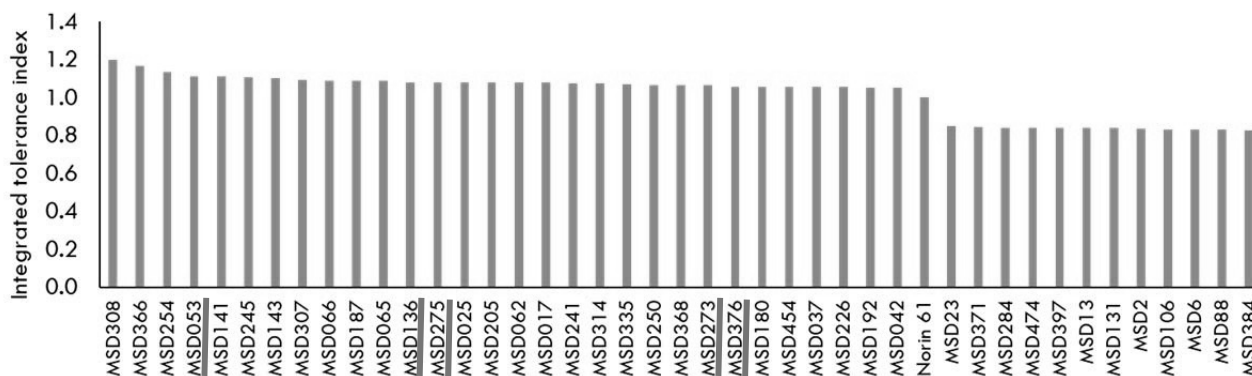


Fig.1 Integrated tolerance index of some multiple synthetic derivatives lines and the parent Norin 61. The stable tolerant lines are underlined.

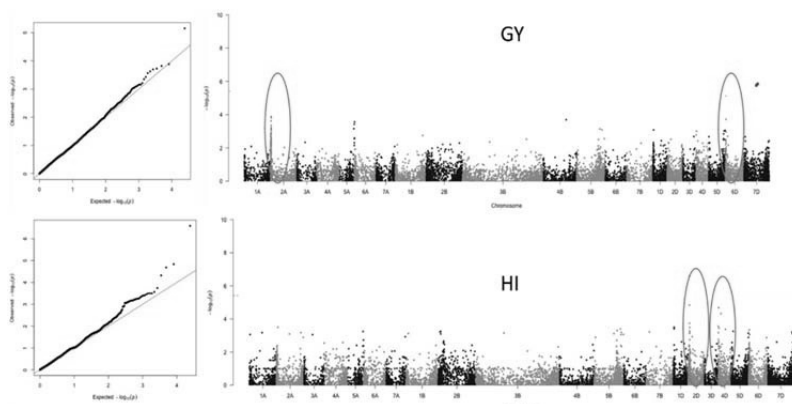


Fig.2 Genome wide association analysis of grain yield (GY) and harvest index (HI) under the combined heat-salinity stress. Significant associations for grain yield in chromosomes 2A and 6D, and harvest index in chromosomes 2D and 4D are circled.



Fig.3 Multiple synthetic derivatives lines growing under the combined heat-salinity stress.

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

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

October 2017 - September 2018

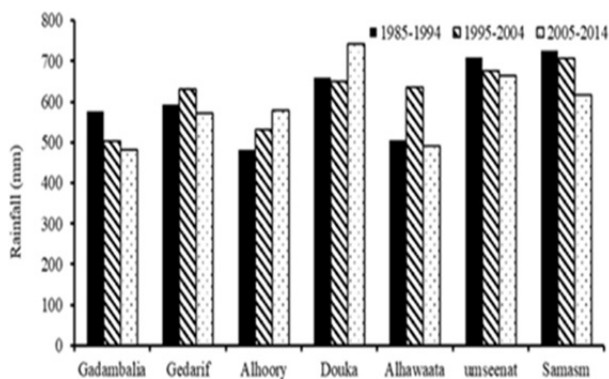
Development of Crop production Scenarios in Sudan under Changing Climate

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.

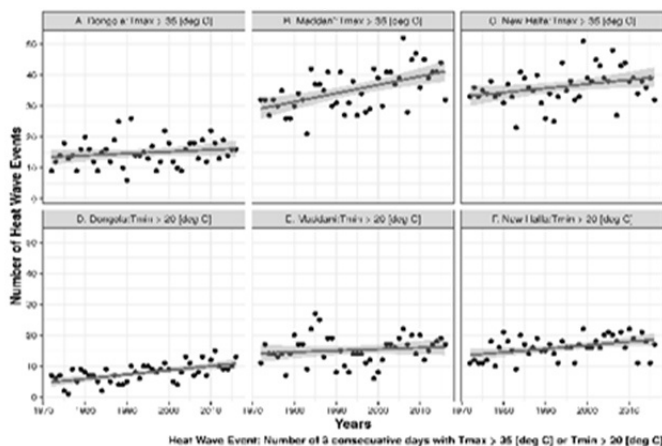


Total annual rainfall (mm) during each ten years (1985 to 2014) at seven stations in Gedarif State

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 Agriculture Research Corporation (ARC). The climate data were quality controlled and cleaned. Checking for homogeneity and consistency were performed and adjusted. Analysis of rainfall and temperature data were performed. Temperatures trends and climatic changes were analyzed. Developed spring wheat yield temperature models for Sudan.



Number of heat wave events for the spring wheat seasonal cycle (Oct. – Mar.)

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

April 2018 - March 2019

- Water use of eggplant as affected by abiotic stresses
- Effective polyacrylamide (PAM) and amendments (gypsum, lime) incorporation to improve soil physical properties and quality, and prevent erosion of vulnerable lands

Water use of eggplant: effect of abiotic stresses (Greenhouse)

- Using controlled sand ponics may have a benefit of controlling 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 and modified new ponics was used.
- Effective approaches considered a) water use efficiency, b) salinity in root zone and leaching fraction, and b) net income. Results was used in macroscopic modelling of crop water use under salinity and drought stresses.

Pot experiment

- Representation of the water use efficiency of eggplant under abiotic stresses in root uptake model is still open.
- The tolerances of eggplant to drought and salinity stresses by means of pot experiment was evaluated using 8 columns: 2-drought stresses, 2-salinity stress and 4- potential transpiration.
- Using the sensors installed in the pot in two depth and daily weight of pots, plant transpiration, soil moisture and electrical conductivity and end root distribution, the parameters of macroscopic root water uptake model were determined.
- Plant water uptake at each depth and time was calculated by including matric and osmotic potentials into the stress response function.

Effect of PAM concentration on structure stability. Land use change, intense cultivation without conservation, and change in rainfall distribution associated by climate change can decline soil quality, water and nutrient use efficiency, and increase erosion leading to land degradation.

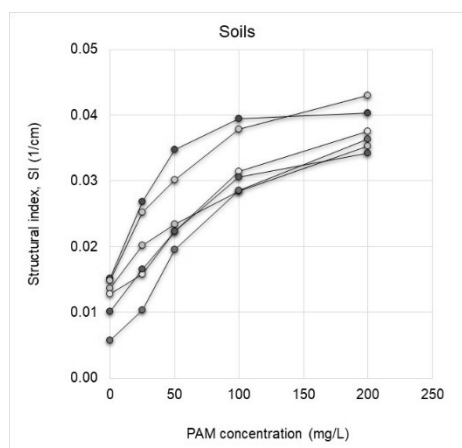


Fig.1 Structural stability (SI) of six soils as affected by PAM concentration

• Limited information is available about the soil physical quality and stability of Ethiopian soils affected by long-term agriculture management nearly without conservation.

• The objective of the study (field & laboratory) was to evaluate the role of soil amendments (e.g. polyacrylamide [PAM], lime, gypsum, biochar, manure) on soil quality and structure stability, and water retention parameters of 15 long-term intensively cultivated soils from 3 Ethiopian watersheds (Dibatie, Guder, Aba Gerima) for assessing soil conservation practices efficacy.

• Results showed that (i) aggregate and structure stability increased exponentially with increase in PAM concentration, (ii) tap water increased soil stability up to 20%, and (iii) increase in stability was soil dependent (Figures 1 and 2).

• Most of soils were sensitive to wetting condition and had lower (SI<0.15) stability due to various breakdown mechanisms, revealing their high susceptible to rill and interrill erosion.

• PAM (25-200 mg/L) treatments improved (2-5 times) the soil water holding and drainage capacity, and hence aggregate or structure stability of soils (SI=0.3-0.5). PAM efficiency was soil type dependent, and various site-specific PAM rate (20-80 kg/ha) could be used before rainfall (when crops are small to cover) to bind the soil against runoff generation and soil erosion (soil particles detachment and transport).

• Filed plot (PAM, amendments) and land use results from 3 watersheds, Ethiopia are under evaluation processes.

Other activities.

- Published 5 papers & submitted 6 papers for publication.
- Contributed to SATREPS project on soil & water conservation.
- Field survey trips to Ethiopia and laboratory experiments.
- Giving top scientist lecture on soil and water conservation and soil quality; Training graduate students from Ethiopia.
- Given 4 seminars: ALRC, Tottori University-2 and Ethiopia, and Tsukuba University.
- Presentation at 3 international and 2 national conferences.
- Scientific committee member of 3 international conferences.
- Reviewed several papers for high impact factor journals.
- Received awards as a top reviewer.

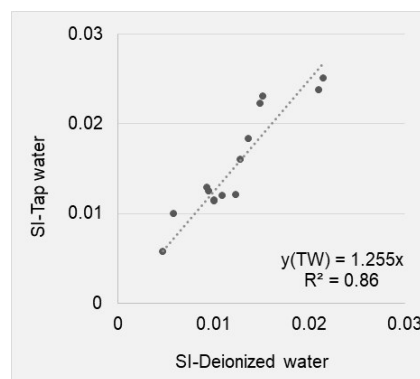


Fig.2 Relation between structure stability (SI) of soils wetted with deionized and tap water.

Muhammad Irshad (Prof., Eco-physiology)

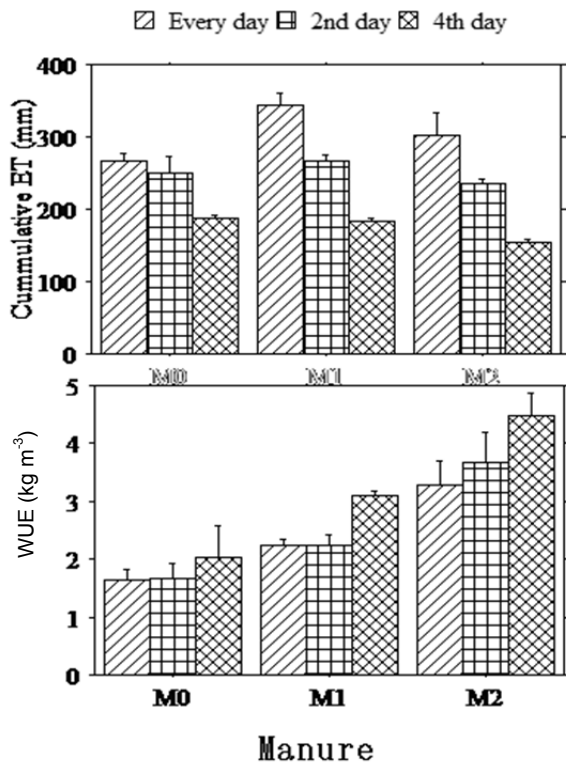
April 2018 - March 2019

Extractability, Bioavailability and Leachability of Plant Nutrients from Sand Dune Soil Applied with Organic Manures under Saline Irrigation Conditions

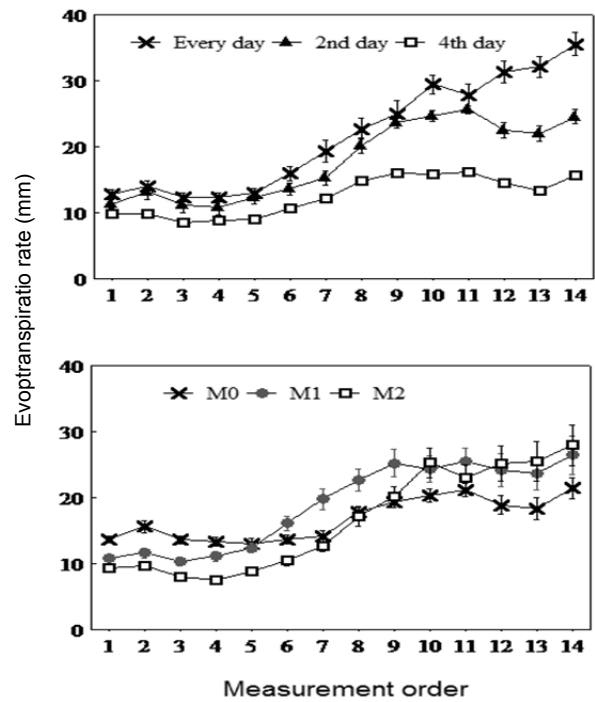
The research titled ‘Extractability, Bioavailability and Leachability of Plant Nutrients from Sand Dune Soil Applied with Organic Manures under Saline Irrigation Conditions’ has been carried out. The research work has been supported by Arid Land Research Center, Tottori city.

1. Irrigation water is the most essential resource for the production of agricultural crops. The efficiency of irrigation water use has been reported lower in the developing countries. The performance of water management system has not been found satisfactory. Organic amendments improve the productivity of soils and the nutritional value of crops. A proper water management using a suitable organic amendment is required for better agricultural production.
2. Studies on the interaction of irrigation scheduling after application of composted manure treatments on the growth and water use efficiency of wheat crop have not been well investigated.

3. This research ascertained the effects of irrigation frequency and application of composted manure on wheat. Irrigation was applied at every day, 2nd day and 4th day, denoted as W1, W2 and W3, respectively. The manure amendment was mixed in the soil at the rate of 10 (M1) and 20 t ha⁻¹ (M2). There was also a control treatment (M0).
4. Irrespective of the manure treatments, the daily irrigation produced higher biomass yield than W2 and W3 irrigation. Application of manure significantly increased biomass yield, irrespective of the application rate.
5. The cumulative evapotranspiration was also increased in M1, whereas in M2 it was similar to M0 in spite of the higher plant biomass.
6. Thus, the manure amended soil saved higher amount of water than control soil. The water use efficiency of crop in manured soil was increased by 42 and 115% than M0.
7. For both evapotranspiration and water use efficiency, irrigation treatments varied as W1 > W2 > W3. Irrigation after longer duration of time apparently decreased the photosynthetic rate, stomatal conductance and transpiration rate. However, plants maintained dark green color in 4 days irrigation.
8. During this research study, shorter irrigation schedule and manure amendments favorably enhanced the crop growth and its water use efficiency.



Manure and irrigation treatments effects on the evapotranspiration and water use efficiency of crop



Effect of irrigation and manure on the evapotranspiration of wheat

Mubarak Abdelrahman Abdalla Ali (Prof., Land Degradation and Restoration)

October 2018 - March 2019

Towards Sand Stabilization by Enhancing Resilience using Different Composts

Sand dunes are known as inert soil freed from any positive characteristics for flora. This is due to: (a) relatively coarse particles and the big pore spaces which result in a low amount of available water to plants; (b) high rate of permeability and leaching which wash away the nutrients necessary for plant growth; and (c) lack of cohesion between the grain particles which increased the erodibility of the sand. Sandy soils have the lowest threshold velocity for erosion of all known soils. Therefore, our objectives were to monitor short-term changes in erosion threshold, erosion rate and quality of a sandy soil after surface application of three sources compost sources. Studies on effects of compost on soil compaction are few.

Rice husk (RH), farm yard manure compost (FYM) and chicken manure compost (CM) were collected from the local market of Tottori city, Japan. Each compost was analyzed for pH_(1:10 dry weight: volume) with de-ionized water and the extract was used to measure the EC, TC and TN after dry combustion, total Na⁺ and K⁺ after digestion with HNO₃ and 30% H₂O₂ using auto-analyzer AA-6800, P, MC and WHC expressed on dry basis and Bd. The particle size of the three composts was generally ranged from 3 to 5 inches. Treatments were compost from CM, FYM and RH applied at the soil surface and at two 1 and 3 cm thickness and a control. An exact of 898 g of sand was added to poly vinyl chloride (PVC) containers (12 cm Ø and 7 cm height) to the exact top of each container (678.2 cm³). In order to add compost on the surface of the soil in each container, a plastic roll was firmly fixed on top of each container. Accordingly, the weight to obtain 1 cm height for CM, FYM and RH were 40.66, 26.25 and 15.65 g whereas for the 3 cm were 121.99, 78.75 and 46.95 g, respectively. Then after, air-dried compost was applied on the surface of the sandy soil. Based on water holding capacity (WHC) of sand and each

compost, distilled water was sprayed on the compost to obtain 75% of WHC for each compost and covered with parafilm wax (prevent moisture loss and air permeable). Each treatment was replicated four times and each replication was repeated six (i.e. six sets) times (7 treatments X 4 replications = 28 X 6 = total of 168 experimental unit). Treatments were arranged in a completely randomized design (CRD) and incubated at the laboratory of Soil Science, Faculty of Agriculture, Tottori University, Japan for 24 weeks. The moisture content was kept at 75% of the WHC by regular weighing (every week) and loss was added in distilled.

After 8, 16 and 24 weeks, the parafilm wax cover was removed from two sets (28 X 2 = 56 experimental unit) and kept in the incubation room for 7 days before transferring to the oven (35°C) for drying. In order not to disturb the soil surface, the compost was carefully removed, inserted in labelled envelopes, oven-dried (75°C) for 48 hrs, the percent remaining weight was calculated, crushed to pass 0.5 mm sieve and analyzed for remaining TC, TN and P. After removal of the compost and to attain stabilization of conditions, all experimental units were kept for 7 days under ambient temperature. One set (28 experimental unit) was used to measure erosion threshold (meter second⁻¹) and rate (gram minute⁻¹). The other undisturbed set was used to determine penetration resistance, surface structure and then after air-dried and used to measure changes in pH, TC, TN and WHC.

Some of measured results showed formation of hard soil surface in the sequence of CM>FYM>RH>C (Figure 1 and 2).

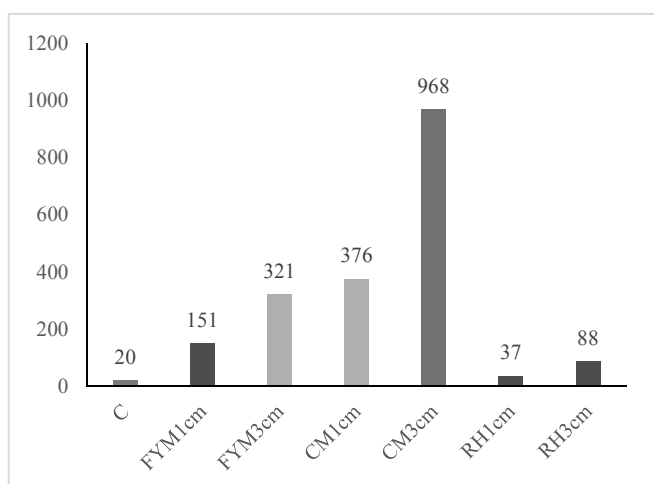


Fig. 1 Penetration resistance (KPa)



Fig. 2 Solid surface with CM

(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、生産性が低いこと貧困度が高く、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。



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 2018, 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.



Evaluation of drought tolerance on sorghum

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。本研究ではこれまでにコムギの ABA 受容体 (TaPYL) の同定、TaPYL を過剰発現したコムギ (TaPYLox) の開発を行い、TaPYLox が「節水型耐乾性」というこれまでになかったタイプの乾燥ストレス耐性を持つことを発見した。本年度は、特に以下の研究で成果を得た。

1. TaPYLox の生理学的解析として、光合成試験を行った。A-Ci 曲線を描くことで、TaPYLox の光合成能を評価するパラメータを計算し、そのうち Rubisco の CO₂ 同化活性の強さを示す V_{max} の値が TaPYLox でコントロール系統よりも高いことを発見した。
2. TaPYLox に似た形質を持つ自然交配系統の探索を行うための方法論の確立を目的として、LC-MS による種々の代謝物の一斉分析の方法を確立し、乾燥応答性代謝物を同定した。

以上の結果から、TaPYLox は ABA への応答性の向上により、Rubisco の活性が向上しており、気孔の開鎖具合だけでなく、分子レベルでも高効率な光合成を行うことが明らかになった。これまでの内容を論文にまとめ、国際学術雑誌「Nature Plants」に掲載された。また、代謝物解析の方法を整備したことで、次年度以降で代謝物をターゲットとした節水型耐乾性系統の選抜を開始予定である。

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. So far, we characterized wheat ABA receptors (TaPYLs) and generated TaPYL overexpressing wheat (TaPYLox). As a result, TaPYLox was validated to possess “water-saving drought tolerance”.

The followings are highlights in this fiscal year.

1. Photosynthetic analysis was performed as one of TaPYLox physiological analysis in order to evaluate photosynthetic activity. Consequently, A-Ci curve indicated that V_{max} of TaPYLox was higher than that of the control line (Fig. 1a). The value means the activity of CO₂ carboxylation in Rubisco.
2. In order to search for the water-saving natural varieties similar to TaPYLox, we attempted to explore metabolites specific for water-saving wheat. We performed LC-MS analysis using wheat leaves extracts under various drought conditions. As a result, several drought responsive metabolites were identified (Fig. 1b).

Our research demonstrated that the carboxylation activity of Rubisco increased following enhanced ABA sensitivity of TaPYLox. This result suggests that TaPYLox could more efficiently photosynthesize even at the molecular level as well as stomatal function. The paper including our findings up to this fiscal year was published in “Nature Plants”, which is one of international scientific journal. Furthermore, we will start to screen water-saving drought tolerant wheat from the next fiscal year based on the target metabolites.

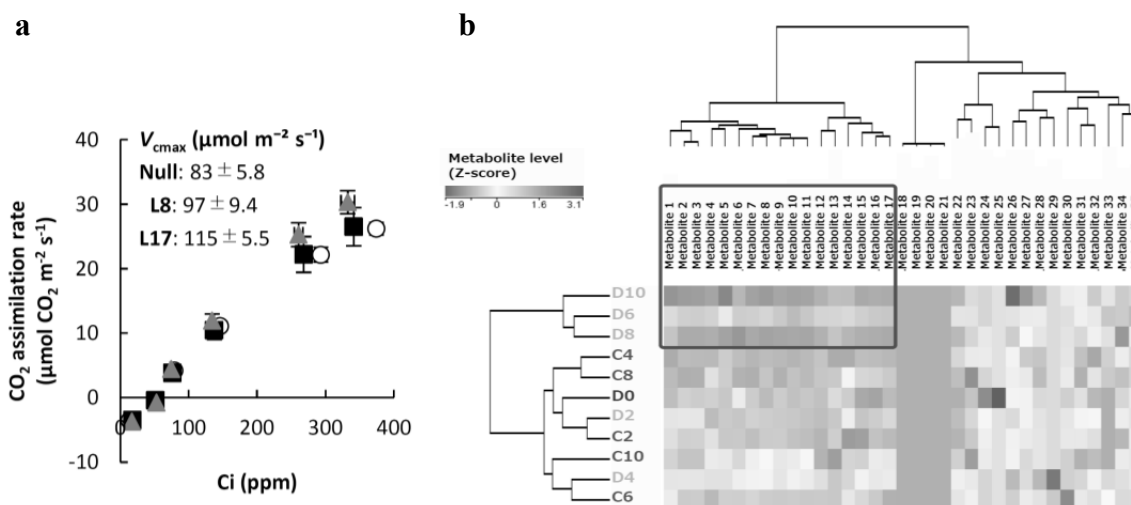


Fig.1 (a) A-Ci curve. V_{max} value was calculated using the fitting model proposed by Sharkey *et al.* (2007) *Plant Cell Environ.* 30, 1035-1040. (b) Heat map of metabolites under various drought condition. The metabolites covered with square were upregulated under strong drought conditions.

劉 佳啓 (環境物理学)

環境物理学分野では以下のような研究を行っている。

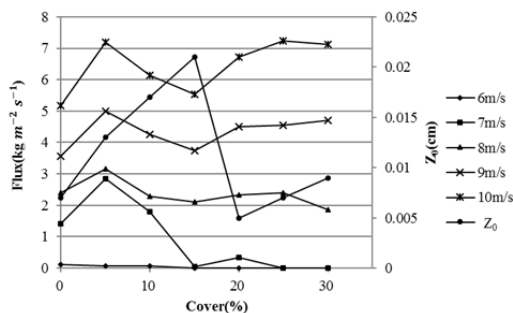
(1) 小型風洞において自然界に近い粗度長を伴う境界層を生成する手法の開発。

(2) レキ面の風速特性と飛砂量の定量評価。

(3) 植生がダストの発生を抑制する物理的メカニズム。

本年度は、特に以下の研究で成果を得た。

1. 簡易な小型風洞,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。
2. レキ被覆率の変化が空気力学的特性や飛砂量に与える影響を比較するとともに、圧電飛砂計で測定した飛砂量分布の特性について検討を行い、ダスト研究で著名な Aeolian Research に掲載された。レキの被覆率による粗度長の増加は、高さ 8cm における飛砂量を減少させる効果がある。また、小さなレキ (粒径 0.005 ~ 0.01m ; ゴビ砂漠のレキの大きさに相当) では、高さ 5cm までの飛砂にしか影響を与えられないことを明らかにした。本結果は、新たな飛砂防止工法の提案または黄砂発生抑止開発へ寄与できる可能性が示唆された。
3. 植物の形状が飛砂量に与える影響を調べるため、植物の概観を模した異なる形の模型 (円柱、円錐、逆円錐台)、小型境界層風洞及び圧電飛砂計を用い、模型の配置密度の変化が飛砂の堆積量に与える影響を調べるとともに、圧電飛砂計で測定した飛砂量分布の特性について検討した。その結果、風に対する粗度物体の面積 (前面面積) が同じでも、前面の形が異なれば飛砂のトラップ効果は変化する。つまり、粗度物体の形によって飛砂のトラップに効果がある被覆率は異なる。円柱形の粗度物体では、被覆率の増加に伴い粗度長は増加するが、ある程度の被覆率になると減少に転じ、ある値に収束する。空気の流れとしては、Isolated roughness flow, Wake interference flow, Skimming flow に対応すると考えられる。堆積量は、Isolated から Wake interference にかけては増加していくが、ある程度堆積すると Skimming に転じ、逆に堆積した砂が飛ばされると考えられる。



Comparison of roughness length and blown sand flux at 8 cm height at seven different gravel.

Jiaqi Liu (Project Researcher, Environmental Physics)

The Environmental physics Subdivision conducts research mainly as follows:

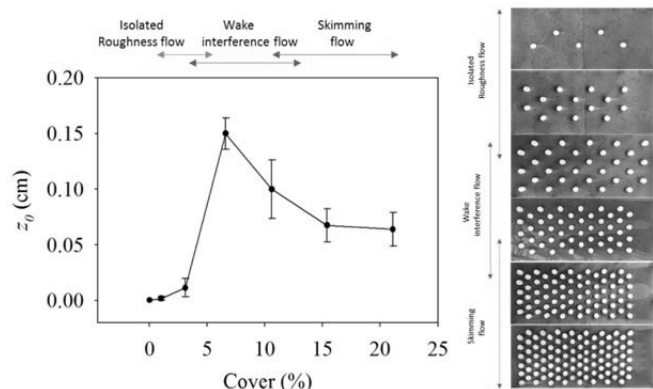
(1) Development of the method to make a boundary layer with roughness length close to the natural condition in the simple type wind tunnel.

(2) Quantitative evaluation of wind speed characteristics and wind-blown sand amount on gravel surface.

(3) To make clear the physical mechanism for preventing the dust outbreak by vegetation.

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

1. We used the turbulence generator (spires and roughness blocks) to create a relatively thick boundary layer in a small-scale open circuit wind tunnel, close to the natural roughness length, uniform horizontal wind speed distribution and stable observation space. And methods and steps to achieve this result are lodged. The results show that, without changing the arrangement and density of the roughness blocks, we tried to modify the shape and number of the spires, and finally achieved this result.
2. Compared the influence of gravel coverage on the aerodynamic characteristics of the experimental wind field and the flux and distribution of blown sand. An increased roughness length that accompanied increased gravel coverage caused the blown sand flux to decrease at a height of 8 cm. The range of influence of gravel coverage was limited to a height of 4 cm by the size of the gravel particles (5–10 mm). These results will contribute to the development of Mongolia dust control.
3. The effect of plant shape on the blown sand flux were examined by applying different shape of plant imitations (cylindrical, cone, inverted truncated cone), and measuring instantaneous change of the blown sand flux. Even if the area of the object against the wind (Windward side area) is the same, the trapping effect of the sand changes if the shape of the windward side is different. As the density of the roughness element array increases, three distinct flow regimes occur around the roughness elements: isolated roughness flow, wake interference flow, and skimming flow. Although the accumulation amount increases from Isolated to Wake interference, when it accumulates to a certain extent, the wake will turn into Skimming, and the accumulated sand will be blown away.



Variations in the average roughness length of cylinder with coverage (left), comparison of wake distributions formed by cylinder roughness elements arrays at a wind speed of 9 m s⁻¹(right).

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。

本年度はツァンバガロ山とタバンボグド自然保護区の 2 か所でサンプリングを実施した。タバンボグド自然保護区はマーキングや足跡などの痕跡が少なく、採集した試料数はこれまで調査した 8 地域の中で最も少なかった。

試料を許可証とともに乾燥地研究センターに輸送し、DNA 抽出、種判定、個体識別を実施した。十分なサンプル数が確保できた 5 地域において、Capture-Recapture 法に基づく密度推定を行った。生息密度はジャルガラント山で最も高く、地域間で大きな差が見られた。要因として、エサである野生草食動物の生息密度や、遊牧民や家畜の密度、生息地の物理的環境要因などが考えられる。生息密度の地域差を説明する要因は分かっておらず、今後の課題である。

昨年度から行っている集団遺伝学構造解析では、これまでの傾向を支持する結果が得られた。地域間の遺伝的分化の程度は低く、明瞭な遺伝的クラスターに分かれることは無かった。中程度の遺伝的多様性が確認され、孤立化による多様性の喪失は深刻ではないことが分かった。生息地間での遺伝子交流は起こっており、今後も生息地間の連結性が維持されることが重要である。



Fecal sampling in Tavan Bogd national park

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 Tsambagarav mountain and Tavan Bogd national park. Density of scrape marking and footprints in Tavan Bogd national park was low, and the number of feces we collected there was lowest among the eight surveyed regions. 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. We estimated the density for five regions in which we collected enough number of samples. Estimated density was highest at Jargalant mountain, and we found large differences in the estimated densities among five regions. The cause for this difference is uncertain, but could be related to density of ungulates, density of herders and livestock, or physical environmental factors.

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.



Tracks of snow leopard in Tsambagarav mountain

山崎 裕司 (分子育種学)

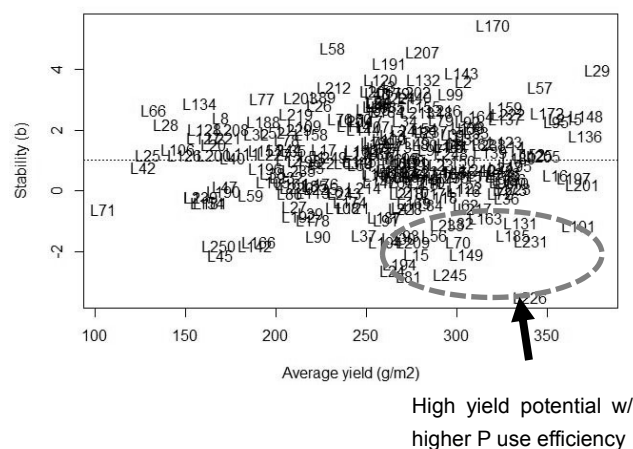
分子育種学分野では以下のような研究を行っている。

- (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）において、未利用遺伝資源を一部に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。平成 30 年度では、2 年目のデータを 8 月に取得し、その後解析を行った結果、スーダンのリン欠乏土壌において、安定的な耐性系統を選抜できた。
2. 耐性系統を人工的に作成したリン欠乏土壌環境で栽培した結果、収量を安定させる特徴的な要因（根、光合成など）を得た。
3. 2 年分の収量・圃場データを用いて、未利用遺伝資源を含んだコムギ系統のリン欠乏土壌に対するモデルを構築した。
4. ゲノムワイド関連解析 (GWAS) により、リン欠乏耐性に関連する遺伝子の染色体の位置を確認することができた
5. 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。



Tolerant selection based on grain yield in Sudan using joint linear regression.

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) Selection and characterization of tolerant line in wheat 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 in the physical year 2018 as my third contract year.

1. We have obtained the screening data in the two consecutive seasons for the multiple synthetic derivatives (MSD) wheat lines containing wild wheat genes under the phosphorus deficiency conditions in Sudan as alkaline soil. From the joint linear regression, the stable tolerant lines under phosphorus deficient condition have been selected based on grain yield.
2. In the growth chamber experiment in ALRC, Japan, the tolerant lines show interesting features relating grain yield such as root morphology and photo synthesis in response to phosphorus deficiency.
3. The predictive model has been created with data in two consecutive seasons in Sudan
4. Genome Wide Association Study (GWAS) described the location of phosphorus deficiency tolerant genes in the chromosome.
5. 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.



Physiological experiments with the tolerant lines to phosphorus deficient condition in the growth chamber in ALRC, Japan.

坂口 巖 (土壌保全学)

平成 30 年度 (4 月-5 月) については、アフリカ乾燥地域 (ICARDA マシューシュ、モロッコ) での、小麦の節水灌漑栽培実験の実施に携わった。

実施状況を、以下に示す。

2017 年 11 月中旬に、モロッコ首都ラバトから南東約 80 km に位置する ICARDA マシューシュの実験圃場で小麦の機械播種 (現地の Durum wheat) および手動播種 (日本の Bread wheat) を行い、点滴灌漑設備およびモニタリングセンサを設置した。実験処理区として、異なる三つの区 (天水区、自動灌漑区、シミュレーション灌漑区) を設け、東西方向に各処理区の反復区を二つ配置した。各区の大きさについては 10 m (東西方向) * 5 m (南北方向) とし、南北方向の半分を Durum wheat および Bread wheat の各々に充てた。Bread wheat については、予め選別された異なる 8 種類を用いた。各灌漑処理区には、8 列の点滴チューブ (チューブ間距離 60 cm、点滴エミッタ間距離 20 cm) を東西方向に設け、4 列を Durum wheat および Bread wheat の各々に充てた。

2018 年 3 月上旬から現地に滞在し、ソフトウェア WASH_2D を用いた数値解析上の土壌水分状況、現地の気象観測データおよび気象予報データに基づいて決定された最適灌漑量での、灌漑実験を開始した。灌漑日については、毎週二回 (月曜・木曜) として固定した。数値解析上の入力パラメタの内、現地土壌の物理特性の同定については予め日本国内で行った。その際の測定方法として、飽和透水係数に変水位法、不飽和透水係数および土壌水分特性曲線に蒸発法、熱伝導率に非定常線熱源法を用いた。また水分特性曲線から、自動灌漑開始の閾値となる水分量を決定した。現地 Durum wheat の生育状況から 2018 年 4 月下旬で灌漑期間を終了し、5 月下旬以降のラマダン終了後に収穫した。



Picture of field experiment at ICARDA, Marchouch, Morocco (25 May 2018).

Iwao Sakaguchi (Project Researcher, Soil Conservation)

Field experiment of the water saving irrigation of wheat was conducted at ICARDA Marchouch, Morocco during Apr.-May 2018.

In mid-Nov. 2017, both of Moroccan Durum wheat and Japanese Bread wheat were sown at the experimental field of the ICARDA marchouch located 80 km away from Rabat to south-east. Drip irrigation system and monitoring devices were also installed. Three different experimental treatments (Rainfed, Automated-irrigation, and Simulated-irrigation) were established. The each treatment had an area of 10 m longitudinal length and 5 m latitudinal width, and had two replicates arranged latitudinally. The each treatment area was latitudinally divided into two area for cultivations of the Durum and Bread wheats. The Bread wheat included 8 different variations selected beforehand. Each of the irrigated-treatments longitudinally had 8 drip tube lines, spacing of approximately 60 cm between the tubes and intervals of 20 cm between emitters on the tube. Half of the 8 drip tubes were used for the Durum and Bread wheats, respectively.

From Mar. 2018, Simulated-irrigation was started, i.e., amount of irrigation water was optimized with observed weather data, weather forecast data, and soil water content condition analyzed by the software WASH_2D. Irrigation interval of the Simulated-irrigation was three or four days a week (every Mon. and Thur.). Some of the input parameters for the WASH_2D, soil physical properties, were measured in advance. As the hydraulic parameters of intact soil, the saturated hydraulic conductivity was measured with falling head method, the unsaturated hydraulic conductivity and soil water characteristic curve were measured with transient-state evaporation method. For the thermal parameter, moisture-adjusted soil samples were packed into container and used for measurement of the thermal conductivity with transient-state line heat source method. The measured soil water characteristic curve was also used to determine threshold for opening solenoid valve of the Automated-irrigation. From growth condition of the Durum wheat, irrigation period was finished in late-Apr. 2018, wheat was harvested in June 2018 after Ramadan period.



Picture of field experiment at ICARDA, Marchouch, Morocco (2 Apr. 2018).

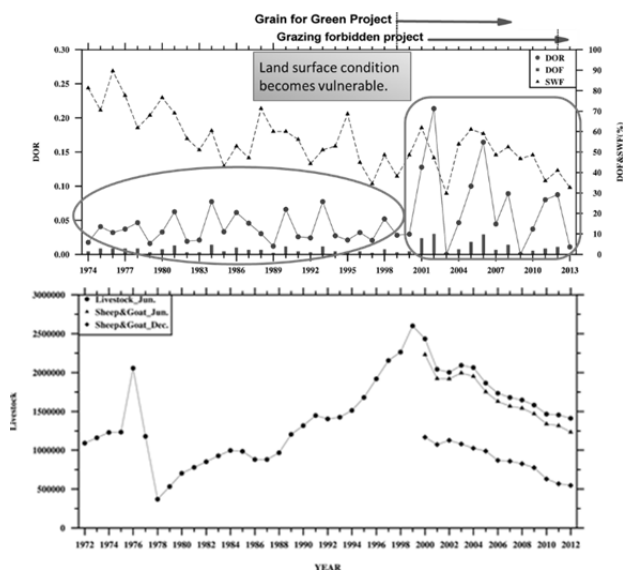
Jing Wu (Project Researcher, Wind Erosion Climatology)

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) Monitoring and assessing aeolian desertification based on a wind erodibility index, and understanding the mechanism(s) of its processes in arid and semi-arid regions.

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

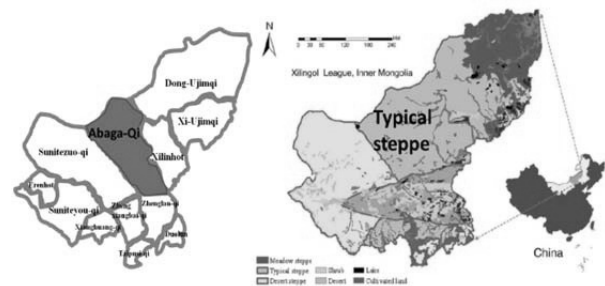
1. Field survey was conducted at Tsogt-Ovoo, which is located in the south Gobi of Mongolia in the early May. I visited the observation site, which was set by Arid Land Research Center, Tottori University. Cooperated with Dr. Suvda of the Institute of Geography and Geocology (IGG), Mongolian Academy of Sciences, we conducted interview to the local citizens about how dust occurrence and grazing activities affect their lives. Meeting with researchers of IGG was held at Ulaanbaatar to discuss joint research in the future.
2. Aeolian desertification is land degradation characterized by wind erosion, which is dependent on erosivity and erodibility. Progressive aeolian desertification causes dust to occur frequently, which has negative impacts on the environment and human health. To effectively prevent the expansion of aeolian desertification, it is crucial to monitor the processes of aeolian desertification and understand its mechanism(s). However, due to its complexity, it is difficult to apply a common indicator for monitoring desertification status.
3. Aeolian desertification was assessed by using an erodibility index as an indicator that reflects the vulnerability of the land surface to wind erosion. The erodibility index (dust occurrence ratio, DOR) was calculated as the ratio of the frequency of dust occurrence to the frequency of strong winds. The status of aeolian desertification was assessed at



Inter-annual variations in DOF, SWF and DOR during the period of 1974–2013, and variations in livestock number from 1972 to 2012 at Abaga-Qi, Inner Mongolia.

one site (Abaga-Qi) in the Xilingol grassland during the period 1974–2013. DOR values during 2001–2013 were notably higher than those in 1974–2000, indicating that land surface conditions became vulnerable to wind erosion in recent years. However, the DOR values trended lower from 2001 to 2013, corresponding to periods in which restoration projects were implemented aimed at combating desertification in China.

4. To understand the mechanism(s) underlying aeolian desertification after the implementation of restoration projects, we conducted multiple regression analysis of climatic variables (precipitation and temperature) and an anthropogenic variable (livestock number) on recent variations (2001–2013) in aeolian desertification. Stepwise multiple regression results indicate that the recent decline in DOR values was associated with abundant precipitation and low temperature during summer of the previous year and a small livestock population at the end of the previous year. Livestock reduction made the greatest contribution. Those results suggest that aeolian desertification can be effectively reversed by reducing the number of livestock in the Xilingol grassland.
5. I attended the Meteorological Society of Japan Spring Meeting 2018 and presented a poster entitled with 「Contributions of Climate and Human Factors to Aeolian Desertification in Xilingol Grassland」 in 18 May.
6. I attended the International Conference on Aeolian Research (ICAR) 2018, which was held in Bordeaux, France during 24-29 June. A poster entitled with 「Contributions of climate change and human activities on aeolian desertification in Xilingol Grassland, Inner Mongolia」 was presented. I also collected information about monitoring dust emission and observation of dry vegetation.
7. We expected an application of the method to evaluate the climatic and anthropogenic effects on aeolian dust and desertification in a wide arid and semi-arid regions. We also expected the results can give suggestions to local people and policy makers for appropriate grassland management.
8. Assessment of aeolian desertification was conducted at Tsogt-Ovoo, Mongolia. However, the parameters of precipitation, temperature and livestock number were not significant to explain the variations in DOR. According to the observation experiences of Prof. Kurosaki, conditions of soil crust and dry dead leaves have strong influence on dust emission. Analysis of dead leaves based on MODIS remote sensing data is on-going at Tsogt-Ovoo.



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

河合 隆行 (地下水水文学)

平成 30 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)

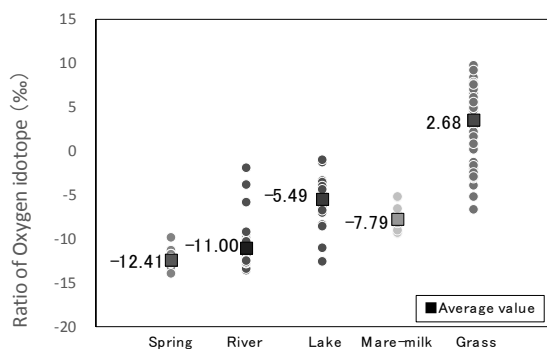
モンゴルの伝統的乳酸発酵飲料である馬乳酒において、その風味を左右する要因を自然環境因子から解析した。平成 27-29 年にかけてサンプリングした、草本の地上部、水 (湧水・川・湖)、馬乳、馬乳酒、ホジル (集積塩) のミネラル濃度を、乾燥地研究センターの Agilent 8900 トリプル四重極 ICP-MS にて分析した。また、ウマの水分摂取源の割合を推定するために、ウマが摂取する水や草本地上部と馬乳の同位体比を、乾燥地研究センターのガスベンチ付き安定同位体比質量分析計にて計測した。

それらの結果、馬乳酒を生産している地域の中でも特に名産地と呼ばれる地域では、他の生産地と比較して①馬乳内の Na 濃度が高いこと、②ウマが体内に取り込む水資源の多くが湧水起源であること、③1 と 2 の結果を踏まえてホジルと低硬度の飲み水が地域に豊富にあることが名産地の条件になりうる、等が明らかになった。

2. 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)

地下水位や地盤構造が既知である砂地地盤において、複数の可視化技術を用いた地下 3 次元構造の解析をおこなった。用いた調査方法は、1. 地下流水音調査法、2. 比抵抗映像法、3. 地中レーダー法 (GPR)、4. 核磁気共鳴法 (NMR) である。このなかで NMR 法は日本国内での初のフィールド実験であった。

これらの調査の結果、一般土壌と比較して粒度の大きい砂地では、地下流水音調査法による地下水面推定は精度が低下すること、反対に GPR 法は砂の均一性のために通常探査の数倍の探査精度があることが判明した。そこで、35MHz を使用して CMP 測定を行い電磁波速度を求めて深度断面を作成した。GPR の深度断面図から、深度 29~30m 付近に地下水面に対応する反射波が連続してみられた。この地下水位の深度は、周囲に存在する井戸の水位計測結果とも整合していた。同時に NMR 法では 1 辺 35m の正方形を 2 つ組み合わせた 8 の字型探査を実施した。その結果、深度 30m 付近に数 m の帯水層があると推定され、GPR とあわせて高精度の帯水層推定が可能となった。



Distribution of oxygen stable isotope ratios

Takayuki Kawai (Project Researcher, Groundwater Hydrology)

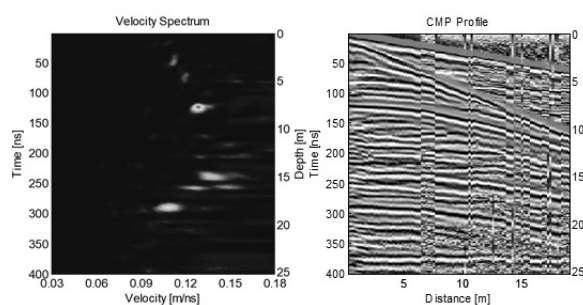
We carried out the following two research subjects in 2018 and obtained results as follows. In addition, we assigned numbers to the issues that were aided by Japan Society of the Promotion of Science Grants.

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

Airag (fermented mare's milk) is Mongolian traditional lactic acid fermented beverage. Factors that influence the flavor of Airag were analyzed from natural environmental factors. Mineral concentrations of herbaceous ground, water (spring, river, lake), horse milk, airag, and hosil (accumulated salt) were analyzed using the Agilent 8900 Triple Quadrupole ICP-MS at the Arid Land Research Center. In order to estimate the ratio of the water intake source of horses, the isotope ratio of the water ingested by horses and the above-ground parts of grass and horse milk were measured with a stable isotope ratio mass spectrometer. As a result, it was clarified that the famous production region that produces airag has the following characteristics compared to other production regions. 1. High Na concentration in horse milk, 2. Many of the water resources that horses intake originate from springs, 3. Abundant hosil and low-hardness drinking water in the area.

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

In the sand ground where the groundwater level and the ground structure are known, the three-dimensional structure was analyzed using multiple visualization techniques. The survey method was as follows. 1. Groundwater-Aeration-Sound (GAS), 2. 2D Resistivity image profiling (2DR), 3. Ground-Penetrating-Radar (GPR), 4. Nuclear Magnetic Resonance (NMR). Among them, the NMR method was the first field experiment in Japan. As a result of these field surveys, the following results were obtained. The accuracy of groundwater level estimation by the GAS survey is lower in sandy soil with a larger particle size. The GPR method has several times the accuracy of normal exploration due to sand uniformity. As a result of CMP measurement using 35 MHz antenna, the reflected wave corresponding to the groundwater level was continuous at a depth of 29-30 m. At the same time, the NMR method estimated that there was a few meters thick aquifer near 30m depth.



Groundwater level and rock mass by GPR_CMP method

Ayele A. Fenta (Project Researcher, Integrated Desertification Control)

The division of Integrated Desertification Control conducts research mainly as follows:

- (1) Improve our understanding of land susceptibility to water and wind erosion risk over the Eastern Africa region through integrated application of field-based observations, high to moderate resolution remotely sensed datasets, spatial analyses tools, and modeling techniques.
- (2) Investigate the spatial patterns and severity of separate and combined water-wind erosion risk over the region.
- (3) Analyze water and wind erosion severity viz-à-viz each country and dominant land cover types in the region.

In this fiscal year, the following are the main extracts of the research findings:

1. We adopted RUSLE model for water erosion assessment (Fig. 1) and validated against observed sediment yield data from 100 watersheds ($r^2 = 0.4$) as well as with plot-scale observations.
2. A wind erosion index has been developed to assess soil erosion risk by wind (Fig. 2) and validated using frequency of dust occurrence observed from SeaWiFS Level-3 daily aerosol optical depth and angstrom exponent data averaged from 2000–2010 with an overall accuracy of 70%.
3. An overlay analysis between the water and wind erosion risk maps has been performed to extract common or separate regions, which allowed identifying respective soil erosion risk zones to prioritize hotspot areas for management planning.
4. Mean annual gross soil loss by water erosion amounts to 4 billion ton, with mean soil loss rate of $6.3 \text{ t ha}^{-1} \text{ yr}^{-1}$, of which about 50% is originating from Ethiopia.
5. Nearly 10% of the Eastern Africa region is experiencing moderate and above ($>10 \text{ t ha}^{-1} \text{ yr}^{-1}$) water erosion risk.

6. Among land use types, ca. 50% of the soil loss by water erosion is originating from cropland which accounts 15% the total area coverage of the study region, with an overall mean soil loss rate of $18.4 \text{ t ha}^{-1} \text{ yr}^{-1}$.
7. Nearly 25% of the study area is under moderate and above wind erosion risk (Fig. 2) (equivalent to frequency of dust occurrence $>45 \text{ days yr}^{-1}$), of which Sudan and Somalia (bare/sparse vegetation cover) take the largest share (ca. 90%).
8. Nearly 8 million ha of the total area is experiencing moderate and above soil erosion risk both by water and wind (Fig. 3).
9. This study helps prioritize regions for water, wind and both water and wind erosion risk zones where further investigations are needed and where remedial actions should be implemented.

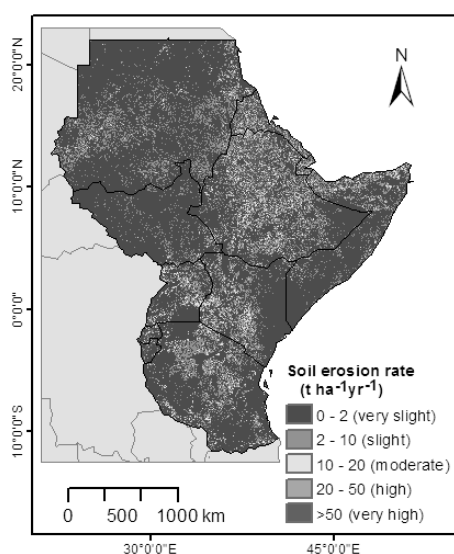


Fig. 1 Spatial distribution of soil loss rates by water erosion

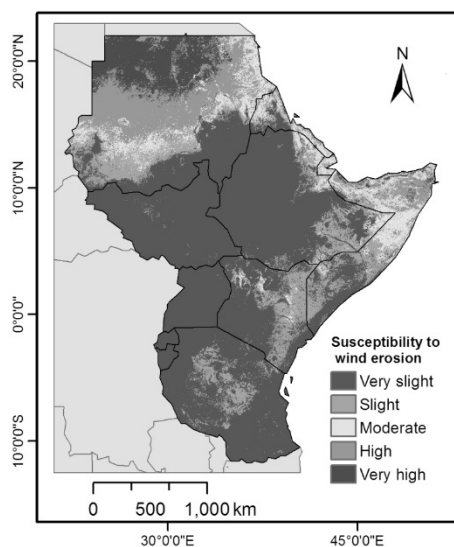


Fig. 2 Index of land susceptibility to wind erosion

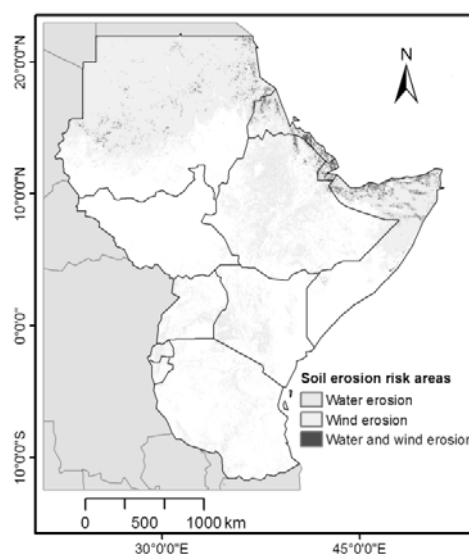


Fig. 3 Moderate and above soil erosion risk areas and dominant erosion process.

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により、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た。（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つのチームで構成した。

● 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とを目標とした。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が本プロジェクトの円滑な実施を可能にした。

最終年度の平成30年度は、開発した耐暑性コムギ系統及び節水灌漑管理の実証を海外共同研究機関の研究者と行った。乾燥地植物資源バンク室においては、植物材料の提供や植物の環境耐性評価を行ったほか、昨年に引き続き、乾燥地の有用植物を紹介した書籍を出版した。また、育種研究グループ及び栽培研究グループは、高温耐性コムギ系統の開発、節水灌漑法の現地適用等を行った。このプロジェクトの成果の一部は、地球規模課題対応国際科学技術協力プログラム（SATREPS）の採択（平成30年5月）に繋がった。

1.2 Research Projects and Training Programs

(1) Project Marginal Region Agriculture

ALRC had 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,” since FY 2015, funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

The challenge of this project was 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 consisted 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 (LALPR)

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 aimed 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 allowed smooth implementation of this project.

In FY 2018, we evaluated the efficiency of the heat-stress wheat lines and water-saving irrigation system with the researchers in the overseas countries. LALPR evaluated the performance of the collection and provided them to the researchers. Also, LALPR published a book about plant resources in dryland. A part of this project became the main body of SATREPS-Sudan accepted in FY 2018.

(2) 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30年度、3件の共同研究（新規課題）が開始した。7月19日、各共同研究課題と各グループのメンバーが集まり、国内会議を実施した。12月2日、スーダンとモンゴルの研究者5名を招き、第2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。2月4日、ハルツームにおいて、ARC、SMA 共催のワークショップ「スーダンに着目した高温地域に於ける気候変動とコムギ生産」を実施した。また、平成31年度共同研究（継続課題）の公募を行い、3件の課題を採択した。

(2) 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 2018, three new subjects of collaborative research started. A domestic meeting was held on July 19th. ALRC held the 2nd International Workshop, inviting five researchers from Sudan and Mongolia. ALRC, ARC and SMA held a workshop “Climate Change and Wheat Production in Hot Regions with Special Focus on Sudan” at Khartoum on February 4th.

(3) 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。

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：

エチオピア連邦民主共和国

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～令和3年度）

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。

平成30年度の主たる成果としては、各小流域のガリ侵食について、1957年、1982年の航空写真および2000年代、2010年代の衛星画像を用いてガリの空間分布マップを作成し、分析した結果、すべての小流域においてガリ侵食が進行していることが明らかになった。その要因として、土地利用変化などが示唆された。さらに、地球観測衛星データを用いて1982年から2017年の土地被覆の変化を分析した結果、長年の土地利用変化が農業生態系の社会経済・環境に密接に関連していることが示された。

(3) 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).

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.

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 since 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. SLM 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 these 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.

As a main result of the fiscal year 2018, we made maps and analyzed the spatial distribution of gully development using 1957, 1982 aerial photographs and satellite images of the 2000s and 2010s to clarify the process of gully erosion of three watersheds. It was found that gully erosion was progressing in all the watersheds. Land use change was attributed as the main factor. Furthermore, analysis of land cover change from 1982 to 2017 using Earth Observation Satellite data showed that long-term land use change is closely related to socioeconomics and environment of the agroecosystem.

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 Researcher	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 Subject	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>We realized one time of field survey on livelihoods and agriculture, mainly at T village in Mandaley region, which is located in dry land at the center of Myanmar.</p> <p>Almost all inhabitants of research target village practice dry land farming, growing beans, groundnut and sesame which are adapted to dry climatic condition. However, their staple food is paddy. Farmers grow crops for buying rice.</p> <p>But this agricultural economic way is declining, because of rainfall variation and situation of international market, especially crops import policy of India which is main importer of agricultural products of Mandaley region.</p> <p>We classify 3 categories farmer according to land owing area; 1st more than 30 acres (large scale), 2nd 10-30 acres (middle scale) and 3rd less than 10 acres (small scale). More over landless people are found in the village.</p> <p>Regarding household economy, income from cropping is not enough at middle and small scale farmers caused by rain shortage and labor cost increasing. These households need to find other complement jobs. Practically, these complement incomes become main source of household revenue. Even large scale farmers sometimes need financial assistance from family member when harvest is not enough.</p> <p>In conclusion, dependence of household economy on off-farm income have increased for the subsistence in T village. The advantage of location of T village is short distance from Bagan town which is animated by tourist industry based on Buddhist ruins. It is recommended to villager's empowerment building for more entrance into tourist industry.</p> <p>Moreover, for revenue improvement from agriculture, groundnut cropping which has high Nitrogen-fixing capacity and high Phosphoric acid absorption should be recommended. And residue of groundnut which provide animal feed should be return to the field as fertilizer.</p> <p>Substitute of groundnut as animal feed, intensive cropping of sorghum and millet is recommended. And introduction of high yield varieties of sorghum and millet is also recommended.</p>	

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 Researcher	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 Subject	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>This joint research was conducted to developmentally continue the joint researches in Loess Plateau in China for combatting desertification cored by Arid Land Research Center, Tottori University and Institute of Soil and Water Conservation, Chinese Academy of Sciences & Ministry of Water Resources initiated since 2002. In the fiscal year of 2018, we sampled the forest soil in Zhifanggou, Goonglushan and Yangshou in Loess Plateau for material cycle analysis and have started the measurements of soil moisture and photosynthetic photon flux density in the two 10 x 50 m plots for control and experiment in the artificial forests of <i>Robinia pseudoacacia</i> in Yangshou to conduct the throughfall reduction experiment. In addition to these field researches, we analyzed the previously measured sap flux data of <i>Quercus liaotungensis</i> and <i>R. pseudacacia</i> and obtained the following results. 1) Sap flux of <i>Q. liaotungensis</i> reached daily peaks earlier than solar radiation and vapor pressure deficit. Under the same soil moisture conditions, trees with larger diameter and sapwood areas had significantly high-</p>	

	er sap flux than those with smaller diameter and sapwood areas. The ratio of daily sap flux per unit vapor pressure deficit under lower soil moisture condition to that under higher soil moisture condition was linearly correlated to sapwood area. These results indicated that wider sapwood of larger diameter class provided a buffer against drought stress. 2) Although <i>Q.liaotungensis</i> and three other major broadleaf trees showed the similar diurnal variation of sap flux, the sap flow of <i>Q.liaotungensis</i> started about one hour earlier than the others and its daily peak was also earlier than the others. Compared with <i>Q.liaotungensis</i> , the other tree species had relatively narrow peaks. 3) Transpiration of <i>R. pseudoacacia</i> trees was suppressed by the throughfall reduction treatment. The responses of transpiration to meteorological factors decreased compared with a pretreatment period or control plot. These results suggest that decrease in precipitation will not only reduce soil moisture, but may cause decreased transpiration, decreased responses to climatic variables, and lowered productivity.
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(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 Researcher	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 Subject	乾燥地の産業用油料作物に関する生産と利用の研究 Study on production and application of industrial oil crops for arid lands	
共同研究要旨 Summary of Joint Research	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 2017. About 4,000 Egyptian good female cuttings, about 1,000 Egyptian seedlings, and seedlings 12 American strains transferred from USDA were cultivated from August 2017 by using drip irrigation with groundwater (salinity 300 ppm). We measured the plant height in November 2018, and found that the average heights were over 50 cm. We will continue the measuring in the next financial year. We examined fruiting in March 2019, and showed that about 60% of the plants had fruits one year and seven months after starting the cultivation. We will examine the seed yield and the oil in the next financial year. We are also doing trial cultivation of the USDA strain at OU (green house), ALRC (house), Miyako Island (open-field), etc. Seeds were obtained from plants at OU and ALRC. Plants at Miyako were damaged by typhoons, but some strains were resistant. We will consider doing open-field cultivation in other places than Miyako. We extracted genomic DNA from leaves of a USDA strain grown at OU, and examined the genomic DNA sequence by PacBio Sequel and NovaSeq 6000. We will generate DNA markers from the sequence data in the next financial year. We examined antioxidant activity in the extract of the jojoba seed cake, and found that it had antioxidant activity at the same level as ascorbic acid. The activity was kept after heat denaturation of the protein. It suggests that the activity was not caused by enzymes in the extract. As for <i>Jatropha</i> , 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 <i>Jatropha</i> 's association analysis. We also applied a patent on proliferation activation of epidermal skin cells by the external agent including jojoba oil.	

重点研究 2 Focused Research 2	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	川田 清和 (筑波大学生命環境系) Kawada, Kiyokazu (Faculty of Life and Environmental Sciences, University of Tsukuba)	
研究課題 Research Subject	バイオマニピュレーションによる半乾燥地の生態系シフトを用いた環境修復 Environmental restoration using ecological shift of semi-arid region by bio-manipulation	
共同研究要旨 Summary of Joint Research	The randomized block design was used for the design of the field survey. Total 16 treatments that com-bined as Control (CT), Plowing (P), Fertilization (F), Sowing (S) and Watering (W) are used as one block, A total of 8 blocks was set. For Plowing, the survey plot dug up to 15 cm from the ground surface and removed plants and stones. For fertilization, 20 cm x 20 cm subplot was placed at the center of the survey plot, and nitrogen and phosphoric acid were each applied at 10 g m ⁻² . Seeds of <i>Stipa krylovii</i> collected from the previous year and stored indoors were used for sowing. 12 seeds were sown	

	<p>in the subplot. The watering was carried out in the subplot for 10 mm of water once a week for 3 weeks. In Sep-tember 2017, June 2018 and September 2018, germination and establishment of sown seeds were confirmed, and recorded the number of leaves, number of tillers and maximum plant height of all germinated individuals.</p> <p>The germination rate of the treated area (S) which only sowed seed was $29.2 \pm 20.4\%$. The germination rate of the plowing treated area (PS, FPS, PSW, FPSW) which was more than 50%. The germination rate of the fertilization treated area without tillage (FS, FSW) were less than 10%. The germination rate of the watering treated area (SW) was $30.2 \pm 24.0\%$, and there was no difference from the S area. In the plowed treatment areas (PS, FPS, PSW, FPSW), more than 50% of individuals one year after sowing survived.</p> <p>The present study suggests that it is possible to make an ecosystem shift possible by cultivating the abandoned cultivation area. It might be possible to return the abandoned cultivation area where the vegetation transition is stagnant to the original grassland species composition by sowing of <i>Stipa krylovii</i>. The once germinated, it has high retention rate in the next year, so the practicability of this method is considered to be high.</p>
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(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 Researcher	鹿島 薫 (九州大学大学院理学研究院) Kashima, Kaoru (Faculty of Science, Kyushu University)	
研究課題 Research Subject	モンゴル・アルタイ山地における湖沼環境と気候・風成塵 (黄砂) の長期的変動 The long-term fluctuations of lake environment, climate and aeolian dusts (KOSA) at Altai Mountain 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 2018, we surveyed at lakes and marshes in the western part of Mongolia, and took diatom samples and drilling cores of lake deposits. The diatoms in the lakes and marshes distributed according to the water environment, especially electric conductivity. In addition to the field survey in Mongolia, we used the drilling cores at Altai Area which were storage at Gottingen University in Germany for our discussions. We stayed at Gottingen University during one and half months and presumed the lake environmental histories using diatom analysis. We made the manuscript of our first result of the lakes to the scientific journal.</p> <p>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.</p>	

一般研究 2 General Research 2	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	石塚 正秀 (香川大学創造工学部) Ishizuka, Masahide (Faculty of Engineering and Design, Kagawa University)	
研究課題 Research Subject	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 fall experiment:</p> <p>Soil crust collapse experiments were carried out using a sand fall instrument. As a result of the experiment, it was found that the mass of the eroded soil tends to decrease as the amount of supplied water increases for any drying time. The relationship between the water supply amount w and the eroded soil mass Mw was calculated as follows,</p>	

$M_w = 1099.4e^{-0.073w}$ <p>Using this relationship, we define an aggregation factor (f_{ag}), which is $M_w = f_{ag}M_0$ due to soil aggregation (M_0 is M when $w = 0$).</p> <p>Finally, the following relational expression was obtained.</p> $f_{ag} = e^{-0.073w}$ <p>Air gun experiment:</p> <p>We developed an air gun that causes particles to collide with the soil surface. The incident angle of the emitted particles (glass beads) and the incident velocity were changed. Fine sand was used for the test body, and the water ratio was 15% which was added to the fine sand. As a result, as the incident angle was larger, the shape of collision mark become rounding. In addition, the following results are obtained 1) The larger the incident angle, the smaller the injection speed against the incident speed, 2) The injection angle is smaller than the incident angle, and 3) The kinetic energy of the incident particles generates new saltation sand particles.</p>
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一般研究 3 General Research 3	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 & Environmental Science, Faculty of Life & 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	<p>Field investigation of parasitic plants</p> <p>In order to clarify the growth characteristics of <i>Cassytha filiformis</i> and alien dodder (<i>Cuscuta</i> sp.), field investigation was carried out at Yaeyama Islands in Feb. 2019 (total itinerary was from Feb. 24 till Mar. 2). Field examination was conducted in Iriomote, Kohama, Ishigaki, and Yonaguni Islands where those two species were found in the past survey, and additionally in Taketomi Island. Growth of <i>C. filiformis</i> was confirmed in all islands including Taketomi Island. Phenology of this species was much different not only among islands but also within each of the islands. Large amounts of seeds were only collected in Higawa beach in Yonaguni Island and Aiyaru beach in Taketomi Island. The vines were green in color and small amount of flowers were found in most of other growing area. Although non-synchronicity in the phenology of <i>C. filliformis</i> was already reported from the data on the fixed observation points in Iriomote Island (Iwase et al. 2019), further examination on phenology of other chlorophyllous plants is going to be done. On the other hand, alien dodder was found both in Yonaguni and Kohama Islands, but seeds were collected only in Nanta beach in Yonaguni Island. In a previous survey, alien dodder was found to grow into the town area, but it seems to be cleaned already.</p> <p>Identification of alien dodder species</p> <p>Species of alien dodder was identified by the morphology of flowers. Sepals covered corolla deep with non-sharpened apex. Therefore, this was not identified as <i>Cuscuta pentagona</i>, which was recognized to be widely established in Japan, but as closely related species, <i>C. campestris</i>. It seems that further studies were required to assess whether plural species in alien dodder was already established. A scientific paper is going to be prepared after more detailed study is performed.</p>	

一般研究 4 General Research 4	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	中野 智子 (中央大学経済学部) Nakano, Tomoko (Faculty of Economics, Chuo University)	
研究課題 Research Subject	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 x 10 m) at</p>	

	<p>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 have been stored since May 2016. In August 2018, GPS-loggers were attached to horses and sheep to monitor their tracks.</p> <p>The results indicated that more livestock were photographed at BN than at BU during the observation period from May 2016 to August 2018, suggesting that the grazing pressure was stronger at BN than at BU. We also found that travel distances of horses and sheep were 17.9~19.5 km and 15.8~19.6 km, respectively, and they tended to follow the set routes. The numbers of hours and distances for feeding were 17 hours and 10 km for horses and 15 hours and 8 km for sheep, respectively.</p>
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一般研究 5 General Research 5	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 2018. Four bread wheat varieties (Cham6, SW15, Haruyokoi and Harukirari) were cultivated under well-irrigated and restricted-irrigation conditions. After the ear emergence, further two treatments were imposed, 1) shading on ear photosynthesis, 2) Non-shading on ear photosynthesis. Their drought performances, flag-leaf photosynthesis and canopy photosynthesis were evaluated. The results obtained were below.</p> <ol style="list-style-type: none"> 1. After 18 days after anthesis, the different ear growth rates were observed among the treatments. There was a significant correlation between the canopy photosynthetic rate and yield ($p<0.05$), which indicates that the significant contribution of canopy photosynthesis to grain yield in wheat. And, the significant reductions on canopy photosynthesis by the shading of ears under restricted irrigation. 2. There was no disinfectant decline on the photosynthetic rate of flag leaf by the ear shading and irrigation restriction treatments. However, the significant reduction was observed on the leaf areas of all leaves including the flag leaf, and which could be the reason why the canopy photosynthesis were declined by the irrigation restriction treatment. <p>These results indicate the importance of ear photosynthesis for maintaining the grain yield in wheat, especially under the drought environments where adequate leaf area developments could not be expected.</p>	

一般研究 6 General Research 6	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Researcher	篠田 雅人 (名古屋大学環境学研究所) Shinoda, Masato (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Subject	地中海沿岸地域における干ばつが農業・生態系に及ぼす影響 Drought impacts on agriculture and ecosystems around the Mediterranean Sea	
共同研究要旨 Summary of Joint Research	<p>Drought is among the highest-impact natural hazards over world drylands in a warming climate. Especially, the Mediterranean region including Tunisia is projected to experience most predominant drying trends worldwide. However, a detailed drought study at the regional scale of Tunisia has been limited so far, hampering an assessment of drought impact on the ecosystem and society.</p> <p>This study explores drought frequency, duration, and severity, and its effect on vegetation in three vegetation zones of Tunisia during 1982-2011, taking advantage of various drought indices and identifying the most appropriate one for each zone. Both monthly meteorological (Standardized Precipitation Index, SPI and Standardized Precipitation Evapotranspiration Index, SPEI), and soil moisture (Palmer Drought Severity Index, PDSI and the soil moisture percentiles, Wp) drought indices were used to analyse drought characteristics using gridded-meteorological and ground-measured soil data, and compared to the weekly Normalized Difference Vegetation Index (NDVI) to assess vegetation responses to drought.</p>	

	The results indicated that meteorological droughts account for 42-50 events and soil moisture droughts account for 8-39 events over Tunisia during 1981-2011 and that both showed a high frequency of short-term (1-month) duration and moderate intensity. Short-term meteorological droughts were frequent, triggering soil moisture droughts that were more persistent and severe. Regionally, growing-season (September-March) droughts have slightly increased in the central steppe and southern desert. Comparing the indices, SPI was identified as the best indicator of droughts in the northern forest due to the highest correlations with NDVI, while PDSI in the central steppe and southern desert. The lag correlation analysis revealed that the response of vegetation to droughts is more pronounced and has a longer significant lag in the central steppe. The region-specific indices identified here will provide a very useful measure for drought monitoring and mitigation in Tunisia.
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一般研究 7 General Research 7	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researcher	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 Subject	落葉広葉樹における水分欠乏による耐乾性と耐凍性の類似性の検証 Verification of the affinity of drought and/ or freezing tolerances under water deficit in deciduous broad-leaved trees	
共同研究要旨 Summary of Joint Research	<p>Water freezing in winter brings serious problems on plants. This phenomenon diminishing the amount of liquid water, and the plants are exposed to water-deficit, desiccate-like condition. Trees in cold regions have acquired some abilities to tolerate and/ or to avoid the freeze-induced problems. For example, inland of Asia as Mongolian plains is semi-arid (annual precipitation is less than 250 mm), and cold (winter temperature falls down below -30°C) area. Woody plants surviving in such areas are desired to possess both higher drought- and freeze-tolerant abilities. If woody plants can exploit some drought-tolerant property against water deficit to respond to the lack of liquid water under freezing condition, these plants might increase the potential to survive in wider range of environment.</p> <p>We focus on these drought- and/ or freeze-tolerant (or -avoidant) properties of woody plants, and 1) analyzed micro-structures on the inner wall of vessels using ESEM, 2) measured sap flow and concurrent temperature distribution in the trunk of deciduous broad-leaved trees, 3) analyzed wood structures anatomically with staining treatments. These investigations brought us fragmental but useful results as follows: a) micro-structure of vessel inner wall, especially smoothness and pit distribution, were different with wood traits (ring- or diffuse-porous), b) sap flow fluctuated dynamically and locally in time-series, and temperature distribution around sap flow probes also relevantly fluctuated, c) nevertheless different wood traits, abundant granule-like sugars were accumulated in parenchyma and ray cells around vessel in autumn.</p>	

一般研究 8 General Research 8	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	加納 靖之 (東京大学地震研究所) Kano, Yasuyuki (Earthquake Research Institute, The University of Tokyo)	
研究課題 Research Subject	史料の収集・翻刻・解析による過去の黄砂イベントの復元 Reconstruction of Asian Dust Event Based on Historical Documents	
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>Possible Asian dust events are extracted from “Inpu-nenpyo” and “Gatsudo-kenmonsyu.” “Inpu-nenpyo” is historical record of the Tottori domain. There are plenty of descriptions which possibly represent Asian dust event. “Gatsudo-kenmonsyu” is a journal written in Kyoto. The situation of dusty air for about one month are recorded. The situations can be examined in detail by careful reading of weather records before, during, and after the events.</p>	

一般研究 9 General Research 9	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	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 Subject	長距離輸送される黄砂・PM _{2.5} など大気エアロゾルの観測 Observation of long-range transported atmospheric aerosols such as Kosa and PM _{2.5}	
共同研究要旨 Summary of Joint Research	<p>The size-segregated mass concentration of atmospheric aerosols has been observed by using the PM712 on the roof of the ALRC. So far, we obtained data of PM2.5 and PMc from April 2013 to February 2019. PM2.5 represents particles having diameter of 2.5 μm or less, and PMc represents coarse particles having diameter of 2.5 to 10 μm. Transport of KOSA dusts was not so often during the past several years, including 2018. In addition to mass measurements of size-segregated aerosols, fine and coarse aerosol samples were also collected on a tape filter by the same instrument. We performed chemical analysis of the tape filters for daily or more shorter time intervals depending on aerosol concentrations. During high PM 2.5 concentration without KOSA dust, several events with high nitrate and ammonium concentrations in coarse particles were observed for half day to several days in spring. These events could be important for transboundary transport of N-containing nutrients to Japan. We will conduct further study including chemical analysis of tape filters and interpretation using chemical transport model for the long-range transport to Japan.</p> <p>We developed a new provenance-tracing method using cathodoluminescence (CL) spectral analysis of single quartz grains (Nagashima et al., 2016). CL spectroscopy can detect crystal-chemical features in quartz such as impurities and intrinsic imperfections that depend on the conditions affecting quartz from its formation onward. This new method is useful to distinguish quartz grains from the Gobi and Taklimakan Deserts. This year, we applied the method to sediment trap samples from the Northwestern Pacific and ice core samples from Canada to check whether this method is applicable to detrital samples with extremely small amount.</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 Researcher	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 Subject	砂漠上空に舞い上がるバイオエアロゾルの発生メカニズムとその長距離輸送の解明 Long-range transport of bioaerosols originated from Asian desert areas	
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 Gobi Deserts. High-throughput sequencing targeting 16S rRNA genes (bacterial marker) and internal transcribed spacer regions (fungal marker) showed that many kinds of airborne bacteria and fungi were distributed vertically over the both sampling sites. Furthermore, several kinds of microorganisms have been isolated from the air samples for comparing to the downwind microbial communities.</p> <p>In addition, bioaerosol samples have been collected at Asian-dust source regions (Gobi Desert; Tsogt-Ovoo and Dalanzadgad) and arrival regions (Noto Peninsula, Mt. Tateyama) during the Asian dust event in 2017 and 2018. Microbial strains (80 isolates) could be isolated from the air samples, and were composed of several kinds of bacteria and fungi. The species of the genera <i>Bacillus</i>, <i>Altermaria</i>, and <i>Penicillium</i> were commonly detected from the all sites. 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. Additionally, some isolates were found to have ice-nucleic activities and the Asian-dust particles including microorganism showed high activities of ice nucleation, suggesting that Asian dusts transport ice-nucleic microorganisms influencing on the climate change indirectly.</p>	

一般研究 11 General Research 11	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, 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><i>Elymus tsukushiensis</i> and <i>El. racemifer</i> plants were collected in Tottori City areas. After hard surface sterilization, the plant tissues were placed on a PDA medium and the growing mycelia were subcultured to isolate <i>Epichloë</i> endophytes. Colony and spore morphology of the isolated strains were observed. After decolorizing and aniline blue staining of the leaf sheath or seeds of the collected plants, mycelial growth of the endophytes in the plant tissues was observed under microscope. Endophyte DNAs were extracted from each colony on the plates and rDNA ITS region, β-tubulin gene and TEF 1-α gene were sequenced for phylogenetic analysis. Furthermore, secondary metabolite biosynthesis abilities of the <i>Epichloë</i> spp. were examined by PCR analysis for toxin gene clusters. The <i>dmaW/lpsB</i>, <i>idtG/idtQ</i>, <i>lolC/lolA</i> and <i>perA</i> genes, which are involved in ergot alkaloids, indole-diterpenes, lolines and peramine biosynthesis respectively, were examined by multiplex PCR methods.</p> <p>As results, 44 and 10 endophyte candidate strains were isolated from ca. 100 <i>El. tsukushiensis</i> plants and ca. 30 <i>El. racemifer</i> plants, respectively. Mycelial growth were observed in the leaves and the seeds of those plant tissues. Molecular phylogenetic analysis revealed that all <i>Epichloë</i> spp. isolated from those <i>Elymus</i> plants are <i>E. bromicola</i>. The polymorphisms were observed in the <i>E. bromicola</i> strains based on the rDNA ITS and the TEF1-α gene sequences. There are two genotypes (type A and type B) in the <i>E. bromicola</i> population. The multiplex PCR analysis also revealed that the type A strains have <i>dmaW/lpsB</i> (vertebrate toxin) and <i>perA</i> (insect toxin) genes, while the type B strains have <i>lolC/lolA</i> (insect toxin) and <i>perA</i> genes. The results suggest that a genetic diversity in the secondary metabolite biosynthetic genes exists in the <i>E. bromicola</i> population collected in Tottori.</p>	

一般研究 12 General Research 12	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	田中 裕之 (鳥取大学農学部) Tanaka, Hiroyuki (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	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, following last year, we focused on high-molecular-weight glutenin (HMW-GS), a seed storage protein that greatly affects dough strength, which is a major factor in flour quality. We investigate the genetic diversity of HMW-GS in a population with various chromosomal subregions from <i>Aegilops tauschii</i> introduced via crosses between practical wheat varieties and synthetic hexaploid wheat, comparing with the original HMW-GS of <i>Ae. tauschii</i>.</p> <p>Materials and Methods</p> <p>We used tetraploid (genome formula, AABB) durum wheat cultivar 'Langdon', diploid (DD) wheat ancestral wild type <i>Ae. tauschii</i>, 43 lines obtained by crossing and amphidiploidization of them, and multiple synthetic derivatives (MSD) BC₁F₄ population produced by crossing and backcrossing 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 'Langdon' (Elbashir <i>et al.</i> 2017). Proteins were extracted from the endosperm of three mature seeds of each cultivar/ line and separated by SDS-PAGE to investigate the composition of HMW-GS.</p> <p>Results and Discussion</p> <p>So far, it has been clarified that the gene frequency of <i>Ae. tauschii</i>-derived HMW-GS in the MSD pop-</p>	

	<p>ulation is about 1/4, and there is no selective pressure and self-fertilization up to F₅ generation at the same rate. <i>Ae. tauschii</i>-derived HMW-GS was divided into five types based on molecular weight. In this fiscal year, the frequency of HMW-GS was investigated according to classification for TauL1-3 classified in <i>Ae. tauschii</i> parents of MSD population based on population structural analysis (Matsuoka <i>et al.</i> 2015) by polymorphism of DNA markers. As a result, the largest number of 58 lines were classified into TauL2, and the largest 26 lines among them possess the same type of HMW-GS. Although this HMW-GS is the most abundant type in the MSD population, TauL1 has no lineage to carry. TauL3, which is close to TauL2, was similar to TauL2 in the holding type of HMW-GS. On the other hand, a unique HMW-GS was found in TauL1. Furthermore, the frequency of one HMW-GS that contributes to the improvement of bread-making quality was high.</p>
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一般研究 13 General Research 13		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 stations in the Mongolian Gobi desert.</p> <p>We have conducted a comparison analysis of the Asian-dust-related quantities (dust flux, dust concentration, and ground surface wind velocity) between the estimations of the meso-scale numerical aerosol simulation model (WRF-Chem) and the observations from the Gobi Tsogt-Ovoo dust monitoring stations. It was shown that a local dust concentration is not always correlated well with a local dust flux. In some cases, there is no correlation between dust concentration and flux.</p> <p>Based on the correlation between the global soil dataset “SoilGrids” <i>bedrock probability</i> and the <i>stone coverage</i> observed at seven stations around Mongolian Gobi Tsogt-Ovoo, we globally estimated the distribution of surface stone coverage. The observed percentages of stone coverage were defined by the area ratio of surface stones pictured in-situ at each station. Although we have to carefully handle the applicability of this estimation because it was derived from the information only in the Gobi Desert, we found that high stone-coverage areas are complicatedly distributed in and around the Gobi Desert.</p> <p>Additionally, we calculated dust flux by a simplified model with varying a stone coverage parameter and compared the modeled dust flux with the in-situ observations of the Tsogt-Ovoo station. In the result, it became possible to estimate the impact of the model’s stone coverage presumption on the performance of the model’s dust flux simulation. We can expect that these results will improve the dust flux estimation of 3-D numerical aerosol simulation models.</p>		

一般研究 14 General Research 14		対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	明石 欣也 (鳥取大学農学部) Akashi, Kinya (Faculty of Agriculture, Tottori University)		
研究課題 Research Subject	乾燥地作物の葉面ワックス層の構築メカニズムと環境ストレス耐性との関連 Developmental mechanism of leaf wax layer in arid land crops: Evaluation on the relevance to the environmental stress resistance		
共同研究要旨 Summary of Joint Research	<p>Wax deposition on the surface of plants is suggested to be involved in suppression of water loss, reflection of excessive light, and pest and disease resistance. Characteristics of wax accumulation and light reflection in arid land plants are diverse. For example, wild watermelon responds to drought by expressing a trait that preferentially reflects blue light, while <i>Jatropha</i> shows no noticeable change in the reflection characteristics during drought. In wheat, glaucous is known in which wax particles are deposited on the leaf surface and shows whitish appearance, however detailed mechanism underlying this morphology has been unknown. In this study, using a wheat accession S615 as a genetic back-</p>		

	ground, various NILs in which <i>hw1</i> or <i>hw2</i> expressing a suppressor of wax biosynthesis is introduced, or in which wax synthesis loci <i>w1/w2</i> are mutated, are used for the analysis. As a result, leaf reflection of red light in the <i>w1/w2</i> line decreased by 11% as compared to the S615 control, suggesting that the light reflecting trait was suppressed in this non-glaucous line. In S615 line, higher contents of C28-C30 long-chain fatty acids and C25-C35 alkanes were observed, and the total wax amount showed high level of 1.67 $\mu\text{g mm}^{-2}$. On the other hand, <i>w2</i> strain specifically lacked C30 fatty acid, and the total wax amount was lower. In <i>w1/w2</i> double mutant, the total wax amount showed lowest value of 0.97 $\mu\text{g mm}^{-2}$. Electron microscopy observation showed that <i>w2</i> line is defective in trichome formation on the abaxial side of the leaf, suggesting that <i>w2</i> locus influences not only wax deposition but also tissue developmental pattern in wheat.
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一般研究 15 General Research 15	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	平田 收正 (大阪大学大学院薬学研究科) Hirata, Kazumasa (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	Proline biosynthesis pathway is an important pathway for prokaryotic and eukaryotic cells. Recently, the cross-talk between proline and glutathione biosynthesis pathway is suggested. We previously performed a functional analysis using the recombinant proteins of CrGPR (glutamyl phosphate reductase in <i>Chlamydomonas reinhardtii</i>) and found that, in contrast to GPR from <i>Escherichia coli</i> (EcGPR), CrGPR had much lower inductive activity for γ -EC synthesis. Here, we showed that the γ -EC synthesis is dependent on the properties of GPR proteins but not of GK (gamma-glutamyl kinase) using in vitro ADP assay using the recombinant proteins. We also found that two important amino acid residues on γ -EC synthesis of GPR proteins using the mutagenic analysis. Furthermore, we created the <i>C. reinhardtii</i> transformants expressing CrGPR or codon-modified EcGPR (cEcGPR) for analyzing a physiological function of γ -EC synthesis via GPR. Preliminary experiments suggested the effects of GPR on stress tolerance of <i>C. reinhardtii</i> cells. Our results might provide a molecular basis for bifurcation control of biosynthesis of important stress-related metabolites, proline and glutathione. From here on, we are going to investigate the physiological function of γ -EC synthesis via GPR in detail.	

一般研究 16 General Research 16	対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researcher	坂本 敦 (広島大学大学院理学研究科) Sakamoto, Atsushi (Graduate School of Science, Hiroshima University)	
研究課題 Research Subject	アラントインのプライミング作用による低温馴化と凍結耐性の向上 Enhanced cold acclimation and freezing tolerance mediated by the stress priming effect of allantoin	
共同研究要旨 Summary of Joint Research	Allantoin is a major intermediary metabolite in purine catabolism that accumulates in a wide variety of plants under various stress conditions. Previously, we demonstrated that this metabolite can prime abiotic stress responses in <i>Arabidopsis</i> , at least probably via activation of abscisic acid and jasmonate production, thereby increasing the tolerance of allantoin-accumulating, <i>allantoinase</i> (<i>aln</i>) loss-of-function mutants to drought and osmotic stress. Global gene expression suggested that <i>aln</i> mutants also enhances tolerance to low-temperature stress since expression of several canonical cold-responsive genes were moderately increased in the mutants grown under normal conditions. We therefore examined this possibility and found that cold treatments induced allantoin accumulation in both wild-type and <i>aln</i> mutants, with a greater extent in the latter. Correlated with allantoin levels, <i>aln</i> mutants exhibited less symptoms of cold injury, such as low temperature-induced chlorosis and photoinhibition, when compared to wild-type controls. These results suggest the possible protection in plants by allantoin against cold stress through its stress priming effect.	

一般研究 17 General Research 17	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>In this study, we developed a system to estimate surface soil moisture content using camera modules with low cost. Furthermore, the method to estimate the soil moisture content of 5 mm surface layer from the visible image was examined. The imaging system was a visible/ near infrared/ thermal infrared camera module (Raspberry Pi Camera V2, Raspberry Pi NoIR Camera V2, Lepton 2.0, respectively) and a small computer (Raspberry Pi 3B) for photographing control. As a result of combining small and inexpensive modules, it has become possible to capture almost the same wavelength range at a price (about 500 US\$) less than a tenth of that of a commercially available multispectral camera.</p> <p>It is considered that the water content can be estimated from the reflectance when the water content is less than about 60% using this system. The regression line was obtained for each band, and the surface soil moisture content of the field of horticulture was estimated. The RMSE was 5.8%, 7.9% and 6.7% for the green, red and near infrared bands, respectively. As the cause of the error, it is considered that the actual field has more shadows due to unevenness than the sampled soil, and the reflectance may have been calculated too low. An image taken using this system was used as input layer data of CNN, and machine learning was used for the soil water content as an estimated value for 40 images. From the classified images, when the image is dry (near permanent spot), the visible image with large DN value is uniform, and when the image is wet (near field capacity), the visible image with small DN value is chosen. When the water content was intermediate, the dry and wet areas became mottled, and the form was linked to the soil water content and the image. From the above, it is suggested that it is possible to estimate the soil surface moisture, which is an index of dust generation, from the DN value of the visible camera or the distribution pattern of the dry and wet parts of the soil surface.</p>	

一般研究 18 General Research 18	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	松岡 由浩 (福井県立大学生物資源学部) Matsuoka, Yoshihiro (Department of Bioscience, Fukui Prefectural University)	
研究課題 Research Subject	乾燥地栽培コムギ品種の育成に向けて:重要病害さび病抵抗性合成6倍体コムギのスクリーニング Screening of leaf rust resistance of synthetic hexaploid wheats for use in dryland cultivar breeding	
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 leaf 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. Also, leaf rust resistance of LDN was examined. The resistance was tested at the seedling stage (by inoculation) and under field conditions. We also examined whether the synthetic lines have <i>Lr21</i>, a known leaf rust resistance gene of <i>Ae. tauschii</i>, using a PCR test. At the seedling stage, 11 out of the 55 synthetic lines showed resistance to leaf rust. LDN was susceptible. Under field conditions, nine lines and 10 lines showed stable and relatively stable resistance, respectively. LDN was susceptible under field conditions. In the PCR test, seven lines were found to have the <i>Lr21</i> gene. All but one of the seven lines were resistant at the seedling stage and under field conditions. Interestingly, three lines that stably showed leaf rust resistance under field conditions were negative in the PCR test. All these findings suggest that <i>Ae. Tauschii's</i> leaf rust resistance can be inherited to synthetic hexaploid wheat lines and that <i>Ae. tauschii</i> might have leaf rust resistance genes other than <i>Lr21</i>.</p>	

一般研究 19 General Research 19	対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researcher	永淵 修 (福岡工業大学総合研究機構) Nagafuchi, Osamu (Comprehensive Research Center, Fukuoka Institute of Technology)	
研究課題 Research Subject	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>During 2018 fiscal year, we have mainly conducted the sample and data analysis which were collected until 2017 fiscal year sampling campaigns. For data analysis, we have argued the professor Kanefuji (The Institute of Statistic and Mathematics) in order to support the statistical back up for our analysis. Based on the obtained dataset, we have been submitted the manuscript however, it was rejected. At this moment, it has not been accepted. Now, we are preparing to submit this manuscript to another journal. This manuscript argues the human health risk concern level of groundwater use as a drinking water in Inner Mongolia. Based on the probabilistic risk analysis and Hazard Quotient (HQ) ratio, fluoride and arsenic were the risk concern level components in the groundwater of this area. In order to clarify the risk reducing way, we have conducted scenario risk analysis. We set four scenarios based on the hearing from the nomad which was conducted with folklorist. For scenario analysis, we set the scenarios the nomad drinks not only groundwater but also, river water, and snow water (i.e., they drink boiled snow water in winter). Until 2017, it is not easy to reach Inner Mongolia for us in winter, because of the climate. Therefore, we use the dataset of snow water which was sampled in Japan, alternatively for risk analysis. This means that there exists uncertainty. Luckily this year, we could be able to obtain the snow water sampled from the Inner Mongolia. Part of this analysis has been reported in Arid Land Research Center Tottori University annual meeting and achieve the good presentation award.</p>	

一般研究 20 General Research 20	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	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 Subject	オゾン-水ストレス複合環境が半乾燥灌木種の生長と生理生態に及ぼす影響の解析 Impact analysis of ozone-water combined stress on the growth and eco-physiology of semi-arid shrub species	
共同研究要旨 Summary of Joint Research	<p>In recent years, some simulation results suggested that relatively high concentrations of ozone have spread to semi-arid grasslands in Northeast Asia (Yamaji et al, 2008, J. Geophys. Res., 113). On the other hand, there have been very few studies for the effects of ozone on plants growing in those areas (Shimizu et al, 2005, Phytol, 45), so that impacts of ozone on semi-arid grasslands of Northeast China have not yet been assessed. In the present study, we focused on the major shrub species growing in semi-arid grasslands and examined the mechanism of the combined effects of ozone and water stresses on the dry matter production of those plants from an eco-physiological viewpoint.</p> <p>Seedlings of shrub species (<i>A.halodendron</i> and <i>C.korshinskii</i>) were transplanted in pots (100 mm × 40 cm²) packed with artificial soils close to the soil particle size of Mu Us Sandy Land, and were grown in a greenhouse. Thereafter, seedlings were moved into plant growth cabinets controlled to a semi-arid environment: 14 hours/ 10 hours (light/dark), approximately 1,500 μmol m⁻²s⁻¹ in photon flux density (light), 25/15°C in temperature (light/dark), 50/60% in relative humidity (light/dark). A four-week growth experiment was carried out with/without ozone exposure. Irrigation corresponding to 30, 60, 90 (control) and 120 mm/month were performed every 2-3 days; the average water potential is -15.2, -6.7, -3.1, -2.6 kPa, respectively. Plants were simultaneously exposed to ozone of 0 or 50 ppb (20-100 ppb).</p> <p>Water stress suppressed a dry matter production of <i>A.halodendron</i> remarkably, which was also somewhat reduced by ozone exposure. Leaf senescence was particularly accelerated by water stress; therefore, impact on leaf dry weight was particularly significant when comparing with other plant organs. Similar growth suppression were also observed in <i>C.korshinskii</i>, though the degree of effect on each organ was slightly different compared to <i>A.halodendron</i>. Growth analysis and statistical analysis</p>	

	on these results are currently underway. In the future, we plan to compare the impacts of various shrub species such as <i>Artemisia</i> and <i>Caragana</i> species on dry matter production and analyze the eco-physiological effects to clarify the mechanism of these factors impacts. In order to maintain stable semi-arid grasslands, it is necessary to consider the long-term combined impacts of climate change and air pollution.
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一般研究 21 General Research 21	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	杉本 幸裕 (神戸大学大学院農学研究科) Sugimoto, Yukihiro (Graduate School of Agricultural Science, Kobe University)	
研究課題 Research Subject	アポカロテノイド植物ホルモン着目した根寄生雑草ストライガの生存戦略の解析 Functional analyses of apocarotenoid phytohormones as key factors in adaptability of <i>Striga</i> species to parasitic mode of life	
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. The ABA receptor PYL proteins, in presence of ABA, strongly inhibit activity of PP2C type proteins phosphatases, leading to activation of the downstream component of ABA signaling. We elucidated that ShPP2C1, one of four PP2C from <i>S. hermonthica</i>, was not inhibited by any PYL in the presence of ABA. This result suggest that ShPP2C1 play a role in conferring insensitivity to ABA. To reveal the cause of the lack of inhibition of ShPP2C1 by the ABA receptor, we compared the amino acid sequences of the various PP2Cs. Five amino acid residues neighboring tryptophan concerned with PYL-PP2C interaction were different from those in AtABI1.</p>	

一般研究 22 General Research 22	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) Matsuura, Asana (School of Agriculture, Tokai University)	
研究課題 Research Subject	エチオピアにおける世界最小の雑穀テフの栽培と環境ストレス下の生産性 Cultivation of teff in Ethiopia and productivity of teff under stress environments	
共同研究要旨 Summary of Joint Research	<p>Seedlings of common millet (<i>Panicum miliaceum</i>), browntop millet (<i>Brachiaria ramosa</i>), Japanese millet (<i>Echinochloa utilis</i>), little millet (<i>Panicum sumatrense</i>) and finger millet (<i>Eleusine coracana</i>) were cultivated in hydroponics. Aeration is stopped at 21 days after sowing for the hypoxic treatment whereas aeration continued till harvest of all plants (control treatment). The plants were cultivated for about 2 weeks. The water temperature, pH, EC, and dissolved oxygen content of the culture solution were measured periodically. The plants before and after the hypoxic treatment were collected and their weights were measured after drying. The plant growth rate (PGR) was calculated based on the difference of dry weight of whole plant. At the end of the treatment, the crown roots were collected, and a cross section was made every 10 mm from the root tip to observe the accumulation of lignin and suberin and aerenchyma.</p> <p>The dissolved oxygen concentration in the control was 40% or more of the saturated dissolved oxygen concentration. The dissolved oxygen concentration in the hypoxic treatment decreased significantly to 0% of the saturated dissolved oxygen concentration, and the maximum value was 20% during the cultivation period. As PGR in the hypoxic treatment of browntop millet decreased to 57% of the control, browntop millet was considered to be susceptible to the hypoxic environment. PGR did not decrease in other cereals. It is suggested that browntop millet is susceptible to the hypoxic stress mainly due to the inability to develop aerenchyma in the crown root.</p>	

一般研究 23 General Research 23	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	宮沢 良行 (九州大学キャンパス計画室) Miyazawa, Yoshiyuki (Campus planning office, Kyushu University)	
研究課題 Research Subject	塩水下のオヒルギの環境応答の解明とそのモデル再現 Modeling the gas exchange by <i>Bruguiera gymnorrhiza</i> under changing environments	
共同研究要旨 Summary of Joint Research	<p>Measurements were conducted using seedlings grown with freshwater in ALRC and those in the field in Okinawa. We measured leaf-level data based on instantaneous gas exchange measurements and plant-scale transpiration rates using laboratory-manufactured sap flux sensors. Leaf-level gas exchange rates of seedlings in freshwater treatment was similar to those of temperate deciduous tree species. Sap flux showed diurnal trend without clear reduction or level-off in midday for the avoidance of excessive water loss, suggesting that <i>Bruguiera gymnorrhiza</i> transpired without clear water saving behaviors. Leaf water potential, the driving force for transpiration was at the levels similar to temperate tree species, suggesting the high capacity of <i>Bruguiera gymnorrhiza</i> for rapid growth, although researches showed the phylogenetic constraints on the plant hydraulics, i.e., plant growing under drought or evaporative environments show phenotypes adaptive for the growth in the native habitat. The diurnal trend in sap flux in field-grown saplings under seawater in Okinawa was similar to that in the freshwater treatment but the gas exchange rates were lower. The absence of level-off or reduction in sap flux in field grown saplings were not due to the absence of restriction on transpiration under evaporative environments, but to the restriction of transpiration throughout a day even in less-evaporative morning. We found the leaf-traits and xylem anatomical traits were not phylogenetically constrained and show phenotype suitable for rapid growth and high transpiration rate unless the water availability is strictly limited.</p>	

一般研究 24 General Research 24	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Researcher	齊藤 忠臣 (鳥取大学農学部) Saito, Tadaomi (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	物理センサ群を用いた土壌・植物・大気連続系における物質移動の解明 Clarification of mass transfer in Soil-Plant-Atmosphere-Continuum using physical sensors	
共同研究要旨 Summary of Joint Research	<p>The objective of this study was to clarify water use characteristics of trees and mechanism of water movement/ storage in SPAC (Soil-Plant-Atmosphere-Continuum) through non-distractive monitoring of parameters on water conditions of trees. A field experiment was conducted to monitor stem water potential, water content, electrical conductivity and sap flow using several physical sensors. Three test trees of Japanese pear (<i>Pyrus pyrifolia</i>) (Hosui, Gold Nijisseiki, and Oushuu) in Ootsuka FSC, Tottori university were used in this study. Stem water potential was measured using a stem psychrometer (PSY-1). Stem water content and electrical conductivity were measured by capacitance sensors (GS3). Sap flow was measured by a sap flow sensor (SFM-1). Monitoring of soil water content at different depths using capacitance sensors and monitoring of meteorological 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 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> <p>The results also indicated that these trees changed the water use characteristics before and after leaf fall since Japanese pear is deciduous fruit tree.</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 Researcher	衣笠 利彦 (鳥取大学農学部) Kunugasa, Toshihiko (Faculty of Agriculture, Tottori University)	

研究課題 Research Subject	植物の飛砂耐性におけるクチクラの役割 Role of cuticle in plant tolerance to injury from wind-blown sand
共同研究要旨 Summary of Joint Research	<p>Coastal plants are typical species growing in coastal environment, and one of the features allowing them to establish on coastal environment is suggested to be a tolerance to sand blast. Thicker cuticle on the surface of plant body is suggested as one of the mechanisms causing plant tolerance to sand blast. However, to date, no study has measured cuticle thickness of coastal plants nor demonstrated that their cuticle is thicker than inland species. We measured cuticle thickness of coastal and inland species and discussed their contribution to plant tolerance to sand blast.</p> <p>We collected leaves of 11 coastal species and four inland species. Collected leaves were embedded in resin, and then observed by a fluorescence microscope after sliced. Cuticle thickness was measured by a software, Image J.</p> <p>Coastal species tended to have thicker cuticle than inland species. Thickest cuticle was found in a coastal species, <i>Carex kobomugi</i>, with its thickness 8.0 μm, and thinnest cuticle was observed in an inland species, <i>Oenothera laciniata</i>, with its thickness 2.8 μm. No statistically significant intra-specific variation among habitats was found in cuticles of any species. Our study demonstrated that coastal species tend to have thicker cuticle than inland species. However, it is still unclear whether thicker cuticle is contributing to plant tolerance to sand blast or not, and thus experimental exposure of plant to sand blast is needed to test that contribution.</p>

一般研究 26 General Research 26	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	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 Kumamoto)	
研究課題 Research Subject	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>Growth of <i>Suaeda salsa</i> is improved by application of calcium chloride under high salt (500 mM NaCl) treatment condition. In this study, so as to examine the calcium materials for growth improvement, we investigated effects of different calcium materials addition on growth and absorption of inorganic components in the <i>S. salsa</i> under 500 mM NaCl treatment condition. <i>S. salsa</i> was grown on hydroponic systems in the following conditions; NaCl concentration was 500 mM. As calcium materials, calcium acetate, calcium carbonate, calcium sulfate, calcium chloride, and calcium nitrate is respectively used with each concentration 15 mM. Plant height, flesh and dry weight of <i>S. salsa</i> were measured, and absorption of inorganic components (K, Na, Ca, and Mg) was analyzed using an atomic absorption spectrometer.</p> <p>In application of calcium acetate or calcium carbonate, pH of solutions increased, no growth improvement was observed, and absorption of Ca and K was low compared with other calcium applications. Then, in application of calcium sulfate, calcium chloride, or calcium nitrate, absorption of Ca and K increased and growth improvement was observed. The K/ (Ca + Mg) equivalent ratios of <i>S. salsa</i> were within the range of 1.3-1.7 in all applications, and these ratios were lower than 2.2, at which the risk of developing grass-tetany metabolic disease may increase.</p> <p>These results suggest that the application of calcium materials such as calcium sulfate, calcium chloride, and calcium nitrate is effective for <i>S. salsa</i> cultivation under high salt concentration conditions.</p>	

一般研究 27 General Research 27	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	咏 梅 (中国内モンゴル師範大学地理科学学院) Yong, Mei (College of Geographical Science, Inner Mongolia Normal University)	
研究課題 Research Subject	「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	In 2018, we investigated the Abaga typical grassland and Otindag sandy land in Inner Mongolia, China. To clarify the mechanism of the occurrence of the dust storm, we examined the relationship	

Joint Research	between the land surface vegetation and the occurrence of dust storm in each region. Since 2003, to prevent desertification and dust storms, land-uses have been controlled by the grassland protection law (returning grazing land to grassland). We used process-based ecosystem (DAYCENT) and statistical models as well as dust event observations during March–June 1981–2017 to identify critical land surface factors that control dust emission in Inner Mongolian steppe and desert steppe sites, and estimate the impacts of the controlled land-use law on dust events. Results showed that at both sites, the 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. Among the surface factors, vegetation was a critical dust suppressing factor. Importantly, in the desert steppe, the standing dead grasses had the strongest memory and simultaneous significant correlation with the dust events, while no significant correlations were found in the steppe. This suggests that in the steppe, intensive grazing and mowing resulted in smaller dead grasses and a negligible effect on dust events. Moreover, simulations of dust events under controlled land-use (light grazing) and uncontrolled conditions (heavy grazing and mowing) showed that, the grassland protection law resulted in reduced dust events by about 25% and 15% in the steppe and sandy land, respectively.
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一般研究 28 General Research 28	対応教員 Corresponding Staff	安 萍 An, Ping
研究代表者 Principal Researcher	李 偉強 (理化学研究所環境資源科学研究センター) Li, Weiqiang (Center for sustainable Resource Research, RIKEN)	
研究課題 Research Subject	Effects of overproduced ethylene on the contents of other phytohormones and expression of their key biosynthetic genes	
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 at whole plant level using the ethylene-overproducing mutant ethylene-overproducer 1 (eto1-1). Liquid chromatography-tandem mass chromatography system and quantitative real-time PCR were used to compare the contents of various hormones and expression of the associated biosynthetic genes in the 10-day-old Arabidopsis eto1-1 mutant and wild-type (WT) plants. 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 the transcript level of potential rate-limiting SL biosynthetic gene 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 was associated to the similar expression levels of proposed rate-limiting JA biosynthetic gene. Taken together, our results suggest that ET affects the levels of CK, ABA, auxin, SA, GA, and potentially SL, by influencing their rate-limiting biosynthesis processes.	

一般研究 29 General Research 29	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal 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形態的適応と同化産物配分に関する研究 Studies on morphological adaptability and carbon allocation of reforestation trees under sans burial/exposure condition	
共同研究要旨 Summary of Joint Research	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 study was conducted to identify the environmental factors and the morphological characteristics affecting coppice development under moving sand dune condition.	

	<p>We surveyed root coppice frequency around sand dune and discussed the relationships between root coppice and root depth. We settled research plots around moving sand dune: a) top of moving sand dune; b) mid-slope of sand dune, c) flat area around sand dune. Most root coppice was observed in sand-dune top site, and least root coppice was observed in flat site. Variable selection was made by generalized linear regression model using surface topographic index (slope, surface relief, elevation) 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 surface topography, especially surface relief.</p>
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一般研究 30 General Research 30	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	西原 英治 (鳥取大学農学部) Nishihara, Eiji (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	乾燥地に生育する薬用植物ウラルカンゾウの主根に含まれるグリチルリチン蓄積の促進方法 Promoting method of glycyrrhizin accumulation induced in taproot of licorice (<i>Glycyrrhiza uralensis</i> Fisher) growing on arid land	
共同研究要旨 Summary of Joint Research	<p>This experiment was aimed to determinate the appropriate season to harvest stolon of licorice (<i>Glycyrrhiza uralensis</i> Fisher) in order to use stolon as seedling and to clarify the effects of different basal fertilizer application quantity and planting density on the yield of stolon and root in next year after transplanting. And this experiment was carried out continuously in same field which was used in last year.</p> <p>The seedlings of licorice were transplanted to the field on July 10th, 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 manure pellet (N-P₂O₅-K₂O=2.6-7.1-3.3%) were applied three days before transplanting. The quantity of the poultry manure pellet application assumed it 100, 200, 300 kg/ha with quantity of total 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). Additional fertilizer was never applied in 2018 to remove the effects except basal fertilizer. The investigation was carried out during November 2~8 th.</p> <p>As a result, the yield of stolon was 1.4~2.0 t/ha when poultry manure pellet (total nitrogen: 200~300 kg/ha) was applied and the planting density was 190480 plants/ha. And this yield was 4~8 times increased from 2017. Therefore, stolon should be harvested in next year after transplanting.</p>	

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	舘野 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	中国黄土高原の乾燥傾度に沿った土壌微生物機能群の変化 Changes in microbial community and its functions along a precipitation gradient in Loess Plateau, China	

一般研究 32 General Research 32	対応教員 Corresponding Staff	エルタイプ・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	Objective of this study is to develop new phenotyping methods in the following two experiment: (1) Unmanned aerial vehicle (UAV) remote sensing of sorghum plant height grown in low/ control phosphate conditions. (2) Multi-spectral image analysis of a segregating F ₁ population of kirinso (<i>Phedimus</i>	

	<p><i>sp.</i>). For (1), we evaluated 370 lines cultivated under low/ control phosphate conditions in Arid Land Research Center, Tottori Japan in 2017. We conducted the remotes sensing 29 times in 19 days during the growing season and recorded 11441 images in total. Ortho mosaic and digital surface models were generated and used for measuring plant height. Some traits were manually measured after harvesting. Correlation between replicates within the treatment was high. Correlation between the genotypic values of plant height measured by the remote sensing and the genotypic values of manual measured height was 0.476. Differences in plant height among varieties ($p < 0.001$) and between phosphate conditions ($p < 0.001$) were significant in the remote sensing result. For (2), we evaluated 94 F_1 plants derived from two heterozygous parents. Multi-spectral images of 99 plants in total were acquired by using a multi-spectral camera (EBAJAPAN SIR-X2). Images of 40 plants were acquired twice at different time points to see the influence of lighting conditions. The same plants had different spectral values when they were measured at different time points. The proportion of each spectrum, however, did not change largely between the time points. Principal components of spectra and vegetation indices based on the spectra were calculated. Most of them had similar values among four plants of parent 1 and different values between parent 1 and parent 2. PC1 and PC2 have significant correlation with vegetative indices. In conclusion, the results suggest the new phenotyping methods are useful for measuring plants in a non-destructive manner. Growth of plants can be measured with these methods, because they are high throughput and non-destructive measurements. To increase the precision, further methodological development is necessary especially in UAV remote sensing.</p>
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一般研究 33 General Research 33	対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researcher	片岡 良太 (山梨大学大学院総合研究部生命環境学域) Kataoka, Ryota (Graduate Faculty of Interdisciplinary Research, University of Yamanashi)	
研究課題 Research Subject	耐塩性微生物を用いた耐塩性植物 <i>Mesembryanthemum</i> 属の生育促進—塩類集積土壌のファイトレメディエーションと塩害農地での農業生産性維持を目指して— Growth enhancement of Iceplant using salinity tolerant microorganisms	
共同研究要旨 Summary of Joint Research	<p>Prevalent salinity hinders the plant growth, and efforts for vegetation are limited due to excessive concentration of salts. The microbiome associated with extreme habitats has the potential of inducing stress avoidance, tolerance, and resistance strategies in the host plants for energy requirements. Manipulation of such interactions offers the potential revegetation, and utilization of saline soils, and with the similar objectives, the rhizosphere of common ice-plant was explored for incident bacteria helping the plant grow better. The isolation resulted in 152 isolates, and above 50% isolates were observed tolerant to 513 mM of NaCl, and the two isolates, PR-3 and PR-6, most promising even showed tolerance up to 1250 mM salinity. Both the strains showed indole acetic acid production, and 1-aminocyclopropane-1-carboxylate deaminase activity, but neither of them had nitrogen fixation ability. Phosphorus solubilization, and siderophore production was shown by either of them. Plant growth promoting (PGP) assay showed significant root elongation when compared with control, which was further confirmed by the pot experiment where the above-ground part of the common ice-plant also showed significant growth over control. Concluding, rhizosphere bacteria from the halophyte plant showed different PGP abilities, and thus can be applied for improving the growth of associated plant in saline conditions.</p>	

一般研究 34 General Research 34	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	伊藤 秀臣 (北海道大学大学院理学研究院) Ito, Hidetaka (Faculty of Science, Hokkaido University)	
研究課題 Research Subject	高温活性型トランスポゾンを用いた乾燥耐性植物の作出 Creation of a drought-tolerant plant by a heat-activated transposon	
共同研究要旨 Summary of Joint Research	<p>We analyzed the homology of long terminal repeat (LTR) of heat-activated retrotransposon, ON-SEN-like sequence in beans. We analyzed the public genome sequence and made phylogenetic trees using <i>Aquilegia flabellate</i> as an out-group. Intact full-length ONSEN-like elements were abundant in soybean. To analyze heat-activation of ONSEN-like elements in beans, we analyze the extrachromo-</p>	

	somal DNA of the elements. The result showed that the extrachromosomal DNA was detected in several beans including adzuki and soybean.
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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	花田 耕介 (九州工業大学大学院情報工学研究院) Hanada, Kousuke (Graduate School of Computer Science and Systems Engineering, Kyushu Institute Technology)	
研究課題 Research Subject	複数の環境ストレス耐性を誘導するオオハマニンニク染色体の起源と進化 Origin and evolution of <i>Leymus racemosus</i> inducing multiple abiotic stress tolerance	
共同研究要旨 Summary of Joint Research	<p><i>Leymus racemosus</i> is a wild plant species which has strong adaptability to various environments. Transcriptome analysis in <i>Leymous racemosus</i> was done under multiple environmental conditions using the joint research collaboration with Tokyo University of Agriculture Bioresources Genome Analysis Center. Additionally, wheat lines (Chinese spring) with of A, E, F, H, I, J, K, L, and N chromosomes were generated by Prof. Tsujimoto (Tottori University). After performing transcriptome analysis of these additional chromosome lines, we determined transcribed sequences derived from each chromosome. In these previous studies, gene sequences derived from three pairs of homoeologous chromosomes were obtained. However, despite the fact that almost the same set of gene groups exist in the same homoeologous chromosome, the gene being expressed is expressed only in one homoeologous chromosome, and two homoeologous genes are present. It was revealed that very few genes were simultaneously expressed on both chromosomes. This tendency was significantly lower than the proportion (39-43%) of genes simultaneously expressed in wheat homoeologous chromosomes.</p> <p>Therefore, in the next fiscal year, we will determine the whole genome sequence of <i>Leymous racemosus</i>, and in the homoeologous chromosome, either one of the genes tends to be deficient or to suppress gene expression, and in some cases, it is specific to a specific gene function Find out if it happens. In addition, we aim to clarify differences on the genome scale compared to the tendency of barley.</p>	

一般研究 36 General Research 36	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	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 Subject	中国乾燥地域の緑化植物 <i>Juniperus sabina</i> の通水障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	<p>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 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 confirmed whether recovery of the water transport actually occurs by the dehydration-rehydration treatments and investigated the relations of the hydraulic resistance of pit due to the movement of pit membrane to recovery of water transport function after rewatering in potted plants of <i>Juniperus sabina</i>, dominated coniferous species in semiarid area of China. As a result, two plants with moderate dry intensity tended to recover water transport by rewatering. On the other hand, no recovery was observed in any of the two plants with strong dry intensity. The percentage of water distribution in xylem was relatively high in the two plants in which recovery was observed, while water was hardly distributed in xylem in the two plants in which recovery was not observed. These results suggested that the change of hydraulic resistance due to the movement of pit membrane would cause the decrease and recovery of the water transport function at the stage of moderate dry intensity. On the other hand, at the stage of strong dry intensity, it was thought that the water transport function did not recover after rewatering because the cavitation widespread and the water transport function decreased.</p>	

一般研究 37 General Research 37	対応教員 Corresponding Staff	エルタイプ・アミン Eltayeb Habora Amin
研究代表者 Principal Researcher	三橋 渉 (山形大学農学部) Mitsuhashi, Wataru (Faculty of Agriculture, University of Yamagata)	
研究課題 Research Subject	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	

一般研究 38 General Research 38	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
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>Hormonal analysis could provide physiological information of animals that does not appear in behavioral data. Hormonal analysis using excrement (especially feces) has been conducted since the 1970s in order to find the physiological condition of animals noninvasively. The method has been applied not only to domestic animals and experimental animals but also to zoo animals since around the 1990s, and the development is expected on the research of wildlife. However, since fecal hormones are easily degraded after excretion depending on the animal species, they are applied only in an environment where feces can be stored rapidly.</p> <p>Therefore, we examined the possibility of the hormone extraction method by "field-friendly method" using feces of captive snow leopard. Usually, fecal hormones are extracted after storing feces in the field for a certain period and taking them back to the laboratory. On the other hand, the field-friendly method does not need to store feces in the field site because it extracts hormones when collecting feces. As a result, the concentrations of hormones (estradiol-17β, progesterone and cortisol) in the extract were all highly correlated (over 0.6) with the amounts of hormones extracted by the conventional method.</p> <p>In order to measure hormone concentration at the field site, we tried to develop a simple measurement kit to which immunochromatography was applied. In this study, we focused on cortisol and examined the accuracy of immunochromatography using known standards (3.9-5,000 ng / ml). The concentration was measured by quantifying the color reaction with an immunochromatographic reader. As the result, it has been shown that the concentration could be measured with high accuracy (R² = 0.997).</p>	

一般研究 39 General Research 39	対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	岡本 昌憲 (宇都宮大学バイオサイエンス教育研究センター) Okamoto, Masanori (Center for Bioscience Research and Education, Utsunomiya University)	
研究課題 Research Subject	アブシジン酸の感受性を利用した節水型耐乾性コムギの選抜と分子生理学的解析 Isolation and molecular characterization of water-saving wheat by abscisic acid sensitivity	
共同研究要旨 Summary of Joint Research	<p>Genetic diversity of wheat is poor compared to other major crops, and it is a major barrier to modern wheat breeding. To overcome this defect, Prof. Tsujimoto has been generated wheat multiple synthetic derivatives (MSD) populations, which have variation of D genome from many accessions of <i>Aegilops tauschii</i>. Using this resource, we aimed to isolate water-saving and drought tolerant wheat. So far, approximately 20,000 individual seedlings of MSD have been tested for the sensitivity to the plant hormone abscisic acid (ABA), which is known as a key small molecule for drought tolerant, and we have been isolated ABA-hypersensitive strains. In this fiscal year, 88 strains of ABA-hypersensitive wheat were cultivated in both sand dune field of Tottori University and andosol field of Utsunomiya University, and the score of seed yield per plant was obtained. As the result, there were several strains that yield is not reduced compared to control Norin 61 despite their ABA-hypersensitive traits. Many ABA-hypersensitive strains were derived from primary synthetic 40 wheat line, which is originated</p>	

	KU-2098 accession of <i>Aegilops tauschii</i> . These results indicate that several parts in the D genome of KU-2098 accession might be involved in ABA sensitivity. In the yield experiment using a vinyl house, which can mimic arid land even in Japan, two lines derived from primary synthetic 29 wheat line showed higher yield productivities than control Norin 61 and Cham 6. D genome of these lines was derived from IG126387 accession of <i>Aegilops tauschii</i> . To determine the loci controlling ABA sensitivity in the D genome of KU-2098 and IG126387 accessions, F2 seedlings of Norin 61 and ABA-hypersensitive MDS strains have analyzed by next generation sequencing of DArT company.
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一般研究 40 General Research 40	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	石原 亨 (鳥取大学農学部) Ishihara, Atsushi (Faculty of Agriculture, Tottori University)	
研究課題 Research Subject	ムギ類における誘導性テルペノイドによる生体防御 Defense mechanisms by inducible terpenoids in barley and wheat	
共同研究要旨 Summary of Joint Research	<p>We explored secondary metabolites that are induced by exogenous stresses in barley and wheat. Constitutive secondary metabolites such as hordatines and benxoxazinones have been shown to be involved in the stress responses in barley and wheat, but inducible compounds have not been identified. The aim of this study is the identification of inducible metabolic pathway involved in the responses to the biological and environmental stresses in these plant species.</p> <p>We found that the accumulation of 6 compounds was induced by the infection of the pathogenic fungi <i>Bipolaris sorokinia</i> in barley leaves. Among them, we purified two compounds by column chromatography and preparative HPLC. Both compounds showed ions at <i>m/z</i> 559 on negative ESI mass spectra. On the basis of spectroscopic analysis, we found that they were lyso-galactolipids containing a linolenic acid acyl chain. This is the first finding of the increased accumulation of lyso-galactolipids in plants in response to exogenous stresses. They may act as signal molecules in the induction of stress responses in barley because, lyso-phospholipids have been well characterized as a signal mediator in animal cells.</p> <p>We also analyzed metabolic changes in wheat leaves treated with CuCl₂ solution. The leaves were extracted with 80% methanol and subjected to LC-MS analysis. We detected the increase in the peak area of two compounds. Their molecular weights were determined to be 320 and 304 by ESI mass spectrometry. Further, we measured ¹H- and ¹³C-NMR spectra as well as 2D NMR spectra. Based on the obtained data, we determined their chemical structures as <i>N</i>-cinnamoyl-9-hydroxy-8-oxotryptamine and <i>N</i>-cinnamoyl-8-oxotryptamine. These compounds were new compounds that have not been reported to date. The accumulation of these compounds was also induced by pathogen infection. In addition they showed antimicrobial activity against phytopathogenic fungi. Thus, they were considered to serve as phytoalexins in wheat.</p>	

一般研究 41 General Research 41	対応教員 Corresponding Staff	小林 伸行 Kobayashi, Nobuyuki
研究代表者 Principal Researcher	北川 博史 (岡山大学社会文化科学研究科) Kitagawa, Hirofumi (Graduate School of Humanities and Social Sciences, Okayama University)	
研究課題 Research Subject	乾燥地における廃鉱の商品化と地域再生 Local Reproduction and Commodification of Abandoned Mines in Drylands	
共同研究要旨 Summary of Joint Research	<p>Economic development in arid areas is often limited by the mining industry because of the harshness of their natural environment. Even now, in the arid regions of developing countries, mining development is rapidly progressed in many areas along with the rise in demand for mineral resources.</p> <p>However, if the resources are exhausted, such mines will be abandoned. In the mine settlements and areas located in the abandoned mines and their surroundings, there are many cases where villages and areas themselves are disposed of after the loss of basic industries. In the case of arid lands, it is rare for regions to be regenerated, as the key industries to be replaced are limited, and there is a high possibility that the villages will be disposed of. On the other hand, in dry areas such as Australia and the United States, although there are not many mine settlements and areas abandoned along with waste mines,</p>	

	<p>some of the mining communities are undergoing sustainable development after the mine has been re-furbished.</p> <p>If the processes and mechanisms of regional regeneration in the waste mine settlement of such arid land are clarified, it is possible to develop mining resources for mines and mine settlements and areas that are being developed in a certain way, in a dry place in developing countries, we can provide one hint on advancing sustainable economic development. For that reason, this year we selected Dubai as an advanced case area, studied the regional trends, and tried collecting data. As a result, in order to contribute to regional regeneration and sustainable development in arid regions, it is necessary to engage more stakeholders, to have capital accumulation for economic development and to apply advanced projects.</p>
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(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	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	大西 一成 (聖路加国際大学公衆衛生大学院環境健康科学分野) Onishi, Kazunari (Graduate School of Public Health, Environmental Health, St. Luke's International University)	
研究課題 Research Subject	モンゴルにおける黄砂・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 in Mongolia	
共同研究要旨 Summary of Joint Research	<p>There are concerns about the health effects of Asian dust (mineral dust) originating in arid areas such as the Gobi Desert and the Taklimakan Desert.</p> <p>In this study, we will evaluate the health effects of Asian dust and local air pollution. Especially, we conducted a survey of subjective symptoms in Mongolia population supposed to have high exposure concentration, evaluate the daily environmental status and clarify that cause health effects. Furthermore, the preventive behavior (wear mask, air purifier, go outside) is considered as possible confounders.</p> <p>In cross-border pollution research, it is often cited as a limitation of the research whether the concentration is low concentration and whether it is truly exposed to the aerosol. By conducting this study in high concentration areas, it is expected that the results support the health effects of Asian dust in Japan will be obtained.</p> <p>The survey will be conducted in three seasons: October 2018 (Moderate pollution day), January-February 2019 (Heavy pollution day), and May 2019 (Asian dust season).</p> <p>The number of participants was 50 (Ulaanbaatar) and 70 (Zamynuuud). It is at the stage where the answer data of season 1 and season 2 are complete now, and the survey of season 3 will be continued.</p> <p>Unlike the initial plan, there are few respondents on the web, and most of the participants are conducting paper questionnaire surveys. Therefore, there is a delay in the data input operation.</p> <p>While high exposure is expected in Mongolia compared to Japan, we believe that become an everyday affair of exposure to Asian dust causes differences in subjective symptoms. At the same time, we collect environmental data and continue analysis.</p>	

若手奨励研究 2 Incentive Research by Young Scientists 2	対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	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 Subject	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 stress tolerance in synthetic hexaploid wheat employing NGS strategy	
共同研究要旨 Summary of Joint Research	<p>In this project, I attempted to develop the molecular genetic basis for environmental resilient wheat breeding in the current post-genome era. First, the conventional linkage-based genetic map of wheat was converted to the modern sequence-based physical map. The anchoring process resulted in 4,513 common markers between two maps, and the order of markers was obviously conserved. To evaluate the utility of the converted map, a genome-wide association (GWA) was conducted with traits of flowering date collected from hot and dry fields. I could detect the already reported major genetic locus, with a novel locus, too. Second, I extracted and re-construct the alien genome sequence from the intro-</p>	

gressed wheat accessions with better environmental tolerance. This approach produced hundreds of novel DNA markers to distinguish the chromosomes originated from wheat or the introgression origin *Leymus racemosus*. For the last, I analyzed transcriptomes of transgenic wheat lines of over-expressing the receptor gene of plant hormone abscisic acid (ABA). Since ABA mediates water-depletion signaling in most land plant, the transgenic wheat became more sensitive to surrounding water condition thus consume less water for the equal productivity to the control group. The transcriptome analysis reflected this physiological feature, genes related to water stress already up-regulated in the transgenic wheat even under the satisfied condition, and the stress-responsive induction of those genes was far enhanced compared to the control group. This result support how the transgenic wheat present better performance under drought condition in molecular level. All those achievements have been published in three peer-reviewed scientific journal articles.

若手奨励研究 3 Incentive Research by Young Scientists 3	対応教員 Corresponding Staff	藤巻 晴行 Fujimaki, Haruyuki
研究代表者 Principal Researcher	徳本 家康 (佐賀大学農学部) Tokumoto, Ieyasu (Faculty of Agriculture, Saga University)	
研究課題 Research Subject	乾燥地農業における局所耕うん法の適用性の評価と改良 Improvement and evaluation of the applicability of shaft tillage method for arid land agriculture	
共同研究要旨 Summary of Joint Research	<p>Objectives:</p> <p>For improvement and evaluation of the applicability of the shaft tillage method to arid land agriculture, ① we evaluated root water uptake and downward flow of water through the artificial macropore. and ② root distribution and effect of the shaft tillage method on hydraulic properties of root system were investigated. Additionally, field experiments of shaft tillage method were carried out.</p> <p>Results:</p> <p>a. Root distribution in-and-out of an artificial macropore:</p> <p>Quantitatively, root growth into the artificial macropore was confirmed. Ratio of top-roots and high density roots in the macropore to whole roots was 46%. Although ratio of the high density roots in the macropore to whole roots was 5%, the long-straight roots in the macropore contributed to downward water flow.</p> <p>On the other hand, our finding was that no high density root in the macropore was confirmed in high moisture content of soil. This suggests that the shaft tillage method is most appropriate for arid and semi-arid land agriculture.</p> <p>b. Root water uptake and downward water flow</p> <p>To understand mechanism of root water uptake and water retention for roots having high density in the macropore, pressure heads of soil and the roots were measured. Due to pressure gradients, downward water flow was confirmed. Especially, we found preferential flow through the high density of roots in macropore during irrigation periods.</p> <p>Root water uptake was measured based on water balance. Even if the preferential flow occurred through the high density roots, the amount of water was used as root water uptake from the bottom of the artificial macropore.</p> <p>c. Pre-test of field experiments</p> <p>We worked on pre-test of field experiments to compare plant growth between control and the tillage-method-plots. As a result, pest damage of the control plot was found. At the tillage-method-plot, however, there was no pest damage. To evaluate effects of the different root system on plant productivity, we would need nutrient analysis in the aspect of plant physiology.</p>	

若手奨励研究 4 Incentive Research by Young Scientists 4	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
研究代表者 Principal Researcher	松本 一穂 (琉球大学農学部) Matsumoto, Kazuho (Faculty of Agriculture, University of 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 gymnorhiza</i>) at the mouth of the Okukubi River on Okinawa Island, Japan. Recently, decreases in seedlings and mature trees were found in some plots in this mangrove forest. Takemura <i>et al.</i> (2012) postulated that construction of a dam upstream and subsequent changes in erosion and sediment deposition in the river bed were the cause. In this study, we measured the ecophysiological traits of living mangrove trees in “decline” and “still healthy” (control) plots. The ground height and soil salinity were higher in the decline plot than in the healthy plot. However, there were no significant differences in the maximum photosynthetic ability (maximum electron transfer and carboxylation rates), radial growth, or element contents (Na, N, K, Ca, and Mg) of living mangrove trees in both areas. Moreover, the transpiration rate was significantly greater in the decline plot. As a result, changes in stand environment at this stand did not affect the ecophysiology of the mangrove trees. The wind speed within the canopy was significantly stronger in the decline plot. Therefore, it was suggested that the increase in dead trees in the decline plot was caused by strong wind disturbances, such as typhoons. Construction of a promenade within the stand and the resulting appearance of a canopy gap were thought to be reasons for the effects of the strong winds.
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若手奨励研究 5 Incentive Research by Young Scientists 5	対応教員 Corresponding Staff	山中 典和 Yamanaka, Norikazu
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	We estimated the sheep expenditure energy and nutritious condition of winter sheep in Mongolia. The average expenditure energy for maintenance, grazing, coldness and pregnancy were estimated as 1.58 Mcal, 1.56 Mcal, 2.68 Mcal, 0.41 Mcal/day, respectively, and thereby total energy loss was 6.23 Mcal/day. The actual sheep leptin, albumin and protein in blood were reduced 70.7 %, 54.7 %, 30.0 % after winter season, respectively. Our results showed the significant energy loss and poor nutrient condition of Mongolian sheep through winter.	

若手奨励研究 6 Incentive Research by Young Scientists 6	対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	河合 慶 (名古屋大学環境学研究所) Kawai, Kei (Graduate School of Environmental Studies, Nagoya University)	
研究課題 Research Subject	小型 PM2.5 センサーを用いたゴビ砂漠におけるダスト観測ネットワークの構築 Development of dust observation network in the Gobi Desert using compact PM2.5 sensors	
共同研究要旨 Summary of Joint Research	<p>As planned, we have started test observation of dust concentration using compact PM sensors in the Gobi Desert.</p> <ol style="list-style-type: none"> 1) We decided to use a compact PM sensor produced by SHARP, which can measure dust concentration with all particle size. 2) We tried to use a “Bluetooth Air Quality Monitor (Ratoc System)” that contains the SHARP PM sensor and some meteorological sensors. Test observation of a Ratoc monitor was carried out in Nagoya University in April 2018. The observation result was compared with an optical particle counter (OPC). 3) We have started test observations of Ratoc monitors in the Gobi Desert since April or May 2018. The observation sites are Dalanzadgad and Mandalgobi. We could collect observation results for about one month, which were analyzed and compared with collocated ceilometers (compact lidars). The monitors were able to observe about five dust storms, but then the PM sensors inside were probably contaminated with dust particles. The monitor seems applicable to intensive observation. We suggested making observation instruments using SHARP PM sensors by ourselves. These results were presented at the joint research workshop in Tottori in December 2018. 4) We have developed observation instruments using SHARP PM sensors with micro computers (Arduino) to read and collect data. Since March 2019, we have started test observation of the in- 	

	strument at the ALRC Tsogt-Ovoo observation site, which is located in the Gobi Desert. The observation data will be compared with collocated DustTrak.
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若手奨励研究 7 Incentive Research by Young Scientists 7		対応教員 Corresponding Staff	谷口 武士 Taniguchi, Takeshi
研究代表者 Principal Researcher	赤路 康朗 (国立研究開発法人国立環境研究所生物・生態系環境研究センター) Akaji, Yasuaki (Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies)		
研究課題 Research Subject	マングローブ稚樹の根に共生する内生菌および菌根菌の空間分布と機能の解明 Spatial distributions and roles of root endophyte and mycorrhiza fungi associated with mangrove saplings		
共同研究要旨 Summary of Joint Research	<p>We established six study sites along Siira river in Iriomote island, Japan, and sampled the roots and rhizosphere soils of <i>Rhizophora stylosa</i> and <i>Bruguiera gymnorhiza</i> saplings. The number of root and soil samples were 10 for <i>R. stylosa</i> and 30 for <i>B. gymnorhiza</i>. To evaluate environmental conditions of the saplings, we extracted soil pore water from the soil samples and then measured concentrations of NH4-N, NO3-N, and PO4-P as well as EC (Electric Conductivity). As a result, NH4-N tended to increase with distance from the estuary, while PO4-P and EC were lower in the upstream region than downstream.</p> <p>Also, we extracted genomic DNA from the root and soil samples for identification of endophyte and mycorrhizal fungi, while we isolated endophytic fungi from the root samples, using Gellan Gum and Cornmeal mediums. In addition, to quantify the abundance of endophyte and mycorrhizal fungi, we stained hyphae of fungus in the root samples using Trypan Blue stain solution, after bleaching that using 10% KOH solution. These experiments with regard to fungi were conducted in Arid Land Research Center, Tottori University. Thus, we have done preparation for main analyses in this fiscal year. In the next fiscal year, we will analyze the species composition of endophyte and mycorrhizal fungi associated with mangrove saplings using the extracted DNA samples, quantify the abundance using the stained samples, and inoculate <i>R. stylosa</i> and <i>B. gymnorhiza</i> saplings with endophytic fungi.</p>		

若手奨励研究 8 Incentive Research by Young Scientists 8		対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researcher	石本 雄大 (青森公立大学地域連携センター) Ishimoto, Yudai (Regional Collaboration Center, Aomori Public University)		
研究課題 Research Subject	アフリカ砂漠化前線地域におけるコモンズ論を踏まえた土地政策 Land Policy beyond Tragedy of the Commons in Semi-Arid Africa Affected by Desertification		
共同研究要旨 Summary of Joint Research	<p>Literature review for Zambian land policy and its interview survey were conducted. Their results were mainly three points:</p> <ol style="list-style-type: none"> 1. Changes in Land Policy <p>There were three regime of land administration in Zambia (Oyama 2016); In the colonial administration, rural people lived on communal land by customary law, whereas European settlers owned private property by modern law (Mamdani 1996). In the regime on economic socialism after independence, the 1975 Land Act declared that all land in Zambia shall be vested in the President. The act abolished all freehold estates to statutory leases during 100 years. The 1995 Land Act provides for the statutory recognition and continuation of customary tenure, provides for the conversion of customary tenure into leasehold tenure (NAZ 1995).</p> 2. Problems after the 1995 Land Act: Fencing and Land Grabbing <ol style="list-style-type: none"> 2.1 Fencing <p>Fencing in most customary areas, was traditionally prohibited for the reason for the exclusion of people with secondary rights to land, such as the grazing rights, but now is a growing practice which is meant to fix the boundaries of land (Chitonge et al. 2017). The negative impact is concerned such as land degradation and social conflict.</p> 2.2 Land Grabbing <p>Zambia Development Agency was established in 1996 to facilitate the transfer of customary lands to foreign investors through 'farm block concept' (Castel and Kamara, 2009). For example, the chief permitted to convert 26,000 ha from customary to state</p> 		

	<p>owned lands for a British/ Zimbabwean joint venture, which resulted in 2,000 families in five villages becoming displaced people. Thus, life of residents may be threatened by the chiefs and the government agency (Mousseau and Mittal 2011).</p> <p>3. Discussion of Countermeasures for the problems</p> <p>3.1 Supporting the smallholders by nongovernmental organization Zambia Land Alliance (ZLA) is a network of NGOs, which helps family reclaim the land grabbed.</p> <p>3.2 Revision of Land Law Formalization of group rights over rural lands may be a faster way of securing rights, where there is pressure from 'land grabbing' or 'resource degradation' (Hilhorst 2010). However, in Zambia, there are no clear rules for regulating group rights over common land in land law. Therefore, Zambian Government has started to prepare new National Land Policy (MOLA 2018): It emphasizes the necessity for registration in land either as group land rights or as individual private land, and for protection of customary interest in communal land. However, the draft land policy has not been submitted to cabinet for approval because of rejection by the house of chiefs. Traditional leaders rejected the draft on the grounds that it was trying to temper with the Chieftaincy (Lusaka Times 2018).</p>
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若手奨励研究 9 Incentive Research by Young Scientists 9		対応教員 Corresponding Staff	辻本 壽 Tsujimoto, Hisashi
研究代表者 Principal Researcher	佐久間 俊 (鳥取大学農学部) Sakuma, Shun (Faculty of Agriculture, Tottori University)		
研究課題 Research Subject	環境変化に適応する穂形質可塑性の分子機構の解明 Elucidation of molecular mechanism of inflorescence plasticity adapting to environmental change		
共同研究要旨 Summary of Joint Research	<p>Inflorescence architecture is a key determinant of the final grain number and size in cereal crops. Recent studies have suggested that what grain yield is affected more by variation in grain number per inflorescence than by variation in grain size. However, little is known regarding the genetic basis of grain number, especially for floret fertility in wheat. In this study, the <i>Grain Number Increase 1 (GNII)</i> gene is shown to be an important regulator of floret fertility. The gene encodes a homeodomain leucine zipper class I transcription factor, an ortholog of barley <i>Six-rowed spike 1 (Vrs1)</i> gene. <i>GNII</i> mRNA accumulated most abundantly in the apical florets and in parts of rachilla. The wheat lines carrying an impaired <i>GNII-1</i> allele consistently produced a higher number of grains per spikelet, even in the relatively low-yielding environment (dry) of Ruhama, Israel. Yield tests were conducted in two experimental fields of Hokkaido, Japan. The results showed that plants carrying the impaired allele produced 10 to 30% more grain yield at both sites. These results suggest that improving floret fertility could represent a promising breeding strategy for enhancing grain yield.</p>		

若手奨励研究 10 Incentive Research by Young Scientists 10		対応教員 Corresponding Staff	安田 裕 Yasuda, Hiroshi
研究代表者 Principal Researcher	吉岡 有美 (島根大学学術研究院) Yoshioka, Yumi (Graduate School of Natural Science and Technology, Shimane University)		
研究課題 Research Subject	水質及び酸素・水素安定同位体比からみる鳥取県西部地下水の水質形成機構 Hydrochemical controls of groundwater based on water quality and isotope analyses in the western of Tottori Prefecture		
共同研究要旨 Summary of Joint Research	<p>Groundwater is as important local water resource. The aim of this study is to assess groundwater recharge by stable oxygen and hydrogen isotopic compositions. These isotopes are conservative and do not fluctuate underground, and have been used as diagnostic tracers of water origins and mixing processes in paddy field area.</p> <p>The study area is western part of Tottori Prefecture, Japan. In this area, groundwater supplies 99.5 % of drinking water. We performed regular water sampling from April 2017 to December 2018 at one-month intervals. We collected 18 groundwater samples, 3 spring water samples, 4 river water samples, 2 paddy standing water samples, and 1 precipitation sample during each survey.</p>		

	<p>Isotope values were determined using an isotope ratio mass spectrometry (IRMS), which is the joint-use equipment of ALRC.</p> <p>Oxygen isotopes of groundwater samples were low along the coastal and low elevation areas, and high in the high elevation (mountainous) area. This spatial distribution trend indicated that even if groundwater recharge originating from precipitation predominated while the paddy and upland irrigations were conducted. We calculated the slope of regression line of groundwater samples, where the slope means $\delta^2\text{H}/\delta^{18}\text{O}$, and compared the results with theoretical values of precipitation (slope is 8). The smallest value of the slope was observed at the coastal area except for the sandbar peninsula area. After the heavy rain with more than two-hundreds mm, the slope was less than 8. In addition, the slope of the mountainous area was also less than 8. These results showed that groundwater recharge from the paddy field dominated in the area.</p>
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(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	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	ロベル タケル ミテク (エチオピア農業研究所気候及び地理空間研究プログラム) Robel Takele Miteku (Climate and Geospatial Research Program, Ethiopian Institute of Agricultural Research)	
研究課題 Research Subject	スーダンにおける気候特性と過去・将来気候に対する春小麦の応答に関する研究 Climate characterization and investigation of response of spring wheat to historical and future climate over Sudan	
共同研究要旨 Summary of Joint Research	<p>A changing climate may exhibit increased climatic variability, which changes the frequency of extreme climatic events. The global warming is quite evident in recent years, but magnitudes of warming differ across locations. The demand for wheat is increasing year-by-year in Sudan. A chief characteristic of wheat production in Sudan is that wheat is produced in one of the hottest regions in the world. Since the wheat productivity is mainly driven by temperature, which determines both phenological development and growth rates. So, we can expect that the impact of warming on wheat production will be more evident in Sudan than other wheat production regions. We examined the variability and trends in temperature and their possible impact on wheat production at Dongola, Medani and New halfa located over Sudan by carrying out an analysis of temperature anomalies. The temperature anomaly during a wheat growing season (i.e., November to March) generally shows a warming trend. The warming is consistent in recent decades compared to the earlier decades. Predominantly, pronounced warming of daily minimum temperature shown at Dongola. We defined heat wave by two criteria, which are the daily maximum and the daily minimum temperatures exceed 35 degree ($T_{\max}>35^{\circ}\text{C}$) and 20 degree ($T_{\min}>20^{\circ}\text{C}$), respectively, and we clarified that numbers of heat wave events are generally in increasing trend.</p> <p>In this research, we investigated the relation between temperature and wheat yield using their observed data. Based on the results, we estimated impacts of the warming on wheat yield from the difference between predicted yields with observed temperature and predicted yields with de-trended temperature. The estimations show that the yield reduced by 0.14 t/ha, 0.16 t/ha and 0.08 t/ha at Dongola, at Madani and at New Halfa, respectively. Further increases in temperature are projected in scenarios except for RCP2.6 and this suggests an impact of warming on wheat yield will be more severe. In this research, we made a statistic analysis between temperature during the growing season and the yield. However, we will need process-base analyses for wheat growth. The results should be applied into a crop model, and wheat yield should be predicted by the process-base crop model.</p> <p>Other than estimations of wheat yield from temperature, we carried out an analysis to clarify climatic mechanisms leading interannual variation of temperature. Interannual temperature anomalies are often linked to variations in the systems that control the regional climate with quasi-periodic fluctuations, such as North Atlantic Oscillation (NAO). Attempts were also made to investigate the existence of NAO signals in the temperature anomaly, which could have a potential to drive the year-to-year variations in wheat production. We clarified that NAO on November has a negative correlation with both seasonal average temperature anomaly and wheat yield anomaly. The existence of this time-lag relationship raises the possibility of using the November NAO index to predict the performance of the coming wheat production.</p>	

(6) 海外拠点連携型国際共同研究/ International Joint Research with Overseas Institutions

海外拠点連携型国際共同研究 1 International Joint Research with Overseas Institutions 1		対応教員 Corresponding Staff	恒川 篤史 Tsunekawa, Atsushi
研究代表者 Principal Researcher	薛 嫻 (中国科学院西北生態環境資源研究院) Xue, Xian (Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences)		
研究課題 Research Subject	劣化した乾燥地の持続可能な管理と修復：石羊河流域の事例 Sustainable management and restoration of degraded drylands: A case of Shiyang River watershed		
共同研究要旨 Summary of Joint Research	<p>After the joint project has been approved, both sides conducted the following works.</p> <ol style="list-style-type: none"> 1. Collected the related degraded land restoration policies implemented in Shiyang River Basin after 2000. 2. Collected the human activities data of the study area after the policies have been implemented including the change of farmland, shrub forest, grassland area, and water use amount per farmer, ecological migration situation, and some other data. 3. Collected the environmental data including land cover change, annual surface water amount, groundwater table, groundwater quality. 4. Measured soil salt content and organic matter in some typical regions of the Shiyang River Basin. 5. During the visiting of China member in Japan, both sides analyzed the collected data together and prepared the related research report. Basing on the current result, both sides prepared and submitted the 2019 NSFC-JSPS cooperation program proposal; and made the future research plan. <p>The analysis of the related data has not been done fully until now. The preliminary results show that the ecological policies of degraded land in the Shiyang River Basin greatly changed the local environment, society, and economy situation.</p> <p>Results 1: The land use changed greatly, 20-30% farmland has been substituted by the shrubland and fruit forest land. The land coverage increased significantly. In the down reach of Shiyang River Basin, the wind-shelter belt with a width of 1 km has been set up along the margin of Oasis. A wetland with the area of 20 km² has rapidly presented in the end reach of Shiyang River.</p> <p>Results 2: The groundwater table increased with an annual average rate of 2-3 cm per year.</p> <p>Results 3: The rise groundwater table and reduction of irrigation amount induce the increasing in soil salt content of the abandoned farmland.</p> <p>Results 4: Although irrigation water is strictly limited, new farmland still increased in some region far away the road by purchasing high-price water.</p> <p>In summary, the ecological policies are beneficial to vegetation cover but result in soil salinization. These policies brought a great impact on the local government and farmers. Both the government and farmers try to find some way to weaken their conflict.</p>		

(7) 温暖化プロジェクト/ Project ICC × DRYLANDs

温暖化プロジェクト 1 Project ICC × DRYLANDs 1		対応教員 Corresponding Staff	辻本 壽 Tsujiimoto, Hisashi
研究代表者 Principal Researcher	飯泉 仁之直 (国立研究開発法人農業・食品産業技術総合研究機構農業環境変動研究センター) Iizumi, Toshichika (Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization (NARO))		
研究課題 Research Subject	気候変動下の高温ストレスに対するスーダンのコムギ生産の適応：広域作物モデリングによる評価 Adaptation of wheat production in Sudan to heat stress under climate change: an assessment based on large-area crop modeling		
共同研究要旨 Summary of Joint Research	<p>In this joint research project, the goal of this fiscal year is to proceed the crop model calibration using field experimental data in Sudan to enable the model describing key differences in yield response to growing season temperature across varieties.</p> <p>The observed weather and wheat data for the 10-year period from 2008/09 to 2017/18 (2010/11 and 2011/12 are missing) with two replications were supplied by Dr Izzat Tahir. Using the data, we identified the different yield response to temperature between two varieties, Debeira (conventional) and</p>		

	Imam (more heat tolerant). Both varieties are heat tolerant, although Debeira was released in 1982 and Imam was released in 2000. The sensitivity of yield to temperature is higher for Debeira than Imam. In this analysis, the sensitivity is represented by the slope of a regression line between the growing-season average temperature and yield. This evidently shows that Imam which was released more recently than Debeira is relatively more heat tolerant. The result indicates that the crop model used for this project was calibrated to reproduce the key difference in yield response to temperature presented here.
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温暖化プロジェクト 2 Project ICC × DRYLANDs 2		対応教員 Corresponding Staff	衣笠 利彦 Kinugasa, Toshihiko
研究代表者 Principal Researcher	佐々木 雄大(横浜国立大学大学院環境情報研究院) Sasaki, Takehiro (Graduate School of Environment and Information Sciences, Yokohama National University)		
研究課題 Research Subject	長期データから読み解くモンゴル草原植生の気候変動に対する応答 Long-term data analysis on the vegetation responses to climate changes in Mongolian grasslands		
共同研究要旨 Summary of Joint Research	<p>Understanding ecosystem responses to climate change and predicting future ecosystem changes necessitate a time-series analysis of long-term data because climate change is an on-going phenomenon. Given the deficiency of such a time-series analysis, we know little about how ecosystems respond to future climate change and how we can manage ecosystems under climate change.</p> <p>Mongolian grasslands cover the central part of eastern Eurasian steppe, and forage resources there support livestock production in Mongolia. Mongolian grasslands would also play an important role as a sink for atmospheric carbon in terrestrial ecosystems due to high productivity and slow decomposition processes in these grasslands. Currently, however, we know little about how forage resources have changed under climate change and what factors drive their changes. The answer to these two questions is practically important for the future use of Mongolian grasslands and will therefore have profound societal impacts particularly for the communities of local herders.</p> <p>In this study, by using the long-term time series data collected across Mongolia since 1960s, we will apply a dynamic empirical modelling approach by which we can examine causal relationships among focal variables in the time series data. Although many previous studies on the consequences of climate change on ecosystems focused mainly on increasing temperature, this study explores the ecological consequences of multiple facets of climate change, including temperature changes, precipitation changes, and variabilities of temperature and precipitation for more than five decades.</p> <p>To address study objectives, in this fiscal year (H30), we have completed the collection of the long-term monitoring dataset at 135 fenced and unfenced sites since 1964. We performed screening the dataset for data analysis. The screening was based on the start/end year of monitoring, amounts of missing data, and whether the observation site was ever moved (moreover, if yes, when it was moved).</p> <p>We then performed the preliminary data analysis for the subset of dataset, and have been constructing the base code for the time-series analysis.</p>		

温暖化プロジェクト 3 Project ICC × DRYLANDs 3		対応教員 Corresponding Staff	黒崎 泰典 Kurosaki, Yasunori
研究代表者 Principal Researcher	立入 郁 (国立研究開発法人海洋研究開発機構統合的気候変動予測研究分野) Tachiiri, Kaoru (Department of Integrated Climate Change Projection Research, Japan Agency for Marine-Earth Science and Technology)		
研究課題 Research Subject	全球気候モデルの実験データを用いたアジア・アフリカ乾燥地の将来気候解析 Analysis of future climate in drylands in Asia and Africa using outputs of global climate model experiments		
共同研究要旨 Summary of int Research	<p>CMIP5 data analysis: Future climate change in the Asia-Africa dryland was investigated for RCP 2.6 and RCP 8.5, and the results showed that temperature, precipitation, NPP and LAI increase in most of the Asia-Africa dryland, and in MIROC-ESM, C3 NPP decreased and C4 NPP increased in Mongolia. In addition, it was suggested that bias correction might affect these results.</p> <p>Terrestrial Ecosystems: We assessed terrestrial carbon cycle variability in Mongolia from the 1980s to the present using multiple terrestrial ecosystem models and multiple observational data sets. As a result of analyzing for 2000-2015 using land ecosystem models included in TRENDY data set, models have similar feature in interannual variation of photosynthesis amount around Mongolia, but have large inter-model variation for the amount of photosynthesis and its long-term change.</p>		

Regional Climate Model 1: We compared RegCM4 and CLWRF in their reproducibility of the present climate (1986-2005), and found relatively large (+5–10°C) temperature bias in the northern part of Mongolia in winter for both models (in the other seasons, the bias is in the range of $\pm 5^\circ\text{C}$). Precipitation was overestimated except in summer. Overall, CLWRF was slightly better at reproducing temporal and spatial patterns of temperature and precipitation.

Regional Climate Model 2: By conducting reproduction and sensitivity experiments (i.e., mountain removal, stopping surface heat flux) using regional climate model WRF for summer heavy and light rainfall cases around Ulaanbaatar (UB), we investigated the contribution of mountainous terrain and heat from the surface to the rainfall events. As a result, the heavy rain case was frontal rainfall when low pressure was passing and was dominated by a synoptic scale air field (negligibly affected by surface heat flux), while in the weak rain case, heat flux drove convective clouds to cause precipitation. It was suggested that the mountain topography strengthened the precipitation around UB in both cases.

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, 2019

国名等 Country/Region	機関名	Names of Institutions
中国 China	北京林業大学	Beijing Forestry University
	北京師範大学	Beijing Normal University
	新疆農業大学	Xinjiang Agricultural University
	蘭州大学	Lanzhou University
	中国科学院水利部水土保持研究所	Institute of Soil and Water Conservation, CAS and MWR
	中国科学院遺伝及び発育生物学研究所 農業資源研究センター	Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, CAS
	中国科学院西北生態環境資源研究院	Northwest Institute of Eco-Environment and Resources, (NIEER), CAS
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
アラブ首長国連邦 UAE	国際塩生農業研究センター	International Center for Biosaline Agriculture (ICBA)

(2) 国際共同研究

塩水灌漑および有機肥料の施用における砂地での植物栄養分の吸収およびリーチング

期間：2018年4月－2019年3月

代表者：イルシャド ムハメド（パキスタンペシャワール大学）

組織：パキスタンペシャワール大学（イルシャド ムハメド）・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効率の向上は急務である。本研究は、塩－アルカリ土壌における有機肥料の施用が土壌中の植物栄養分の吸収特性に及ぼす影響を解明することが目的である。主な研究内容は、1) 塩類集積土壌において有機肥料の施用および水質の低い灌漑用水を利用する側面から農業生産効率を高めること、2) 砂地での塩水灌漑における有機肥料の有効性および植物の吸収特性を検討する。

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した。

半数体作成のためのササゲ染色体研究

期間：2018年4月－2019年3月

代表者：石井孝佳（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（石井孝佳）・ライプニッツ植物遺伝学研究所（アンドレアス・フウベン）・オーストラリア連邦科学産業研究機関（アンナ・コルツノフ）

研究費：ライプニッツ植物遺伝学研究所

課題：ササゲ (*Vigna unguiculata*, $2n=2x=22$) は、アフリカでは重要なマメ科作物であり、干ばつや熱ストレスに対して強い耐性を持っている。半数体（倍加半数体）は、植物育種を促進するのに非常に強力な手法である。本共同研究では、セントロメア特異的ヒストンH3 (CENH3) の操作によるササゲの半数体生産法を確立する事を目標にした。ササゲは、二倍体ゲノム中に2種類のCENH3をコードしていることが分かった。ササゲ半数体誘導系統の作成のためのCENH3の改変は現在進行中である。

(2) International Joint Research

Extractability, bioavailability and leachability of plant nutrients from sand dune soil applied with organic manures under saline irrigation conditions

Period: Apr. 2018 - Mar. 2019

Leader: M. Irshad (University of Peshawar, Pakistan)

Organization: University of Peshawar (M. Irshad), ALRC Tottori University (P. An, Y. Shao)

Funding: 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 extractability of plant nutrients within the soil solid phase as well as root selectivity and translocation in plant at different organic manure and salinity levels. Objectives of the research study were to 1) improve production efficiencies in terms of nutrient inputs and marginal quality irrigation water for the enhancement of crop production in saline soils and 2) determine the effectiveness of organic manure on crop growth and nutrient bioavailability from sand dune soil irrigated with saline water.

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

Period: May 2015- Sept. 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 demonstrated a measure for improved feeding regimens of beef cattle through the substitution of alfalfa hay for concentrate feed.

Chromosome analysis of cowpea for haploid production

Period: Apr. 2018 - Mar. 2019

Leader: T. Ishii (ALRC, Tottori University)

Organization: Tottori University (T. Ishii), Leibniz Institute of Plant Genetics and Crop Plant Research, Germany (A. Houben), Commonwealth Scientific and Industrial Research Organization, Australia (A. Koltunow)

Funding: Plant Genetics and Crop Plant Research

Subject: Cowpea (*Vigna unguiculata*, $2n=2x=22$) is an important legume crop in Africa, and has a pronounced tolerance to drought and heat stress. Haploids (doubled haploids) are very instrumental to accelerate the plant breeding process. We intend to establish a haploid production method for cowpea via manipulation of the centromere-specific histone H3 (CENH3) variant. Cowpea encodes two types of CENH3s in the diploid genome. Manipulation of cowpea CENH3s is in progress.

砂漠化地域における地球温暖化への対応に関する研究

期間：2017年4月－2022年3月

代表者：山中典和（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（山中典和、黒崎泰典、衣笠利彦、辻本壽、坪充）・モンゴル気象水文環境情報研究所（P. Gomboluudev, B. Gantsetseg）・スーダン気象庁（Ahmed M. Abdelkarim）・スーダン農業研究機構（Imad-E. A. Ali Babiker, Amani A. M. Idris, Izzat S. A. Tahir）

研究費：鳥取大学

課題：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。乾燥地においても、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っている。モンゴルにおいては気候変動の草原生態系への影響、スーダンにおいてはコムギ生産への影響をテーマとした研究を進めている。

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。

耕作限界地の環境に適応するコムギ品種開発のための近縁野生種の遺伝資源開発

期間：2015年4月－2019年3月

代表者：辻本壽（鳥取大学乾燥地研究センター）

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

研究費：鳥取大学

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

Impacts of climate change (ICC) on Drylands: Assessment and Adaptation

Period: Apr. 2017 - Mar. 2022

Leader: N. Yamanaka (ALRC, Tottori University)

Organization: Tottori University (N. Yamanaka, Y. Kurosaki, T. Kinugasa, H. Tsujimoto, M. Tsubo), Information and Research Institute of Meteorology, Hydrology and Environment, Mongolia (P. Gomboluudev, B. Gantsetseg), Sudan Meteorological Authority (Ahmed M. Abdelkarim), Agricultural Research Corporation, Sudan (Imad-E. A. Ali Babiker, Amani A. M. Idris, Izzat S. A. Tahir)

Funding: Tottori University

Subject: 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, (1) we have conducted analyses of future climate from the viewpoint of such disasters; (2) we have assessed their impacts on desertification and agriculture; and (3) we have developed adaptation technologies to mitigate their associated risks. We have proceeded researches for their impacts on grassland ecosystem in Mongolia and their impacts on wheat production in Sudan.

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.

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

Period: Apr. 2015 - Mar. 2019

Leader: H. Tsujimoto (ALRC, Tottori University)

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

Funding: Tottori University

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

共生関係が成立するコムギおよびエンドファイトの遺伝子型の探索

期間：2017年4月－2019年3月

代表者：辻本壽（鳥取大学乾燥地研究センター）

組織：鳥取大学（辻本壽、児玉基一朗）・ニュージーランドAgResearch（リチャード・ジョンソン、ウェイン・シンプソン）

研究費：科研費・挑戦的研究（萌芽）

課題：コムギ近縁野生種には内生菌が普通に見られストレス耐性に関与しているが、栽培コムギには存在しない。パンコムギに近縁種のエンドファイトを人工的に接種すると、植物体は矮性になり不稔性を示す。本研究では共生が成立し種子を生産するエンドファイト・コムギの組み合わせを調査した。その結果、野生種染色体をもつコムギ系統に、エンドファイトに感染しても正常な生育を示し、種子を形成して、次世代に菌を伝播できる組み合わせのあることを見いだした。

高温耐性コムギ系統のQTL解析と選抜マーカーの開発

期間：2018年4月－2021年3月

代表者：辻本壽（鳥取大学乾燥地研究センター）

組織：鳥取大学（辻本壽、ヤシル・ゴラフィ、妻鹿良亮、山崎裕司）・宇都宮大学（岡本昌憲）・スーダン農業研究機構（イザット・タヘル）

研究費：科研費・基盤研究（B）

課題：これまでの研究によって、申請者は複数の高温耐性コムギ系統を野生種（タルホコムギ）の遺伝資源を用いて開発した。本研究は、これら系統の高温耐性の遺伝様式を解明するため、耐性系統、通常系統およびそれらの雑種後代で作成する分離集団を用いて、関連染色体部位をQTL解析法により解明し、QTLを識別するための分子選抜マーカーを作る。

スーダンおよびサブサハラアフリカの乾燥・高温農業生態系において持続的にコムギを生産するための革新的な気候変動耐性技術の開発

期間：2018年6月－2024年6月

代表者：辻本壽（鳥取大学乾燥地研究センター）

組織：鳥取大学（辻本壽、ヤシル・ゴラフィ、妻鹿良亮、田中裕之、明石欣也、坪充他）・宇都宮大学（岡本昌憲）・スーダン農業研究機構（イザット・タヘル他）・スーダン気象庁（A.Mアブデルカリム他）

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：本研究は、乾燥・高温耐性で、高栄養・高品質なコムギ品種を分子育種技術で迅速に開発し、情報通信技術で効果的に普及させることを目的としている。スーダンを含むサブサハラ地域は、今後最も栄養不足人口が増え、コムギに対する需要が特に高まっている。しかし、乾燥・高温環境が生産の障害となっている。そこで、これまでの研究で開発した乾燥・高温耐性コムギ系統を遺伝資源とし、実用品種を開発するための、育種基盤の構築を行っている。

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

期間：2016年4月－2020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：鳥取大学乾燥地研究センター（藤巻晴行）・ナジャハ大学（Abdel Fattah El-Mallah）

Exploration of wheat and endophyte genotypes that enables symbiotic relationship

Period: Apr. 2017 - Mar. 2019

Leader: H. Tsujimoto (ALRC, Tottori University)

Organization: Tottori University (H. Tsujimoto, M. Kodama), AgResearch, New Zealand (R. Johnson, W. Simpson)

Funding: KAKENHI (Grants-in-Aid for Scientific Research)

Subject: Endophyte is commonly found in wheat-related wild species and provides stress tolerance to the host plant. However endophyte is not found in cultivated wheat varieties. When bread wheat is artificially inoculated with the endophyte of the related wild species, the plant becomes dwarf and sterile. In this study, we investigated wheat-endophyte combination which enables normal symbiosis and seed production. As a result, we found wheat lines having a chromosome of wild species that shows normal plant growth even in the infection with an endophyte. This plant produced seeds with endophyte and transferred it to the next generation.

QTL analysis of heat-stress tolerant wheat lines and production of selection markers

Period: Apr. 2018 - Mar. 2021

Leader: H. Tsujimoto (ALRC, Tottori University)

Organization: Tottori University (H. Tsujimoto, Y. S. A. Gorafi, R. Mega, Y. Yamasaki), Utsunomiya University (M. Okamoto), Agricultural Research Corporation, Sudan (I. S. Tahir)

Funding: KAKENHI (Grants-in-Aid for Scientific Research)

Subject: In the previous studies, we produced several heat-tolerant wheat lines using genetic resources of wild species (*Aegilops tauschii*). In this study, in order to elucidate the genetic behavior of the tolerance, we will produce segregation population using the tolerant line and a normal cultivar. QTL analysis for the segregation population will reveal the relevant chromosome regions to the tolerance and enable to produce selection markers for heat stress tolerance.

Development of climate change resilient innovative technologies for suitable wheat production in the dry and heat prone agro-ecologies of Sudan and Sub-Saharan Africa

Period: Jun. 2018 - Jun. 2024

Leader: H. Tsujimoto (ALRC, Tottori University)

Organization: Tottori University (H. Tsujimoto, Y. S. A. Gorafi, R. Mega, H. Tanaka, K. Akashi, M. Tsubo, etc.), Utsunomiya University (M. Okamoto), Agricultural Research Corporation, Sudan (I. S. Tahir, etc.), Sudan Meteorology Authority (A. M. Abdelkarim)

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

Subject: The purpose of this research is to rapidly develop dry and heat tolerant and nutritious and high-quality wheat varieties by molecular breeding technology and to effectively spread them by information communication technologies. The sub-Saharan region, including Sudan, has the most undernourished population and the demand for wheat is particularly high. However, the dry and hot environment is an obstacle to the production. In this project we are constructing breeding base to develop practical varieties by using the dry and heat tolerant wheat lines that was developed in the previous studies.

Enhancing food security using water harvesting in West Bank of Palestine

Period: Apr. 2016 - May 2020

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: Tottori University (H. Fujimaki), An-Najah University (Abdel Fattah El-Mallah)

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ナツメヤシの最適灌水基準サクシヨンの探索

期間：2018年4月－2021年3月

代表者：藤巻晴行（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（藤巻晴行）・パレスチナ国立農業研究所（Z. Fadda）

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、パレスチナ農業研究所ジェリコ支所内の実験圃場にて異なる3つの灌水基準サクシヨンの栽培している。

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：2017年11月－2020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：鳥取大学乾燥地研究センター（藤巻晴行）・スーダン農業研究機構（Khalid Altaib）

研究費：限界地プロジェクト

課題：スーダン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。

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、坪充）・島根大学（増永二之）・バハルダール大学（Enyew Adgo, Derege Meshesha）

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）

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.

Optimization of trigger suction for automated irrigation to Date Palm in Palestine

Period: Apr. 2018 - Mar. 2021

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: Tottori University (H. Fujimaki), National Agricultural Research Center of Palestine (Z. Fadda)

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

Subject: To enhance food security of Palestine, Date Palm trees are automatically irrigated at three different suctions in experimental orchard in Jericho station of NARC.

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

Period: Nov. 2017 - May 2020

Leader: H. Fujimaki (ALRC, Tottori University)

Organization: Tottori University (H. Fujimaki), Agricultural Research Corporation, Sudan (Khalid Altaib)

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

Subject: Field experiments were carried out in Sudan 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.

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, M. Tsubo), Shimane University (T. Masunaga), Bahir-Dar University (E. Adgo, D. Meshesha)

Funding: KAKENHI (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)

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。

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.

(3) 外国人研究者・受託研究員・研究生の受入れ

外国人研究者

Mostafa Abdelwahed Noureldein Abdelrahman
(平成30年4月1日～令和2年3月31日)
日本学術振興会外国人特別研究員 (一般)

Nasrein Mohamed Kamal Omer
(平成30年4月1日～平成31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・助教
私費

Robel Takele Miteku
(平成30年6月14日～平成30年8月29日)
エチオピア農業研究所・研究助手
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

Elena Shuyskaya
(平成30年7月6日～平成30年9月2日)
ロシア科学アカデミー・上席研究員
私費

Majid Raouf
(平成30年10月9日～平成31年2月15日)
Mohaghegh Ardabili 大学・准教授
私費

Zhang Fen
(平成31年1月4日～令和元年12月27日)
蘭州大学・講師
私費

受託研究員

2018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 (A)」(平成30年8月10
日)
イラク2名、ケニア1名、スーダン1名、パレスチナ1
名、ヨルダン1名

2018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 (B)」(平成30年12月4
日)
アゼルバイジャン1名、アルメニア1名、ウズベキスタン
1名、キルギス共和国2名、タジキスタン1名、トルクメ
ニスタン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
Qing Qing
(平成30年4月1日～平成31年3月31日) 中国

(3) Visiting Researchers, Trainees and Research Students Visiting Researchers

Mostafa Abdelwahed Noureldein Abdelrahman
(Apr. 1, 2018 - Mar. 31, 2020)
JSPS Postdoctoral Fellowship for Research in Japan (Standard)

Nasrein Mohamed Kamal Omer
(Apr. 1, 2018 - Mar. 31, 2019)
Assistant Professor, Biotechnology and Biosafety Research
Center, Agriculture Research Corporation, Sudan
Private funds

Robel Takele Miteku
(Jun. 14, 2018 - Aug. 29, 2018)
Assistant Researcher, Ethiopian Institute of Agricultural
Research
Funded by Guest Research Associate for Joint Research
Program, Arid Land Research Center, Tottori University

Elena Shuyskaya
(Jul. 6, 2018 - Sep. 2, 2018)
Senior Researcher, Russian Academy of Sciences
Private funds

Majid Raouf
(Oct. 9, 2018 - Feb. 15, 2019)
Associate Professor, University of Mohaghegh Ardabili
Private funds

Zhang Fen
(Jan. 4, 2019 - Dec. 27, 2019)
Lecturer, Lanzhou University
Private fund

Visiting Trainees

JICA Group Training Course 2018 “Appropriate Management
of Land and Water Resources for Sustainable Agriculture in
Arid/Semi-arid Regions (A)”
2 Iraqis, 1 Kenyan, 1 Sudanese, 1 Palestinian, 1 Jordanian

JICA Group Training Course 2018 “Appropriate Management
of Land and Water Resources for Sustainable Agriculture in
Arid/Semi-arid Regions (B)”
1 Azerbaijani, 1 Armenian, 1 Uzbekistani, 2 Kyrgyzstanis, 1
Tajikistani, 1 Turkmen

Research Students

Fekremariam Asargew Mihretie
(Oct. 1, 2017 - Sep. 30, 2018) Ethiopia
Gamila Mohamed Idris Elhadi
(Oct. 1, 2017 - Sep. 30, 2018) Sudan
Qing Qing
(Apr. 1, 2018 - Mar. 31, 2019) China