ETH zürich

World Food System Center

Project Booklet 2024

World Food System Center

A healthy world through sustainable food systems

In an era marked by population growth, climate change, and resource scarcity, the global food system faces unprecedented pressure. The question of how to supply a growing world population with nutritious, healthy, and affordable food while simultaneously safeguarding our planet and empowering agricultural communities is one of the greatest challenges of our time.

The World Food System Center at ETH Zurich is strongly committed to foster multi- and transdisciplinary approaches to address these complex challenges in our food systems. Innovative thinking and collaborative efforts are hallmarks of the Center. The collective expertise of its over 45 research groups from ETH Zurich and the ETH Domain encompasses environmental and agricultural sciences, food science, nutrition, and health. The diverse multidisciplinary competences in technological innovation, economics, and policy of the members allows for pioneering solutions that span the entire food system.

In this booklet, you will discover a selection of projects from Center members, each aimed at addressing pressing issues concerning food and nutrition. These projects are an example of the many innovative ideas that the Center aims to initiate. Ventures that, though presently unfunded, represent our dedication to pragmatic, solution-oriented work.

Across these pages, we endeavoured to showcase the passion of our researchers, the depth of their insights, and the real-world impact that their work delivers. It is our hope that this booklet serves as an inspiration to kindle your enthusiasm and propel you to join us to help create sustainable food systems for all.

Prof. Dr. Christian Wolfrum
Vice President for Research
ETH Zurich

The Center

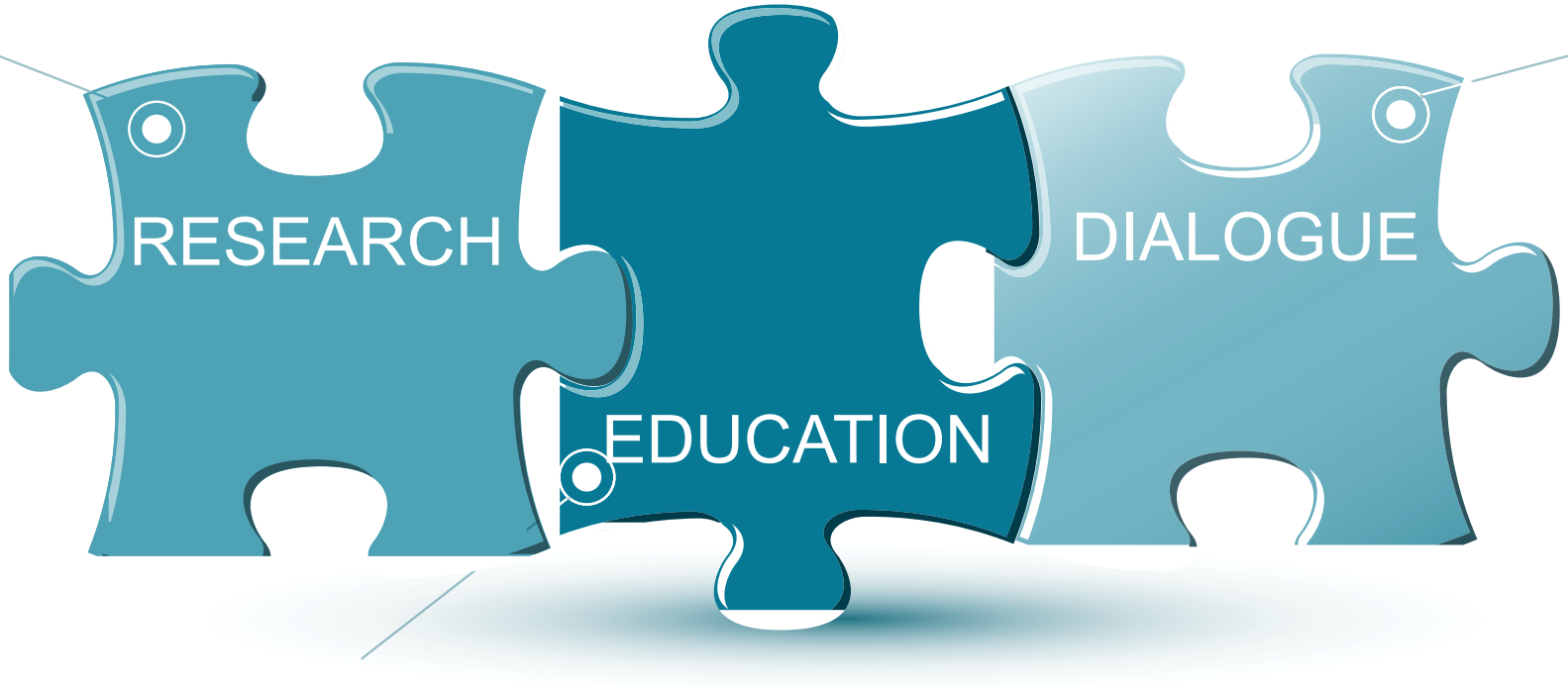
Our Vision: A Healthy World through Sustainable Food Systems

"We strive to provide leadership and foresight on issues connected to food and nutrition security"

The Center aims to generate new scientific knowledge with societal, political, and industrial relevance in a manner that supports real-world impact. We support innovations from the laboratory as well as through dialogue to create lasting positive change.

"Outreach increases awareness of challenges in the world food system and promising approaches to create solutions"

The Center engages with a broad audience to disseminate and discuss new knowledge and innovations that support the achievement of the Sustainable Development Goals.



"Our education courses teach participants to navigate complexity and build sustainable food systems"

The education activities of the Center focus on building capacity in the next generation of decision makers to provide leadership for sustainable food systems issues.

Welcome to the World Food System Center at ETH Zurich

Food systems are key to ensure livelihoods and an adequate supply of healthy and nutritious food for all. However, they strain environmental assets including soil, water, and biodiversity. This is why food systems are at the core of many of the UN Agenda 2030 Sustainable Development Goals (SDGs). The SDGs were defined to support a food systems transformation to make them more productive, environmentally sustainable, and resilient, while preserving and enhancing livelihoods.

Since its inception in 2011, the Center has served as a platform to bring together researchers, with their multidisciplinary expertise, with strategically relevant external partners. We strive to advance sustainable food and nutrition security through dedicated research programs, educational pursuits, and outreach initiatives.

With this booklet, we aim to inspire you to join us in addressing the challenges facing our global food system. We look forward to getting in contact with you, sharing more about the Center and its multifaceted work, and engaging in meaningful conversations and collaborations.

Dr. Martijn Sonnevelt
Executive Director

Reducing N_2O emissions from vegetable farming

Prof. Dr. Nina Buchmann

Rational and Aim of Project:

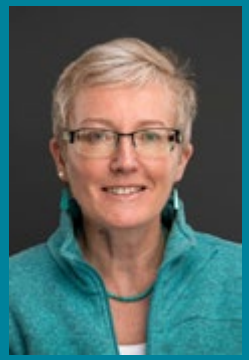
N2O emissions account for 27% of the greenhouse gas emissions from agriculture and hence need to be reduced. Bare soil has been shown to drive N2O emissions, due to the lack of plant root competition for nitrogen. This project aims to quantify N2O emissions from vegetable farming which is characterized by a high fraction of bare soil between crop rows, and to test mitigation options using natural nitrification inhibitors, e.g. plantain.

Prof. Dr. Nina Buchmann

Grassland Sciences

Department of Environmental Systems Science

The Grassland Sciences Group focuses on two major research areas, plant and ecosystem physiology, including functional plant diversity, and ecosystem biogeochemistry, in particular, biosphere-atmosphere greenhouse gas exchange and carbon sequestration.



Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 520,000 CHF

Expected impacts on the food system:

More sustainable vegetable production with reduced greenhouse gas emissions. This contributes directly to the nutrient reduction pathway strategy of Switzerland as well as the new “Klimastrategie Landwirtschaft und Ernährung 2050” of Switzerland.

Increasing biodiversity in Swiss agriculture

Prof. Dr. Robert Finger

Rational and Aim of Project:

Agriculture is key to address biodiversity challenges. In this project we address this issue from two interrelated economic and policy perspectives: i) we investigate factors hindering farms to adopt more biodiversity increasing measures, ii) what policy measures can be used to overcome these factors. A particular emphasis is laid on so far underused approaches such as result based biodiversity payment schemes and exploiting the power of networks.

Prof. Dr. Robert Finger

Agricultural Economics and Policy Group

Department of Management, Technology and Economics and Department of Environmental System Science

The Agricultural Economics and Policy Group aims to improve the understanding of linkages between policies as well as the environment and production and risk management decisions taken in the agricultural sector.

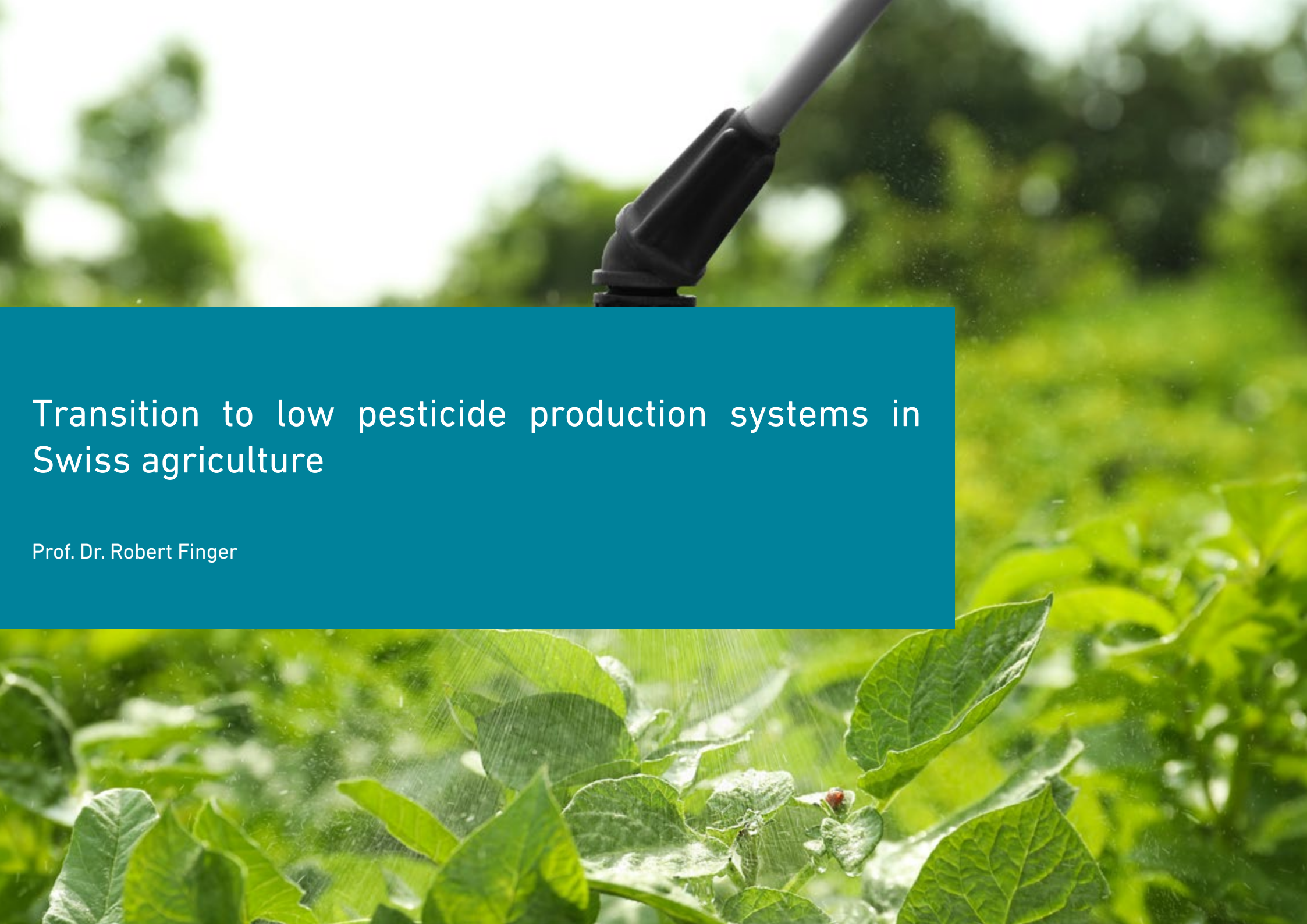
Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

Expected impacts on the food system:

We develop solutions how biodiversity in Swiss agriculture can be increased efficiently. This will be useful for farmers and policy, but also for other stakeholders such as up- and downstream actors.



Transition to low pesticide production systems in Swiss agriculture

Prof. Dr. Robert Finger

Rational and Aim of Project:

Pesticide use risk for the environment and human health need to be reduced. This project will address the required transition of Swiss agriculture from three perspectives: i) the decision of farms to switch their production patterns, ii) the relevance of downstream actors in this transition, iii) the policies that can support such transition. The focus will be on Swiss agriculture, and involve key crops such as wheat, apples and grapevine.

Prof. Dr. Robert Finger

Agricultural Economics and Policy Group

Department of Management, Technology and Economics and Department of Environmental System Science

The Agricultural Economics and Policy Group aims to improve the understanding of linkages between policies as well as the environment and production and risk management decisions taken in the agricultural sector.

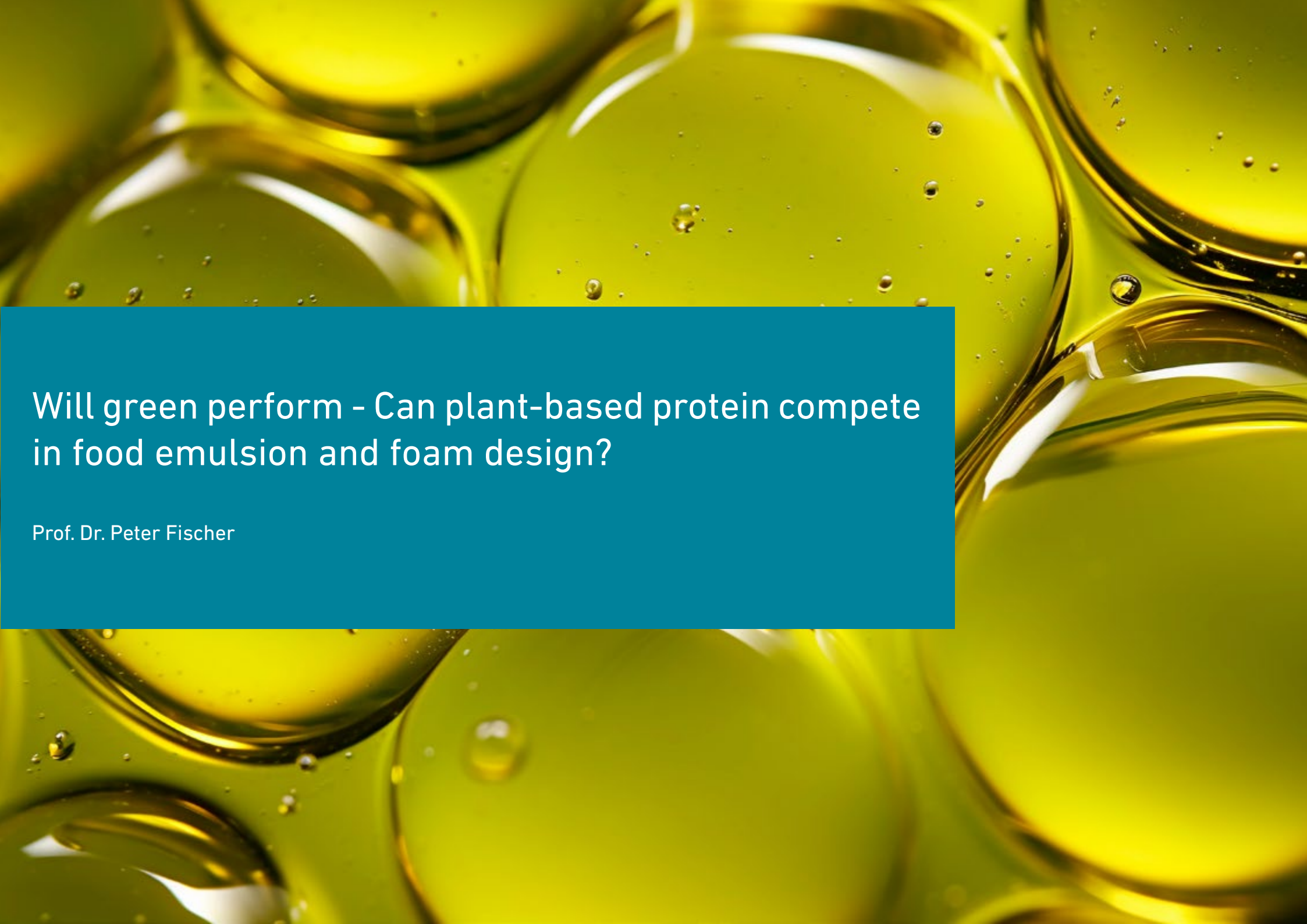
Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

Expected impacts on the food system:

Developing solutions for the transition to low pesticide production system at the level of the farm, the value chain and public policy. These solutions will balance trade-off, e.g. such as farmer income, food production and the environment.



Will green perform - Can plant-based protein compete in food emulsion and foam design?

Prof. Dr. Peter Fischer

Rational and Aim of Project:

Plant-based or green protein sources, which are increasingly replacing animal-based ingredients challenge the existing design and formulation pathways for food emulsions and foams. Using green proteins we compare their performance in bulk and interfacial stabilization of emulsion in comparison to dairy proteins. Further, we address the performance of green emulsions under physiological conditions in different in-vitro digestions setups.

Prof. Dr. Peter Fischer

Institute of Food, Nutrition and Health (IFNH)

Department for Health Sciences and Technology (D-HEST)

The Food Process Engineering group focuses on Process-Structure-Property (S-Pro2) interactions in food/biomaterial systems, which means coupling the fields of food process engineering and food material sciences.

Sustainable Development Goals addressed:

Duration of the project: 3 years

Cost range: 105,000 CHF

Expected impacts on the food system:

The project will identify remaining challenges but also provides detailed recommendations for the transition from animal-based to plant-based proteins within the framework of emulsion and foam structuring.

Understanding rural autonomy: Agrarian restistance movements and self-organization in Latin America

Prof. Dr. Johanna Jacobi

Rational and Aim of Project:

Rural and indigenous farming communities in Latin America are threatened by highly concentrated global food markets. This project aims to study peasant resistance movements and social self-organization through a Photovoice action research process. Farming communities of the Zapatista movement in Mexico and the Consejo Regional Indígena del Cauca (CRIC) in Colombia will participate in the process to communicate their realities as they see them and how their strive for autonomy manifests in agricultural practice.

Prof. Dr. Johanna Jacobi

Agroecological Transition Group

Department of Environmental System Sciences (D-USYS)

By using mixed-methods approaches, the Agroecological Transition Group investigates topics of diversified, democratically organized and culturally acceptable food systems. The group aims to contribute to sustainable and fair agri-food system transformations from social-ecological systems research.

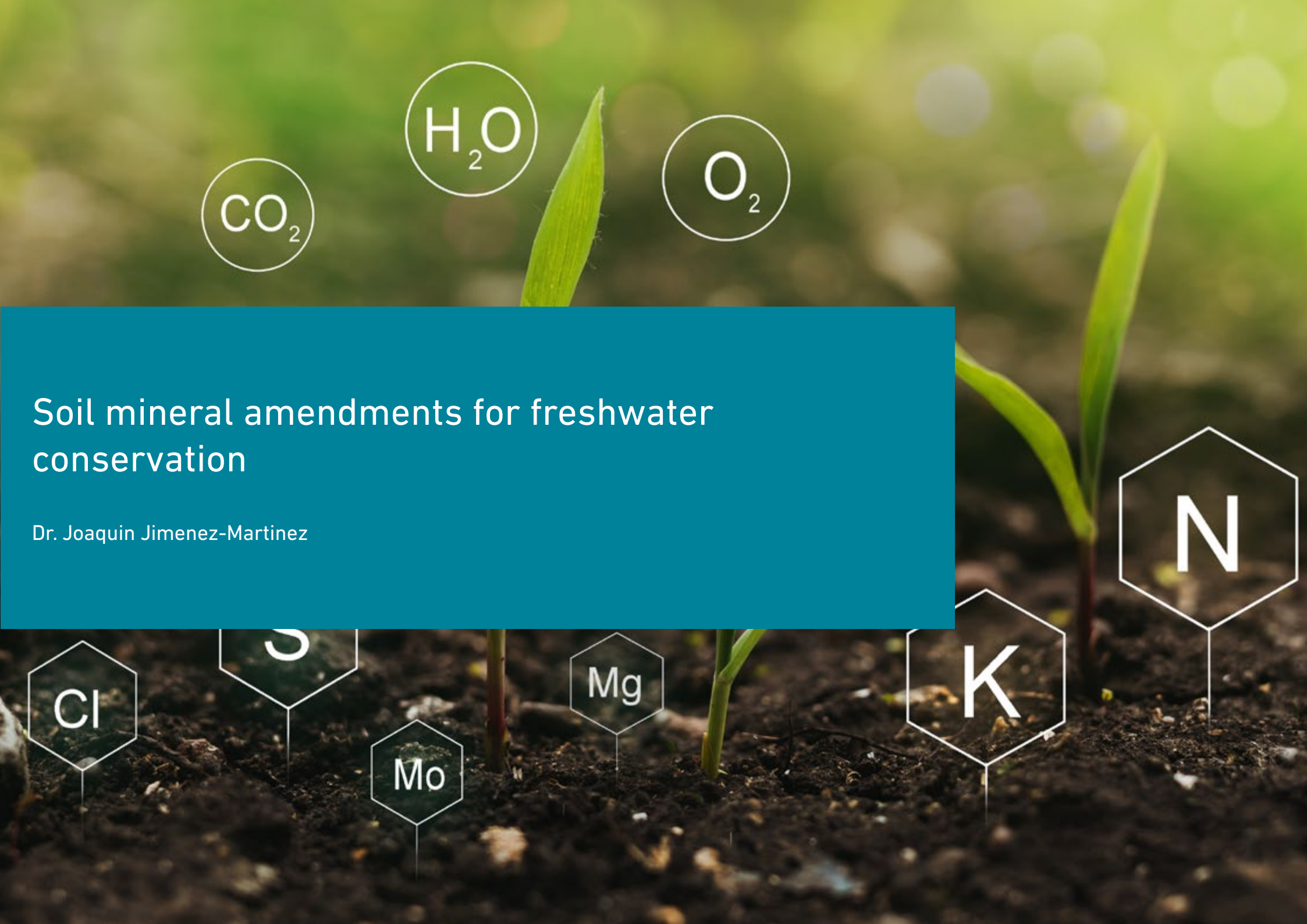
Sustainable Development Goals addressed:

Duration of the project: 3 years

Cost range: 520,000 CHF

Expected impacts on the food system:

The outcomes of this project will inform about drivers and needs of agrarian resistance movements, and demonstrate alternative food system scenarios based on self-organization and mutual support. Furthermore, the visual medium of the Photovoice method will reduce social barriers and allow for engagement and communication with the wider public society.



Soil mineral amendments for freshwater conservation

Dr. Joaquin Jimenez-Martinez

Rational and Aim of Project:

Soil mineral amendments are presented as a low-cost alternative to address several of the Food System Challenges including water conservation (reducing fertilizers leaching), climate change (carbon capturing), and loss of biodiversity (fixing toxic chemicals). However, a barrier to their widespread implementation is the lack of knowledge of their dissolution rates (i.e., the amount of mineral nutrients they can provide to crops).

Dr. Joaquin Jimenez-Martinez

Subsurface Environmental Processes

Department of Water Resources and Drinking Water (EAWAG) and Chair of Groundwater and Hydromechanics (ETH Zurich)

The SEP Group's research aims to quantify the links between the physical heterogeneity of subsurface environments, including porous and fractured media, the heterogeneity of the resulting flow fields, and the effective transport behavior, using both experiments — performed over scales ranging from micro to field scale — and (numerical and theoretical) modelling.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

Expected impacts on the food system:
Soil mineral amendments are expected to improve the productivity of acidified soils, enhance the structure and physical properties of soils, and bind certain toxins (e.g., aflatoxins) as well as heavy metals. While these benefits are mainly oriented towards sustaining crop production, the main expected impacts from this project include the reduction in the use of synthetic fertilizers, and therefore protecting freshwater resources, the protection of soil and groundwater-related ecosystems (biodiversity), and the capture of atmospheric CO2.

Sustainable climate change adaptation for coffee and cocoa cultivation

Dr. Joaquin Jimenez-Martinez

Rational and Aim of Project:

Coffee and cocoa are product connecting the world, from its cultivation in tropical regions to its consumption around the world. Climate change is expected to negatively impact on their cultivation and thus the livelihoods of smallholders in low- and middle-income countries, the primary growers of these crops. Climate change adaptation measures can alleviate these negative effects. They include changes in agronomic practices (e.g., increase in the use of agrochemicals against increases in pests or increase in the water supply for irrigation) and the migration to higher altitudes and latitudes. These different adaptation measures are to varying degrees environmentally, socially, and economically sustainable as well as promotable through behavior change interventions.

Dr. Joaquin Jimenez-Martinez

Subsurface Environmental Processes

Department of Water Resources and Drinking Water (EAWAG) and Chair of Groundwater and Hydromechanics (ETH Zurich)

The SEP Group's research aims to quantify the links between the physical heterogeneity of subsurface environments, including porous and fractured media, the heterogeneity of the resulting flow fields, and the effective transport behavior, using both experiments — performed over scales ranging from micro to field scale — and (numerical and theoretical) modelling.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 520,000 CHF

Expected impacts on the food system:

A project of this characteristics will allow improving our understanding of the impact of social-psychological factors on the adoption of climate change adaptation measures and the subsequent impact on the hydro-system, a hitherto understudied aspect of adaptation measures' environmental sustainability.

Foam mat microwave vacuum drying and microwave freeze drying of algae biomass without additives

Prof. Dr. Alexander Mathys

Rational and Aim of Project:

Algae biomass represents a more sustainable equally nutrient-dense food ingredient as animal-based foods do. However, the quality of algae biomass is often unsatisfactory due to sensory defects origination from the exposure to oxygen and high temperatures during drying. Current air-drying processes use fossil fuels as energy source. In addition, the process is slow due to skin formation on the product surface during drying. Microwave vacuum drying offers a future-proof fully electric drying technology by providing rapid heat transfer, 'volumetric heating', and in-situ product foaming for fast and gentle drying under vacuum (little oxygen) at low temperature.

Prof. Dr. Alexander Mathys

Sustainable Food Processing Laboratory

Department of Health Sciences and Technology

The Sustainable Food Processing group focuses on a system oriented approach in food production via the consideration of the total value chain including emerging needs in society and their environmental, economic and social impact.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

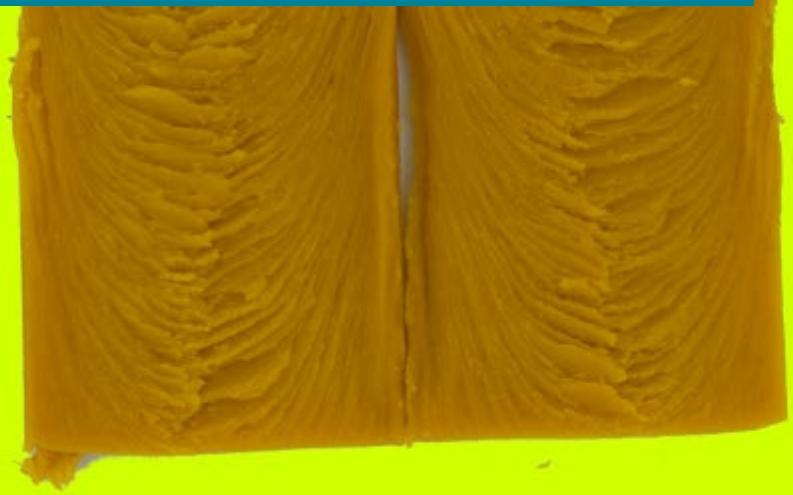
Expected impacts on the food system:

The outcomes of this project will help to develop a resource-efficient, fully electric, and fast drying technology for high quality algae biomass for human nutrition. Electricity will be based on 100% renewable energy.

Food

Health effects of highly processed meat alternatives

Prof. Dr. Alexander Mathys



Obesity

Rational and Aim of Project:

Obesity is considered to be one of the top five threats to mankind, which constitutes the second leading cause of preventable death after smoking. The causes (especially the level of intensity of food processing) that drive positive energy balance among obese people remain unclear. This project aims to understand the relationship between food macronutrient composition, food process intensity, and its effect on the regulation of energy intake in both mouse and human systems.

Prof. Dr. Alexander Mathys

Sustainable Food Processing Laboratory

Department of Health Sciences and Technology

The Sustainable Food Processing group focuses on a system oriented approach in food production via the consideration of the total value chain including emerging needs in society and their environmental, economic and social impact.

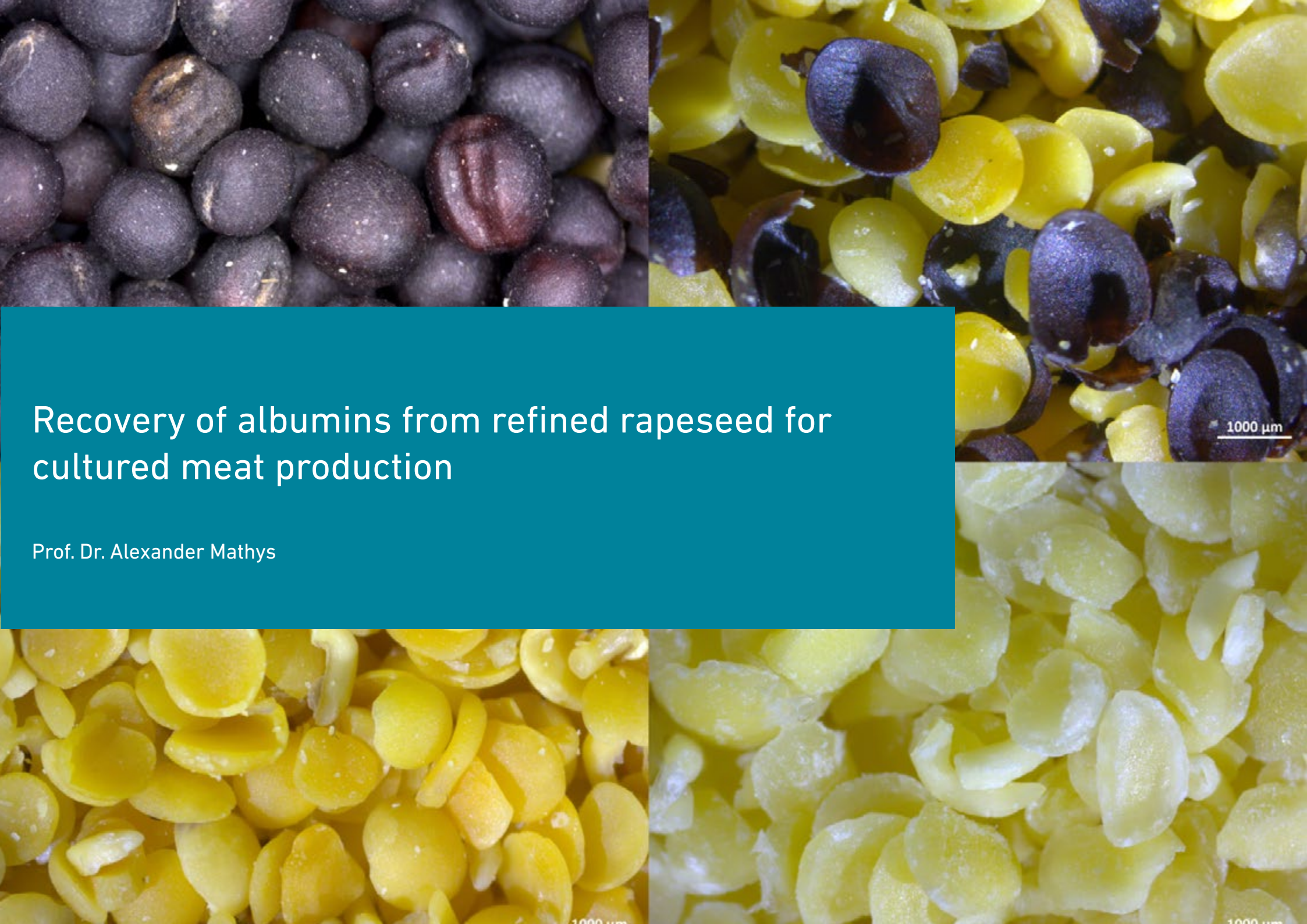
Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

Expected impacts on the food system:

The outcomes of this project will help to develop processes to generate meat alternatives that also have a beneficial effect on health of the population and final sustainability performance.



Recovery of albumins from refined rapeseed for cultured meat production

Prof. Dr. Alexander Mathys

Rational and Aim of Project:

A key challenge for cost-effective production of cultured meat is the availability of an affordable source of albumins to be added to serum-free media. Current formulations use high-cost recombinant albumins since animal-based albumins from fetal bovine serum (FBS) would not be considered vegan or efficient. As a result, there is substantial interest in recovering purified albumin from a high-albumin source (>50% of total protein) such as rapeseed which is low-cost, scalable, sustainable, and proven to be effective.

Prof. Dr. Alexander Mathys

Sustainable Food Processing Laboratory

Department of Health Sciences and Technology

The Sustainable Food Processing group focuses on a system oriented approach in food production via the consideration of the total value chain including emerging needs in society and their environmental, economic and social impact.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 520,000 CHF

Expected impacts on the food system:

The outcomes of this project will help to replace fetal bovine serum or recombinant albumin by refined rapeseed albumin to make cultured meat an accessible and more affordable alternative to traditional meat.

Biological control of below-ground pests using combinations of insecticidal *Pseudomonas* bacteria, fungi and nematodes

Prof. Bruce McDonald

Rational and Aim of Project:

Our aim is to develop a biocontrol strategy based on the combination of insecticidal pseudomonads, fungi and nematodes to control the cabbage maggot, an important pest of cruciferous crops. In several field trials, we plan to evaluate the efficacy and stability of the previously selected biocontrol agents alone and in combination. We further want to study the interactions of these organisms when applied together and to ensure the safety for farmers, consumers and the environment by performing a risk assessment.

Prof. Bruce McDonald

Plant Pathology Group

Institute of Integrative Biology

Department of Environmental Systems Science

Sustainable Development Goals addressed:

Duration of the project: 3 years

Cost range: 520,000 CHF

Expected impacts on the food system:

By developing an effective biocontrol strategy based on the combination of different biocontrol agents, farmers gain an environmentally-friendly way to control pests and pesticide use can be reduced.

Decent work in food systems

Prof. Dr. Eva-Marie Meemken

Rational and Aim of Project:

Reaching the 8th SDG, decent work and full employment, remains a great challenge in food systems globally. While a wealth of literature documents the precariousness of work (in e.g., meat processing, tropical plantation farms, and restaurants especially among hired workers), it remains unclear how conditions can be improved. Our goal is to evaluate existing or new tools/policies (e.g., sustainability standards, blockchain) that are aimed at improving or monitoring working conditions.

Prof. Dr. Eva-Marie Meemken

Food Systems Economics and Policy Group

Department of Environmental Systems Sciences

The FSEP group conducts applied research that contributes to a better understanding of how to promote sustainability goals in global food systems, with a special focus on the analysis of policies and institutional arrangements (such as contracts and standards) and their role in poverty reduction, decent employment, gender equality, and food and nutrition security in lower-income countries.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 260,000 CHF

Expected impacts on the food system:

The social footprint of food consumption receives increasing public and policy attention, but evidence is lacking. We generate novel evidence on how to improve the conditions facing food workers, which is relevant for these workers (who belong to the most vulnerable actors in food systems) as well as consumers, the private sector, and policymakers.

Optimizing nutrition to reduce the impact of heat stress on productivity and welfare of dairy cows

Prof. Dr. Mutian Niu

Rational and Aim of Project:

As climate change brings increasing frequent extreme weather conditions, heat stress (HS) presents a significant challenge to livestock production, particularly affecting animal welfare.
Dairy cows are notably susceptible to HS due to their high metabolic activity, especially during lactation. The overall goal of the proposed project is to better monitor and understand
the physiological and behavioral changes of dairy cows experiencing HS, and then, to develop and evaluate nutritional strategies for the mitigation of HS-related production losses
and impaired cow well-being.

Prof. Dr. Mutian Niu

Animal Nutrition

Department of Environmental Systems Science

The Group of Animal Nutrition performs research in the area of nutrition of ruminants, pigs and poultry. The focus is put on the interactions between plant and animal and animal with the environment. Other focal points are digestive physiology, sustainable low-emission feeding systems as well as meat, egg and milk quality. low-emission feeding systems as well as meat, egg and milk quality.

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 520,000 CHF

Expected impacts on the food system:

The findings from this project will advance the knowledge of the biological functions of dairy cows and respective changes under HS conditions, effectively counteracting the negative impact of HS on animal welfare and nutrient use-efficiency and thereby improving the sustainability of dairy food system.

One health through dynamic cocoa agroforestry in Ghana – A transdisciplinary study

Prof. Dr. Johan Six

Rational and Aim of Project:

Despite being large cocoa producer, Ghana's cocoa sector is faced with an environmental and human health crisis. Bio-physically, full-sun monocultures have led to low soil fertility driving deforestation at significant costs to food security at the local level. The overall objective is to develop science-based recommendations to be integrated into a decision-making tool to accelerate the scaling up of dynamic agroforestry (DAF) in the cocoa sector of Ghana based on geographic information systems (GIS).

Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: 520,000 CHF

Expected impacts on the food system:

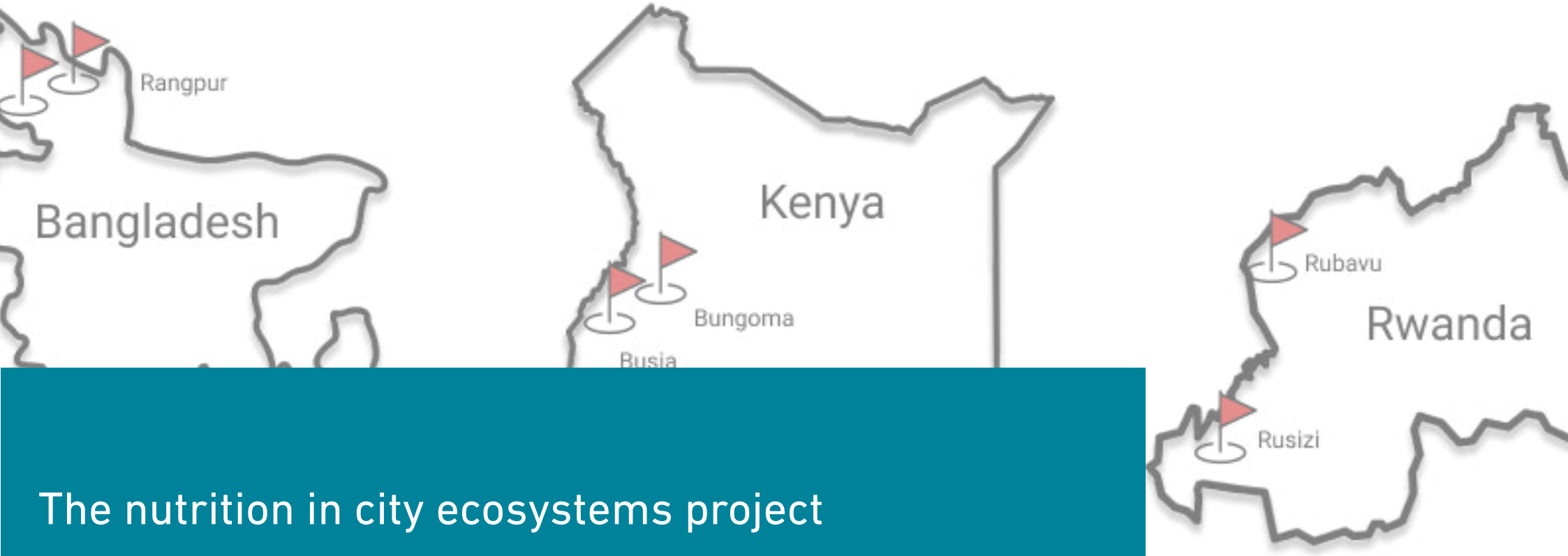
The expected impacts are: i) a deepened understanding of the factors that influence the adoption of DAF, ii) science-based decisions by practitioners on DAF implementation, iii) One Health for improved environmental and human health in the cocoa sector of Ghana, iv) Improve monitoring of dynamics agroforestry using remote sensing.

Prof. Dr. Johan Six

Sustainable Agroecosystems Group

Department of Environmental Systems Science

The group studies how management affects the complex interactions between soil, plants, and carbon and nutrient fluxes within agroecosystems and its implications for food system functioning within a continuously changing global environment.



The nutrition in city ecosystems project

Prof. Dr. Johan Six and Dr. Dominique Barjolle

NUTRITION *in* CITY ECOSYSTEMS

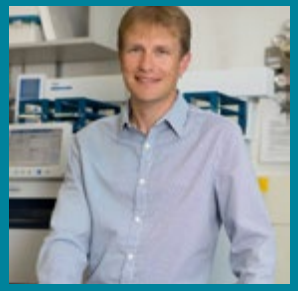
Rational and Aim of Project:

The Swiss Agency for Development and Cooperation's (SDC) Nutrition in City Ecosystems (NICE) project connects the demand and supply side of food systems, engages women and youth - including through social business models - and builds local governance capacity initially in two secondary cities each in Bangladesh, Kenya and Rwanda.

Prof. Dr. Johan Six

Sustainable Agroecosystems Group

Department of Environmental Systems Science



Dr. Dominique Barjolle

Institute of Agricultural Sciences

Department of Environmental Systems Science

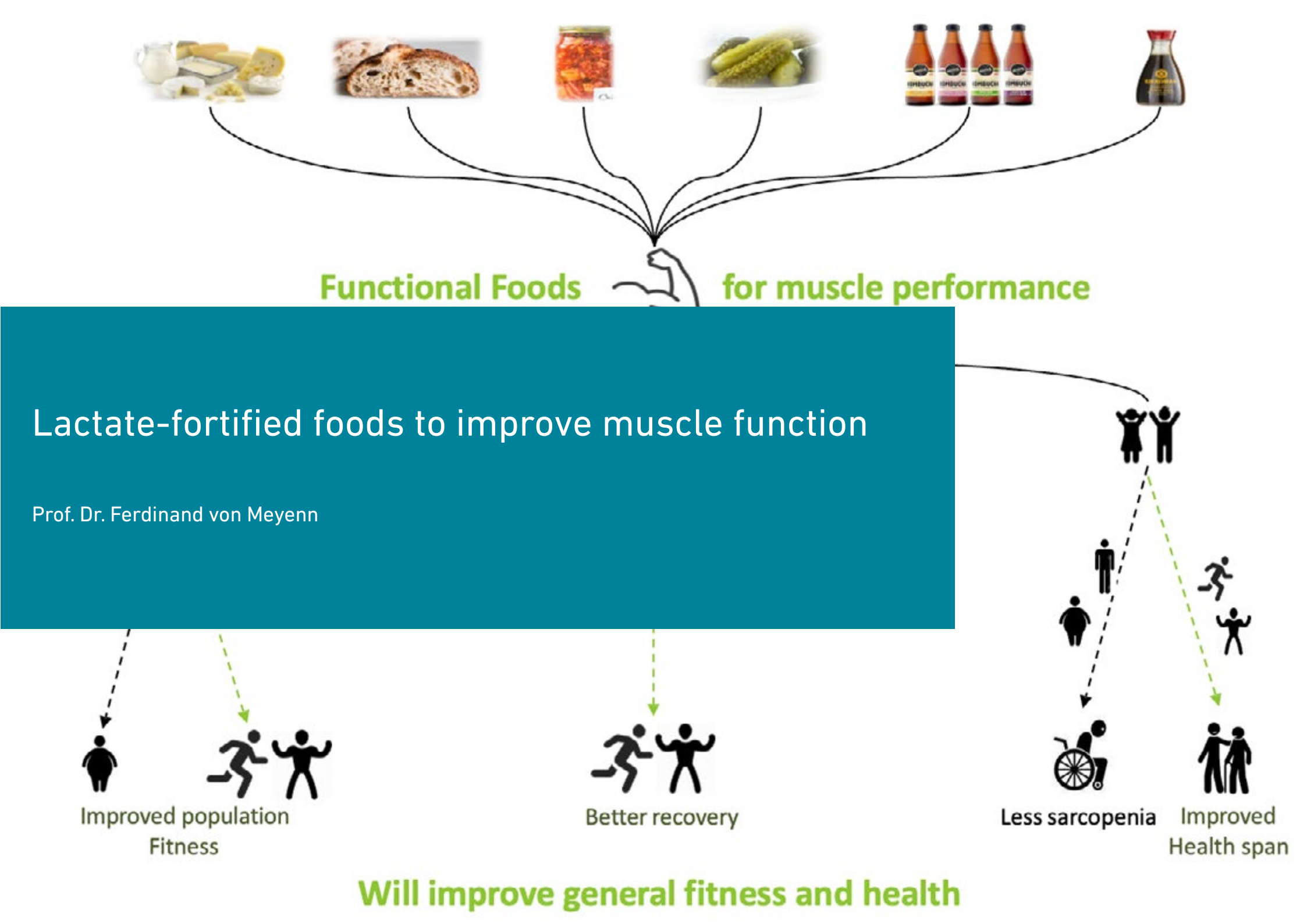
Sustainable Development Goals addressed:

Duration of the project: 4 years

Cost range: >520,000 CHF

Expected impacts on the food system:

Emphasis is placed on increasing the production and demand for local, diverse, agroecologically produced foods, and on making food value chains more nutrition-focused so they contribute to better health. Multi-stakeholder and multisectoral collaboration bring together city authorities, local businesses and civil society and creates a dynamic network of city learning hubs for dissemination and scale up.



Lactate-fortified foods to improve muscle function

Prof. Dr. Ferdinand von Meyenn

Rational and Aim of Project:

We have showed that histone lactylation, which can directly be derived from lactate, is important for cell- and tissue-specific functions, and that its levels in in vitro muscle models are strongly responsive to the manipulation of L-lactate levels (Galle et al., 2022). Since lactate and histone lactylation levels decrease with ageing, lactate-fortified foods to improve muscle function could be of particular interest in the fight against sarcopenia. The goal of our project is to investigate whether orally consumed lactate can mitigate the loss of muscle function that is seen during ageing.

Prof. Dr. Ferdinand von Meyenn

Laboratory of Nutrition and Metabolic Epigenetics

Department of Health Sciences and Technology

Work in the Laboratory of Nutrition and Metabolic Epigenetics focuses on the interplay between nutrition, metabolism and epigenetics in human patients, animal models and in vitro cell systems.

Sustainable Development Goals addressed:

Duration of the project: 3-5 years

Cost range: 260,000 CHF

Expected impacts on the food system:

Address the unmet need of a continuously growing population, the elderly, for easy and non-intrusive access to sarcopenia-alleviating actors.

Nutritional potential of traditional foods and industry side streams as quality sources of micronutrients (Fe, Zn) and protein

Prof. Dr. Ferdinand von Meyenn and Prof. Dr. Diego Moretti

Rational and Aim of Project:

The transition to a more environmentally friendly food system requires the identification of plant-based animal food alternatives which are viable sources of micronutrients and proteins, but at the same time are both economically and environmentally sustainable. We aim to investigate and develop under-characterized traditional foods (e.g. mushrooms) with high potential for acceptability and industry side streams (e.g. spent grains) as potential nutritious sources of micronutrients and protein. The investigation will include nutritional characterization and the assessment of bioavailability and/or digestibility.

Prof. Dr. Ferdinand von Meyenn

Laboratory of Nutrition and Metabolic Epigenetics

Department of Health Sciences and Technology

Prof. Dr. Diego Moretti

Professor for Nutrition, Bioavailability and Food Science (SNSF and SUPSI)

Swiss Distance University of Applied Sciences

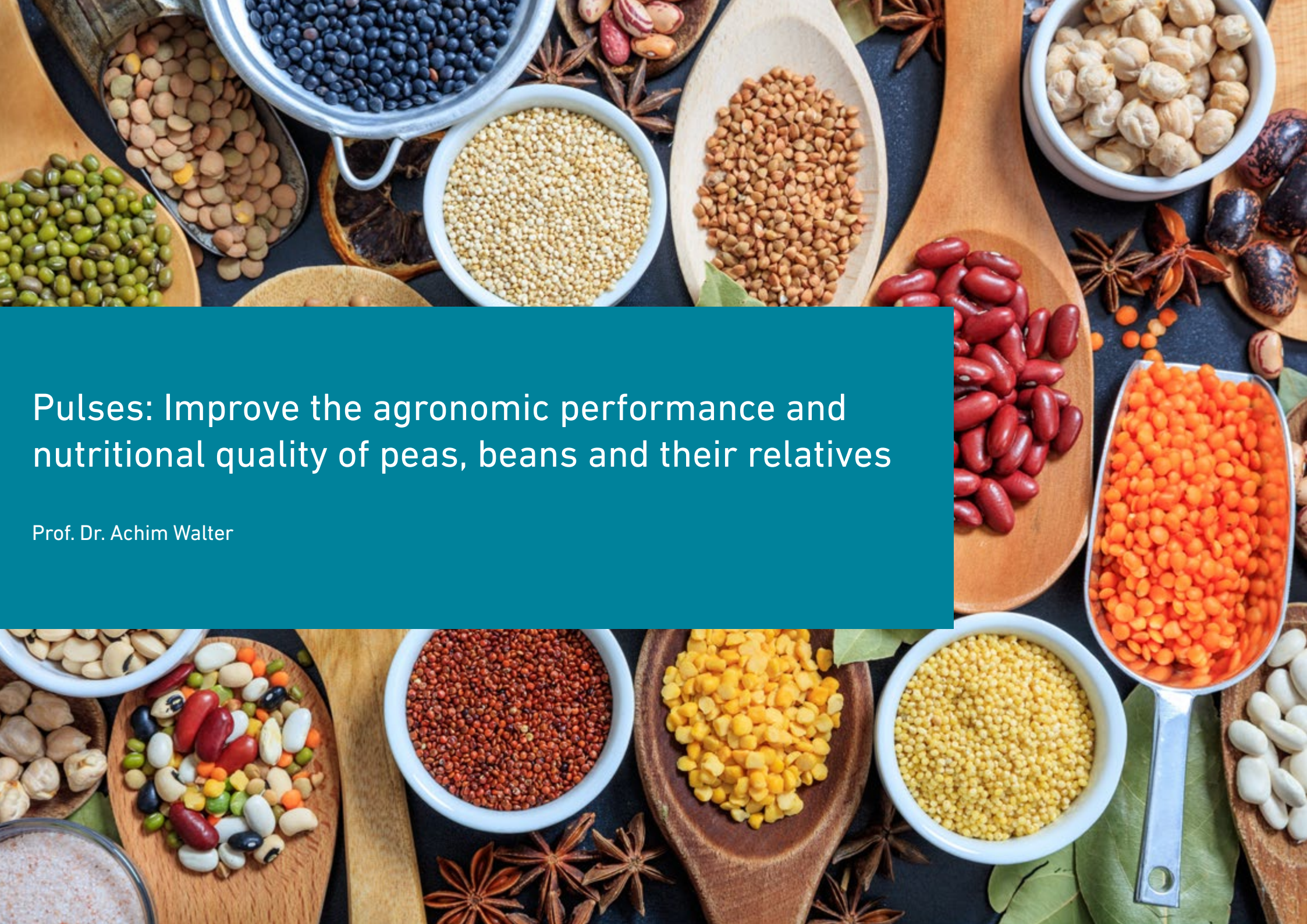
Sustainable Development Goals addressed:

Duration of the project: 3.5 years

Cost range: 260,000 CHF

Expected impacts on the food system:

The identification and characterization of micronutrient content and bioavailability from the foods will allow to identify opportunities for nutritional enhancement within sustainability targets and the planetary boundaries.



Pulses: Improve the agronomic performance and nutritional quality of peas, beans and their relatives

Prof. Dr. Achim Walter

Rational and Aim of Project:

The group of Crop Science has been cultivating pea and soybean varieties / accessions in their field site in Eschikon for some years. Our field phenotyping approaches allow characterization of agronomic features such as susceptibility to cold temperatures, flowering time, canopy closure and others supported by artificial intelligence. Aims of future projects could range from combining phenotypic data with biochemical (e.g. protein quality) analyses of the seed material to establishing market potential of the investigated species, varieties or accessions.

Prof. Dr. Achim Walter

Crop Science

Department of Environmental Systems Science

The Crop Science group establishes and applies crop phenotyping technologies. They address the central question of how the performance of crops can be analyzed from image-based analyses of shoots and roots in the lab and in the field. This is done in crops such as wheat and soybean.

Sustainable Development Goals addressed:

Duration of the project: 1-4 years

Cost range: 260,000 CHF

Expected impacts on the food system:

Improve plant-based nutrition by generating more resilient varieties of pulses that are not only better adapted to the changing climate but also have superior nutritional properties compared to existing species or varieties.

Contact

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