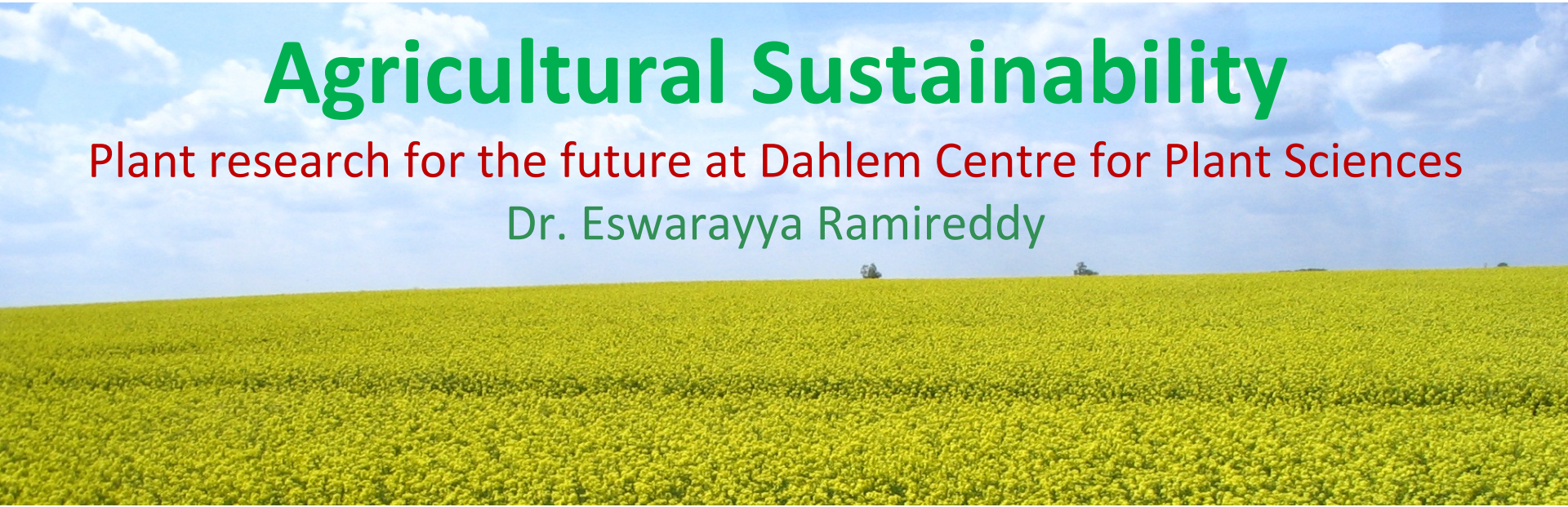
India Germany
connecting cultures

Freie Universität Berlin

DCPS
Dahlem Centre
of Plant Sciences



Agricultural Sustainability

Plant research for the future at Dahlem Centre for Plant Sciences

Dr. Eswarayya Ramireddy

Agricultural Sustainability

The first principle of the 1992 Rio Declaration (UN, 1992) states:

Human beings are at the center of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

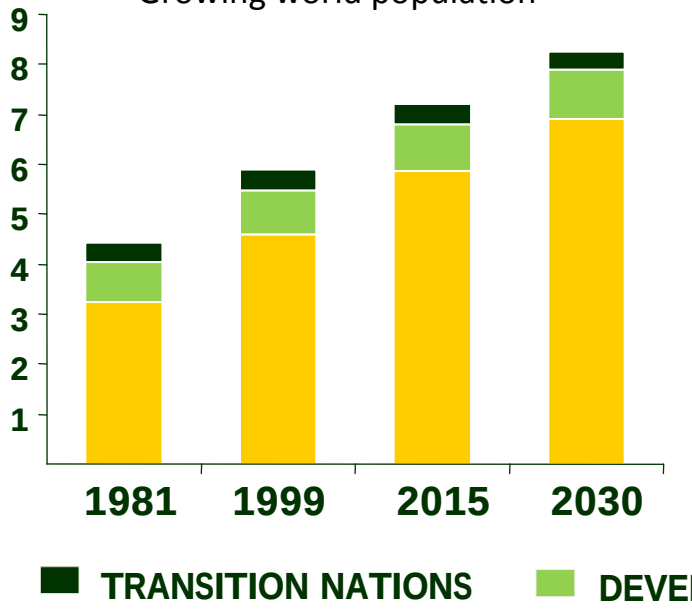
Sustainable development was defined as..

"meeting the needs of the present without compromising the ability of future generations to meet their own needs".

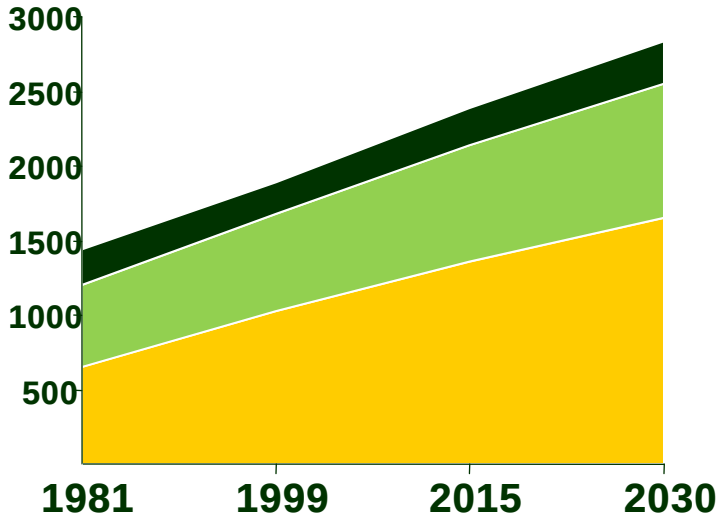
Where we stand after 20 years?

Agricultural production must grow 60 % above the level 2007 to meet the projected demand

Growing world population



Rising cereal demeand (MMT)

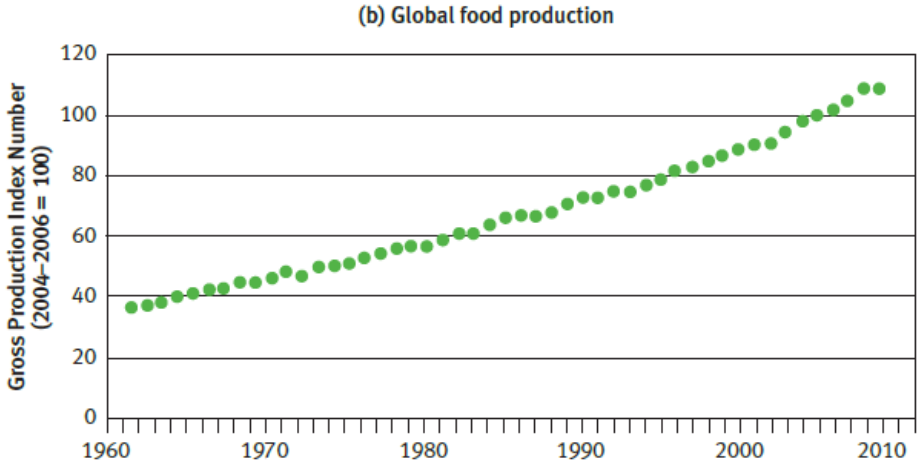


TRANSITION NATIONS DEVELOPED NATIONS DEVELOPING NATIONS

Source: FAO, Statistics Division

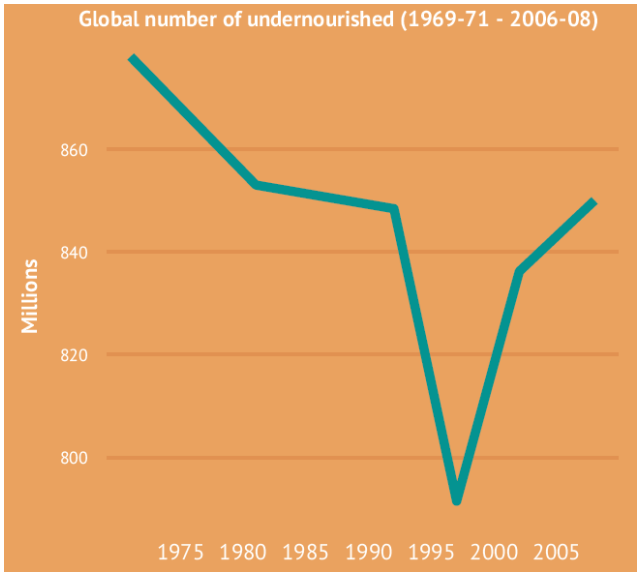
- World population continues to increase
- Per capita food consumption continues to rise
- Consumers continue to demand improved taste, convenience, and nutrition

15 percent of the world's population are suffering from undernourishment



Annual growth in world agricultural production (1997–2007)

2.2%



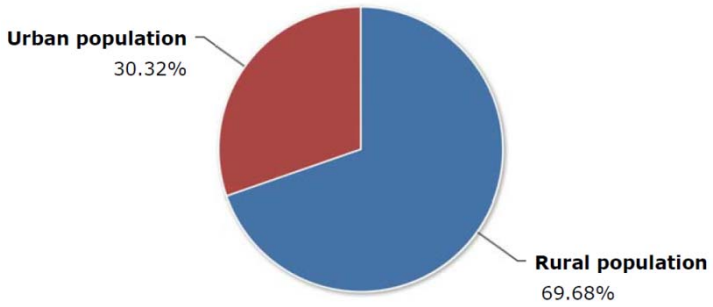
Source: FAO, Statistics Division

People in the world (2011)[58]	**7 billion**
Undernourished people (2010)[59]	**0.9 billion**
Overweight people over age 20 (2008)[60]	**1.5 billion**
People living on less than USD 1.25 per day (2005)[61]	**1.4 billion**

(Source: FAO, Year book 2012)

35 % of world population derive their livelihoods from agriculture

India



Evolution of population and labour force size

	Size [Millions]			
	1996	2001	2006	2011
Total population	982.55	1071.37	1157.04	1241.49
Agricultural population	540.30	563.64	581.88	594.57
Total labour force	376.25	414.49	458.97	505.28
Labour force in agriculture	229.20	242.95	258.61	272.71

Source: FAOSTAT, FAO of the UN, Accessed on June 23, 2011.
http://faostat.fao.org/site/550/default.aspx#ancor

Well over half of the developing world's population – 3.1 billion people, or 45 percent of all humanity – live in rural areas. Of them, roughly 2.5 billion derive their livelihoods from agriculture.

Indian agriculture continues to be a gamble with monsoons, means 22% of the population lives in uncertainty.

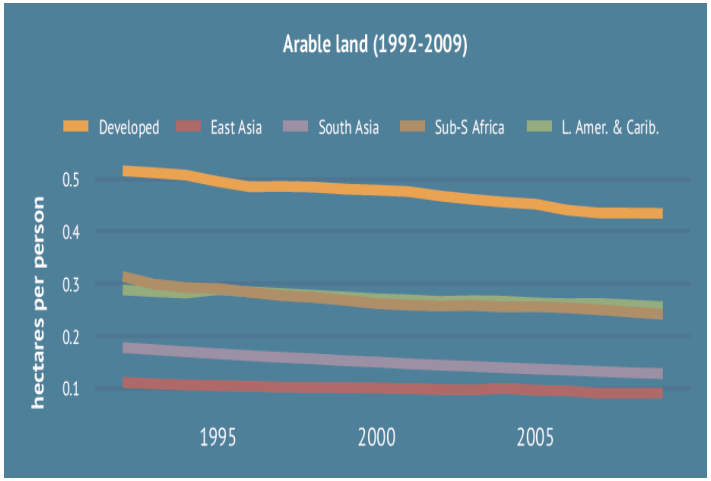
To feed a growing population we must increase agricultural production while preserving the environment.

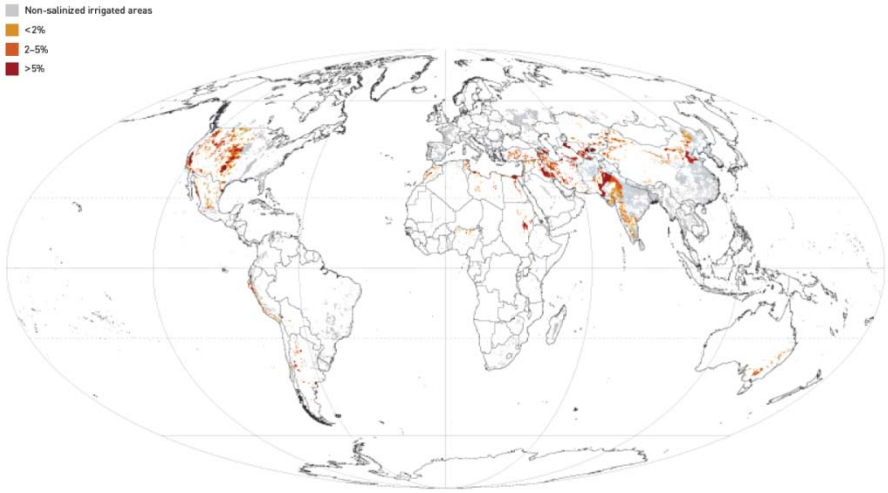
Challenges associated with agricultural growth

Key environmental challenges that can be potentially threaten the future viability of agricultural systems are …..

- Land degradation
- Limits to water availability
- Loss of biodiversity and declining agricultural genetic diversity
- Climate change

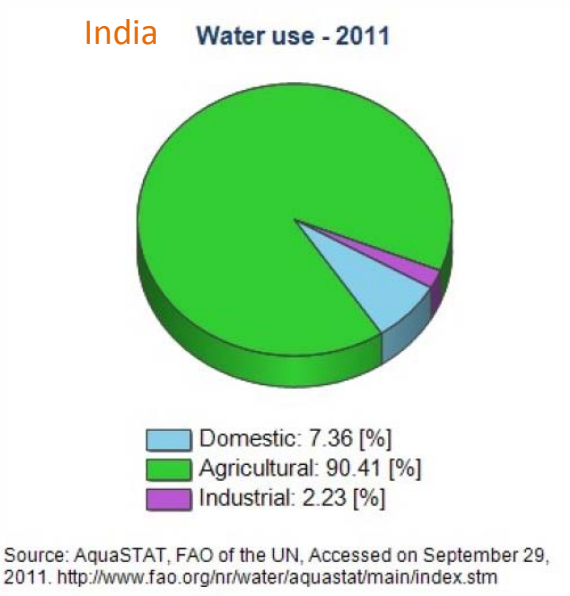
Land degradation threatens the productivity of existing farmland and pastures





- 0.2 hectares of arable land available per person in 2009, less than half the amount 50 years ago.
- About 1.2 billion hectares (almost 11% of the Earth's vegetated surface) has been degraded by human activity over the past 45 years.
- land degradation costs an estimated US$40 billion annually worldwide.
- Nearly 34 million hectares (11 percent of the irrigated area) are affected by salinization.

Coping with water scarcity

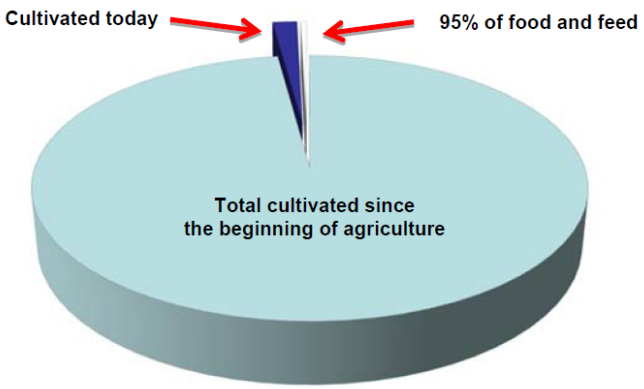


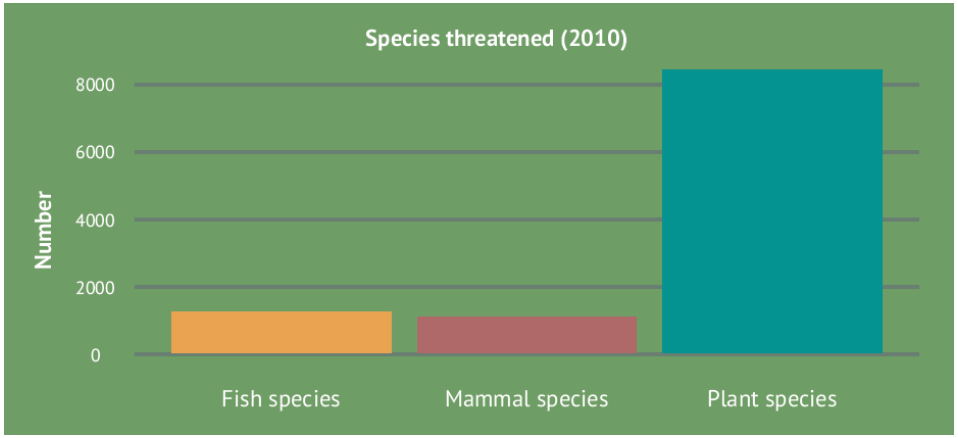
Source: AquaSTAT, FAO of the UN, Accessed on September 29, 2011. http://www.fao.org/nr/water/aquastat/main/index.stm

Today, agriculture accounts for about 70 percent of the **freshwater withdrawals** in the world, mostly through irrigation.

Increasing water scarcity increases the competition for water by different sectors

Sustainable food security is facing a major bottleneck





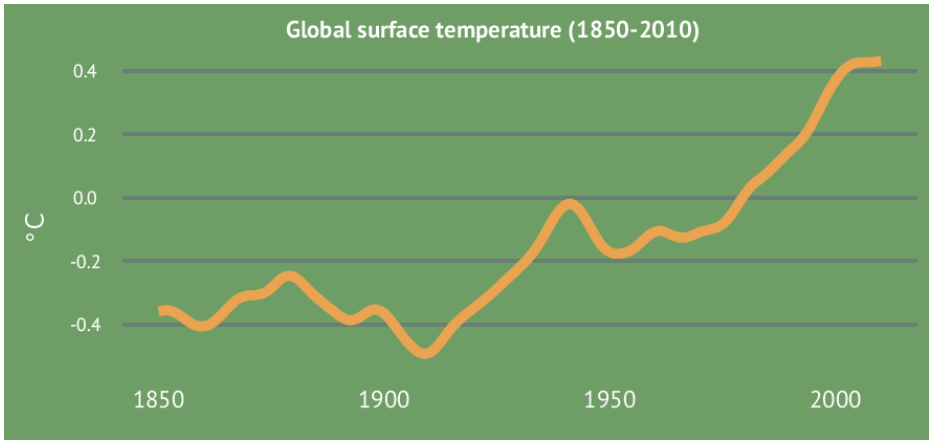
Since the beginning of agriculture, humans have cultivated 7,000 plant species

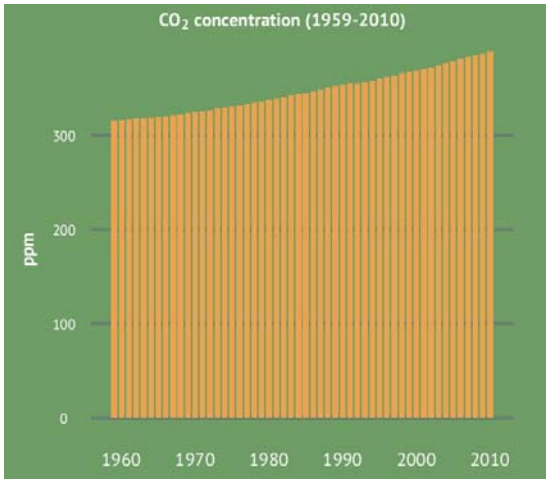
- Today only 150 plant species (2%) are agriculturally relevant for food and clothing
- Only 10 plant species are cultivated today to provide 95% of food and feed
- Only 14 domesticated mammal and bird species now provide 90 percent of the human food supply from animal sources

A large number of animal and plant species threatened from human activity including the intensification of agriculture

Such a narrow genetic basis puts food sustainability at risk

Global warming will have significant impacts on agriculture





Source: IPCC

Global atmospheric **temperature** is predicted to rise by approximately 4°C by 2080, consistent with a doubling of atmospheric CO2 concentration.

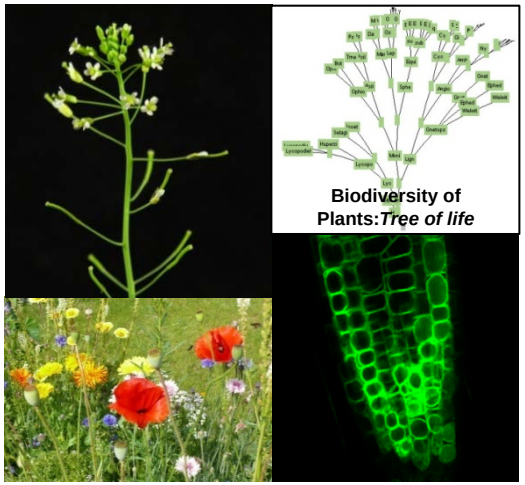
In the past two decades CO2 concentration has risen by 10 percent.

Many edible species may be resilient to climate changes, but they are currently understudied.

Research objectives of DCPS

Our mission:

Understanding of plant diversity and development of science-based tools for their sustainable use



Diversity and Function

Plant and Environment

Applied Plant Sciences

Participating Research Areas

Botanic Garden and Botanical Museum

- Systematics and the Evolution of Selected Plant Groups
- Plant Diversity in the Regions of the World
- Biodiversity Informatics
- History of Plant Sciences

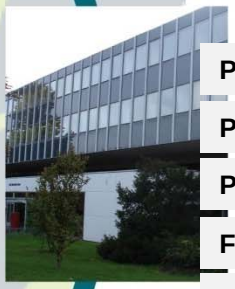
Applied Genetics

- Molecular Developmental Biology of Plants
- Molecular Plant Genetics
- Plant Molecular and Cell Biology
- Molecular Biology of Organelles
- Signal Transduction of Plants

- Animal Ecology
- Molecular Ecology

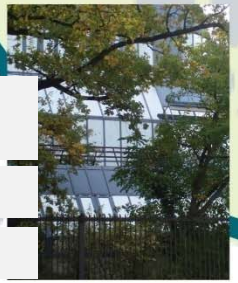
Applied Zoology

DCPS
Dahlem Centre of Plant Sciences



- Plant Biochemistry
- Plant Physiology
- Plant Ecophysiology
- Functional Biodiversity
- Plant Nitrogen Metabolism

Plant Biochemistry and Physiology



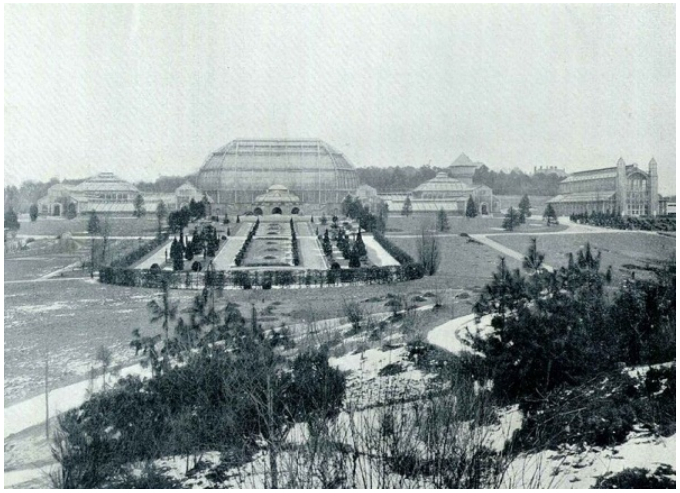
- Systematic Botany and Plant Geography
- Morphology and Systematics
- Plant Ecology

Plant Ecology and Systematics

- Pharmaceutical Biology

Pharmacy

Dahlem – a Historical Centre of Plant Sciences



Botanic Garden Berlin-Dahlem 1909

Genetics conference 1927

- Dahlem is in Berlin (and Germany) a historical site of plant sciences.
- In 1907 the Botanic Garden and Botanical Museum were moved to Dahlem. Today, the Botanical Garden is the third largest of its kind, with respect to surface, number of plant species cultivated (ca. 22,000) and collections (ca. 3.5 m).
- In 1922, the Institute of Heredity Research of the Royal Prussian Agricultural University was established in Dahlem as the first genetics institute in Germany. Today it is part of the Institute of Biology (Applied Genetics).

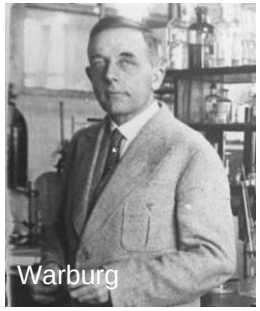
Dahlem – a Historical Centre of Plant Sciences

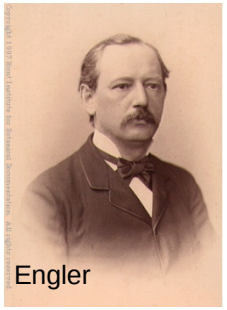
In the beginning 20th century several important contributions to plant research come from Berlin-Dahlem

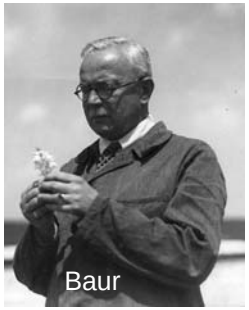
Carl Correns – rediscovery of the Mendel Laws
Richard Willstätter (Nobel Prize 1915) and Arthur Stoll – structure of chlorophyll and anthocyans
Otto Warburg (Nobel Prize 1931) – photosynthesis and primary metabolism
Adolf Engler – plant systematics and plant geography
Erwin Baur – plastid inheritence
Gottlieb Haberlandt – physiological plant anatomy
Hermann Thoms - Pharmacognosy

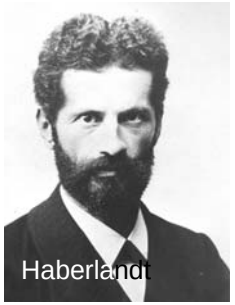

Correns

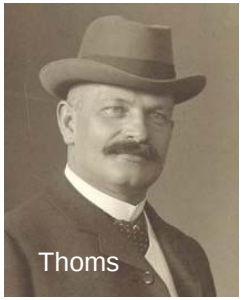

Willstätter


Warburg

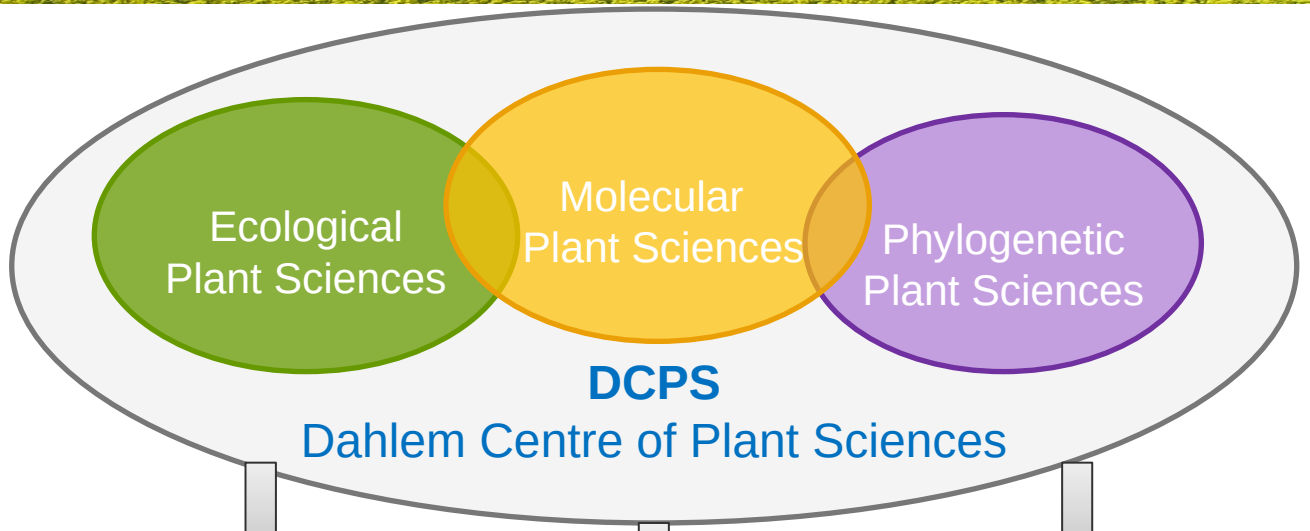

Engler


Baur


Haberlandt


Thoms

Projects in DCPS



Diversity and Function

DCPS Research Unit
Changes in Organismal Complexity across Key Steps in Plant Evolution

DFG – Research Centre "Integrated Biodiversity" CEBAS

Plant and Environment

DCPS Research Unit
•The Invisible Half: Relevance of Root for second green revolution

SFB-973
"Priming of Organismic Responses to Stress"

Applied Plant Sciences

Conservation of Diversity and Sustainable use of Plant Resources

Changes in organismal complexity across key steps in plant evolution

Evolution of proteases in latices of Asterales and their application in medicine

Pharmaceutical Biology (AG Melzig) and Systematics (BGBM, AG Borsch / von Raab-Straube)

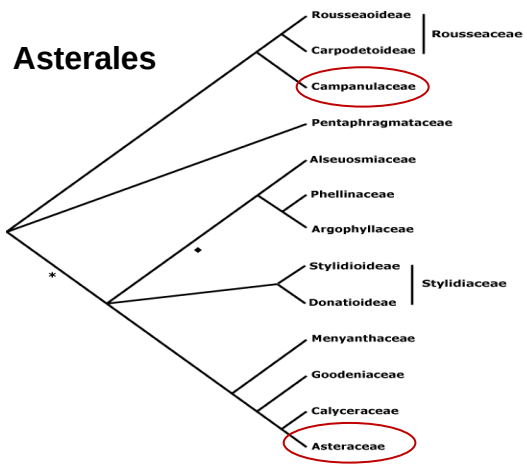
Several hundred Asteraceen and Campanulaceen are among the living collection of BGBM.





Prof. Thomas Borsch

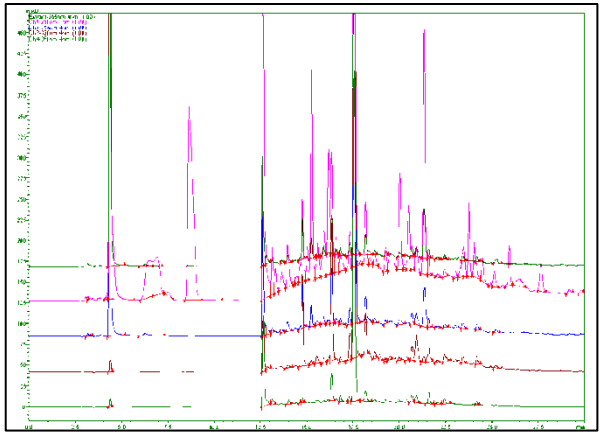

Prof. Matthias F. Melzig



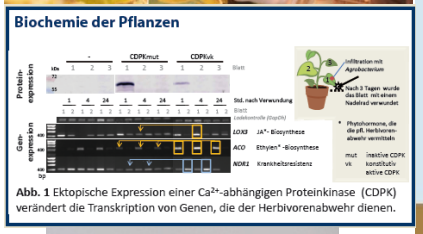
(modified from Angiosperm Phylogeny Website 2009)


ca. 2,400 species

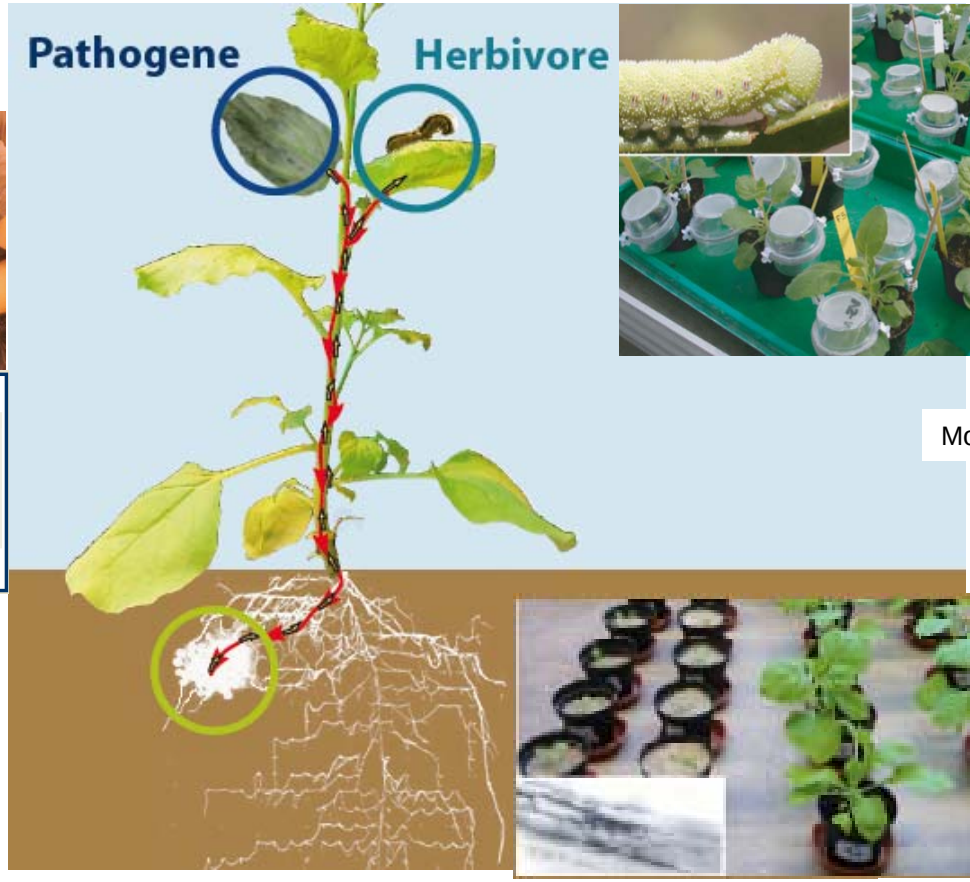

ca. 23,600 species

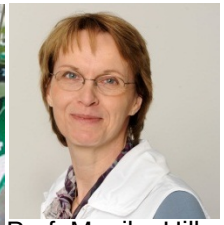

Analysis of latex components

Multitasking Plants – How to cope with many opponents in a row?



Plant Biochemistry (AG Romeis)





Prof. Monika Hilker

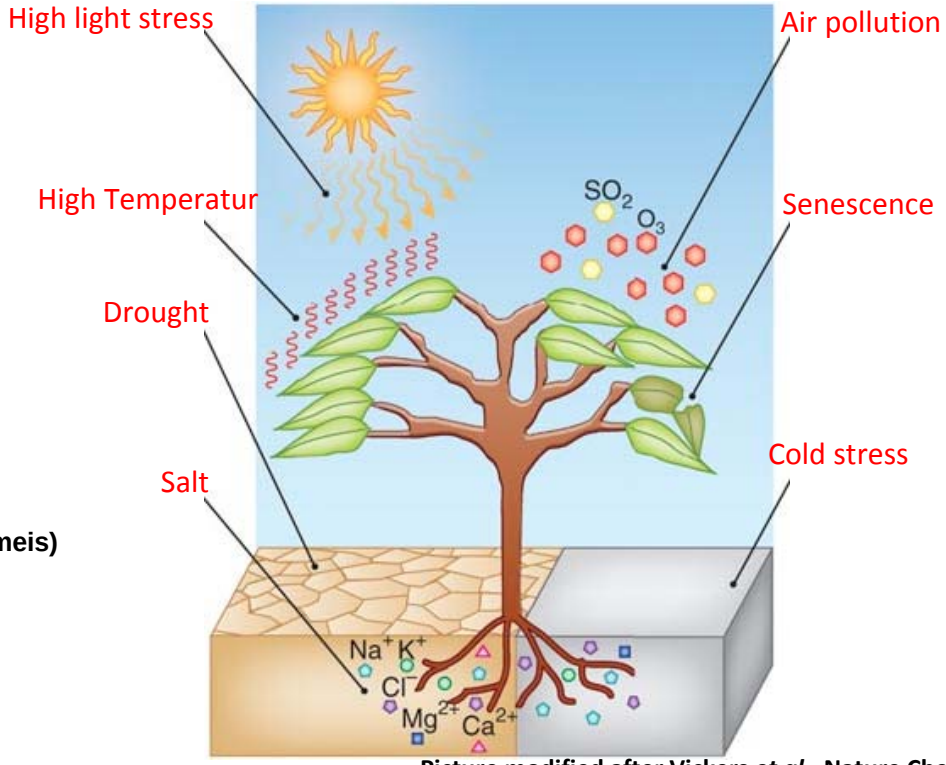
Molecular Ecology (AG Steppuhn)

Functional Biodiversity (AG Wurst)

Plant tolerance to environmental cues

Plant Physiology (AG Baier)

Plant Biochemistry (AG Romeis)

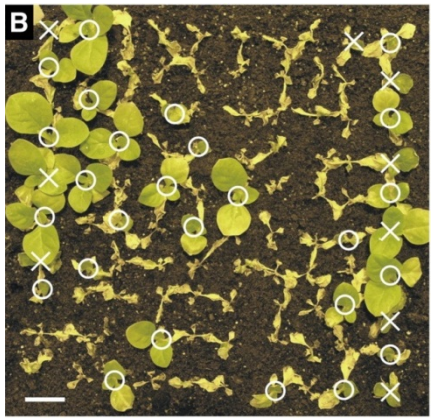


Picture modified after Vickers *et al.*, Nature Chemical Biology.

Molecular Genetics (AG Kunze)

How plants modulate gene expression to adapt to different temporary environmental changes as light intensity, water availability, temperature, nutrient availability and metal stress in the soil.

Single genes can have strong effects on crop performance



Drought stress

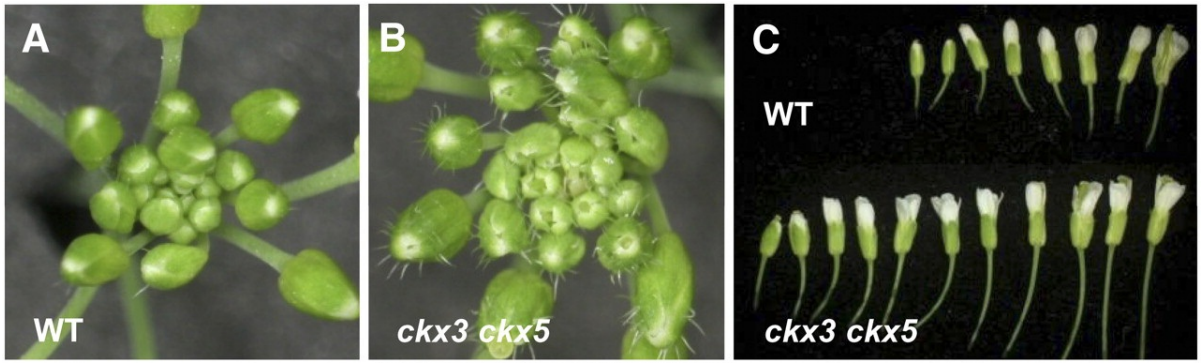
Applied Genetics
(Prof. Thomas Schmülling)

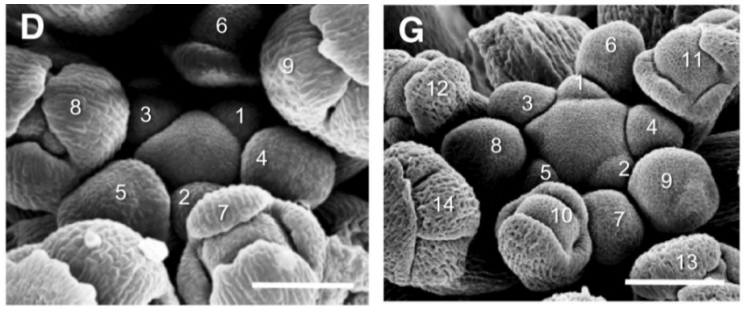
	Element														
Growth condition	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Mo	Na	Ni	P	S	Zn
Standard soil		+9.3	n.d.		-17.0				+27.0				+25.7	+18.8	+11.7
Contaminated soil		+13.7	+29.2		+18.7	-41.7	-18.3		+33.1		+29.0	n.d.		+43.1	+11.4
Hydroponics A	+59.0	+8.5	n.d.	n.d.		-30.7	-11.1	+14.3	+16.2	+29.1		n.d.	+7.1	+9.9	+37.5
Hydroponics B			n.d.	n.d.	+34.8	-29.3	+14.3	+8.9	+25.7	+17.7		n.d.		+20.5	+57.9

Werner *et al.*, 2010 *Plant Cell* 22, 3905-3920

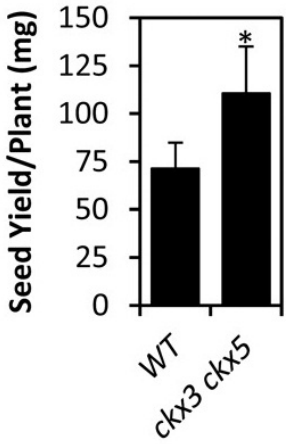
Plant hormone cytokinin is important for plant growth and development.
Root-Specific reduction of cytokinin causes enhanced root growth, drought tolerance, and leaf mineral enrichment in *Arabidopsis* and Tobacco

Single genes can have strong effects on crop performance





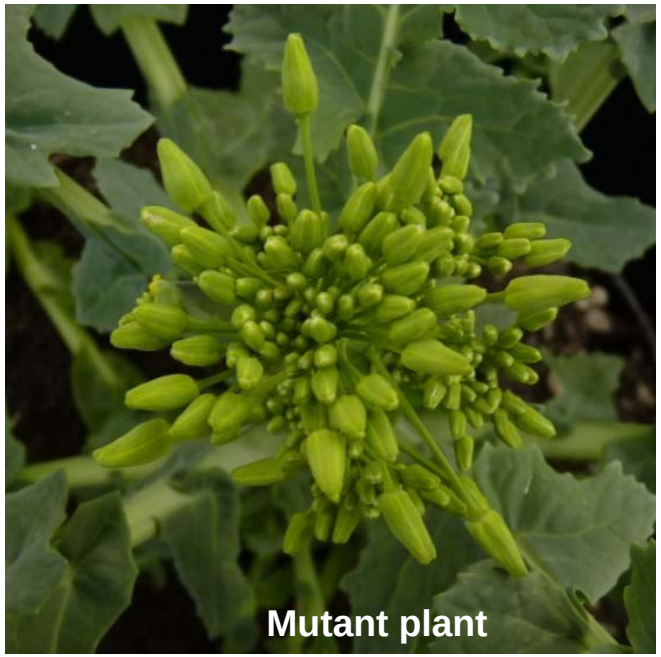
Bartrina *et al.*, 2011 *Plant Cell 23, 69-80*



Applied Genetics
(Prof. Thomas Schmülling)

By mutating CKX genes and there by increasing cytokinin content in shoot apical meristem resulted an ~55% increase in seed yield

Technology transfer from model plants to crop plants



Source: Bartrina et al., unpublished

AG. Schmülling

Transgenic *Brassica napus* harbouring anti-CKX3/5 amiRNA: strong indications of altered reproductive behaviour

India and Germany are 3rd and 4th largest producers of rapeseed oil, respectively.

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Dahlem Centre of Plant Sciences

Thank you

Source: fundiert: Zukunft Erde

BeGenDiv