

Sustainable Agricultural Solutions

1 Introduction

The Jacob Blaustein Institutes for Desert Research (BIDR), part of Ben-Gurion University of the Negev (BGU), are acknowledged leaders in desert studies, and widely respected in the international scientific community for the quality and creativity of their research and training programs. In light of this global reputation and the worldwide need for expertise in the study of drylands, BGU and the BIDR established the Albert Katz International School for Desert Studies (AKIS), which offers programs in English leading to M.Sc. and Ph.D. degrees in Desert Studies (http://in.bgu.ac.il/en/akis/Pages/Desert_Studies/About-Desert-Studies.aspx).

The program for desert studies provides specialization in several topics, two of which are offered by the French Associates Institute for Agriculture and Biotechnology of Drylands (FAIABD):

1. Agriculture and Biotechnology of Drylands
(http://in.bgu.ac.il/en/akis/Pages/Desert_Studies/Agriculture-Biotechnology.aspx).
2. Irrigation and Plant Environment
(http://in.bgu.ac.il/en/akis/Pages/Desert_Studies/Irrigation.aspx)

2 Scope and rationale

Approximately 40% of the Earth's terrestrial surface comprises drylands, which are home to more than 2 billion people. These arid areas, which include such diverse ecosystems as deserts, savannahs and tropical dry forests, are often characterized by population growth, over-exploitation, drought and desertification, which leads to a decline in productivity. Food and water are essential to human existence. Availability of food and water is limited by increasing global population rates. Consequently, the interplay between agricultural yields and water resources is vital for providing food and water to the growing population. In this context, water use efficiency can be increased by the sustainable and efficient management of available resources.

The suggested course "Sustainable Agricultural Solutions" will provide students with fundamental and cutting-edge knowledge and technology as well as an integrated academic perspective related to agricultural practices for improving food and water use worldwide, particularly in view of global desertification. The innovative, multidisciplinary program suggested in the current proposal is structured to offer students exceptional opportunities to pursue a combination of basic and applied research in agricultural and environmental topics. The course will use the infrastructure of AKIS and will be based on offered graduate courses, as part of the program for desert studies, which is taught in English.

The proposed summer course will be taught by scientists from FAIABD. The FAIABD scientists are engaged in intensive, cutting-edge research to increase arid zone food production, to develop biotechnological solutions where traditional or conventional methods of agriculture are inefficient or not possible and to empower sustainable living in arid areas. The proposed course will expose the students to the international community at BIDR, including students and post-docs from China and India that are currently studying at AKIS.

Arid regions compose a significant fraction of both China and India. Arid region-related agricultural and environmental issues are therefore a common challenge facing academic researchers in all three countries. Therefore, the proposed course is expected to significantly promote the bi-national relationships between Israel and China and between Israel and India, including academic collaborations, conferences, knowledge-sharing, and student exchanges.

Students will be exposed to, and familiarized with, the different institutes and departments at BIDR. Students can later apply for M.Sc. and Ph.D. studies at BIDR, as well as for postdoc studies through the Blaustein Center for Scientific Cooperation (<http://in.bgu.ac.il/en/bidr/BCSC/Pages/default.aspx>). The large scope of the course and range of academic topics provides a jumping point to any university which includes agricultural research in its curriculum. Outstanding students participating in the course will be offered full scholarships for M.Sc. or Ph.D. studies at BIDR.

3 Course plan

A four-week intensive course is suggested. The proposed summer course will be based upon courses that are regularly taught at AKIS (listed below). The suggested program will be composed of three tracks that will cover soil and irrigation, plants under abiotic stress and aquaculture, including fish and microalgae. Practical aspects as well as integration between the three topics will be emphasized in the lectures. Hands-on experience will be achieved by experimental sessions (including field- and/or lab-based projects) and concluding seminar presentations by the students. The experiments will be specially designed for the course, conducted by the students, and supervised by all the Institute's scientists: Prof. Shimon Rachmilevitch, Dr. Nurit Agam, Prof. Moshe Silberbush, Prof. Jhonathan Ephrath, Prof. Sammy Boussiba, Prof. Moshe Sagi, Prof. Naftali Lazarovitch, Dr. Simon Barak, Prof. Gideon Grafi, Prof. Aaron Fait, Dr. Gilboa Arye, Dr. Inna Khozin-Goldberg, Prof. Avi Golan, Dr. Claude Aflalo, Prof. Pedro Berliner, Dr. Bertrand Boeken, Dr. Noemi Tel-Zur, Prof. Avigad Vonshak, Dr. Genadi Carmi and Dr. Dina Zilberg. All scientists are senior lecturers or professors at BGU.

3.1 Time schedule

Sunday, Monday, Wednesday, and Thursday:

9:00-12:00 – Lectures/field work

12:00-14:00 – Lunch break

14:00-17:00 – Lectures

(Total lecture time: 96 hours)

Tuesdays – Educational and scientific tours

3.2 Unit syllabuses

Unit 1: Physiology and molecular biology of plant responses to abiotic stress (3 credit points)

Lecturers: Dr. Barak, Prof. Ephrat, Prof. Fait, Prof. Golan, Prof. Grafi, Prof. Rachmilevitch, Prof. Sagi, and Dr. Tel-Zur.

This unit will be composed of topics related to the organismal and cell physiology of stress response. Cellular and molecular aspects will be tackled within the frame of whole plant environment interaction.

Subjects in this unit will include:

- Plant Stress Indicators: Methods and Instrumentation
- Carbon Metabolism in Plants
- Eco-physiology of Plants under Stress
- Water Relations in Plants
- Root and Shoot Relations
- Novel Methods to Measure Roots
- Effects of Flood and Lack of Oxygen on Plants
- Plant Drought Stress and ABA
- Salt Stress – Effects on Plants, Salt absorption, Salt removal
- How Plants Respond to Environmental Changes
- Heat Stress
- Freezing and Cold Stress
- Reactive Oxygen Species and their Importance
- Stress and Early senescence
- Experimental Design for Omics Studies
- Metabolite Profiling from Extraction to Data Quality Assessment
- Environmental and Genetic Regulation of Specialized Metabolism
- Introduction to Plant Molecular Biology
- Molecular Regulation of Plant Responses to Abiotic Stress
- Systems Biology Aspects of Plant Stress Responses
- Epigenetic Regulation of Plant Responses to the Environment

Unit 2: Fertigation and plant environment (3 credit points)

Lecturers: Dr. Agam, Dr. Arye, Prof. Berliner, Dr. Boeken, Dr. Carmi, Prof. Lazarovitch, Prof. Silberbush.

This unit will be composed of topics related to the root zone of irrigated plants. Water flow, heat and solute transport in the plant environment will be emphasized.

Subjects in this unit will include:

- The Solid Phase in the Soil
- Soil-Water Relations
- Saturated and Unsaturated Water Flow
- Field Water Processes
- Fundamentals of the Soil-Plant-Atmosphere Continuum
- Drip Irrigation
- Irrigation Scheduling Methods Based on Soil, Plant, Atmosphere and Lysimeter Parameters
- Irrigation with Saline Water
- Origin and Nature of Salts in Agricultural Soils
- Determination of Salt Properties in the Liquid and Solid Phases

- Reactive Reactions – Adsorption, Cation Exchange and Precipitation/Dissolution
- Salt Influence on Plant Growth and Soil Structure
- Modeling Salt Transport in Soils – Implications for Irrigated Soils
- Soil Fertility and Nutrient Uptake by Plant Roots
- Mechanisms of Ion Uptake by Roots
- Nutrient Interactions
- Nutrient Supply by the Soil
- Nutrient Uptake under Water and Salinity Stress
- Time and Space Scales in Micro-Meteorology – An Introduction
- The Effect of Agricultural Fields on the Radiation Balance in Drylands
- The Energy Balance Components in Irrigated vs. Non-Irrigated Fields
- Soil Heat Flux, Sensible Heat Flux, Latent Heat Flux
- The Role of Soil Evaporation in Agricultural Fields and its Effect on Water Management

Unit 3: Aquaculture (2 credit points)

Lecturers: Dr. Aflalo, Prof. Boussiba, Prof. Khozin-Goldberg, Prof. Vonshak and Dr. Zilberg

This unit will be composed of topics related to fish and microalgae culture. The advantages of desert conditions as well as the associated biological and technological challenges involved in microalgal and fish production in desert areas will be emphasized. The course will include general background on fish and algal biology followed by production technology.

Subjects in this unit will include:

- Physiology and Biochemistry of Microalgae under Stress Conditions
- Basic Principles of Microalgal Biotechnology
- Progress and Perspectives of Microalgal Biotechnology for High-Value Products
- Selected Topics in Metabolic Engineering of Microalgae
- Basic Fish Physiology and Fish Nutrition
- Water Quality in Aquaculture
- Aquaculture Technologies
- Diseases in Aquaculture

Student evaluation for the summer intensive course:

80% - Exam

20% - Oral presentation of research project summary

3.3 Weekly educational and scientific tours

- Week 1 – R&D Arava – Practical agriculture in the desert
- Week 2 – Aquaculture R&D center, Yair station, Arava and microalgal production plant, Kibbutz Ketura, Arava Valley.
- Week 3 – R&D Ramat Negev and the desert viticulture and wine making.
- Week 4 – Mashash experimental farm, Yatir afforestation, and Limans in the Negev – forestry and rain water harvesting in arid regions

4 Acceptance criteria

All applicants must have a B.Sc. degree or higher majoring in biology-related studies. Application of excellent students who finished their 2nd year of a B.Sc. degree will be also considered. Applicants will need to provide a C.V. and documentation from their home universities, including course grade averages. A committee composed of a representative lecturer from each unit in the program will evaluate the application on a competitive basis and decide upon acceptance of candidates that pass the requirements. Required English level will include speaking, understanding as well as reading and writing.

5 Experiencing Israeli culture and people

The program will include cultural events during which students will have the opportunity to socialize with local Israeli students. We plan to carry out tours that will expose the students to Israeli culture and sights of the Israeli Jewish history. The plan is based on the program that was successfully carried out over 3 years as part of a previous international course for students from India and China, also funded by the Council of Higher Education (2012-2016).

Cultural events:

Evening events

Graduate students and post-docs of AKIS including Israeli and international students, as well as currently enrolled Chinese and Indian students, will participate in all evening events.

- Welcoming event and ice-breaking – an international cultural evening
- Learning to speak each other's languages
- Food around the world and wine tasting – a sensorial experience

Afternoon short trips

- Ein-Avdat – a desert hiking experience
- Ben-Gurion desert home and grave – a dream coming true

A guided 1-day trip to Jerusalem

The trip will include visits to the following sites: Mount of Olives, Kidron Valley, Wailing Wall, Local Bazaar, Christian Quarter, Via Dolorosa and the Church of the Holy Sepulchre, the Cardo, and the Jewish Quarter.

Accommodation and living standards

BIDR offers high-standard accommodations including dormitories and a guest house that are maintained by the University staff. All accommodation includes a kitchenette and on-suite bathrooms and are suitable for an extended stay. A laundry, common large and equipped kitchen and a dining room are also available for the students.

The students will be provided with a daily hot meal. A local supermarket is available for groceries and other personal needs on campus.

Time schedule for course preparation

March 1st 2017 – Deadline for registration

April 1st 2017 – Notification of acceptance