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International Center for Development & Decent Work (ICDD)

A global think tank network to address

MDG 1: "Eradicate Extreme Poverty & Hunger"

Target 2: "Achieve Full and Productive Employment and Decent Work for All"

A special focus on the world's 1.5 billion food insecure people – in line with the joint FAO–ILO initiative

Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

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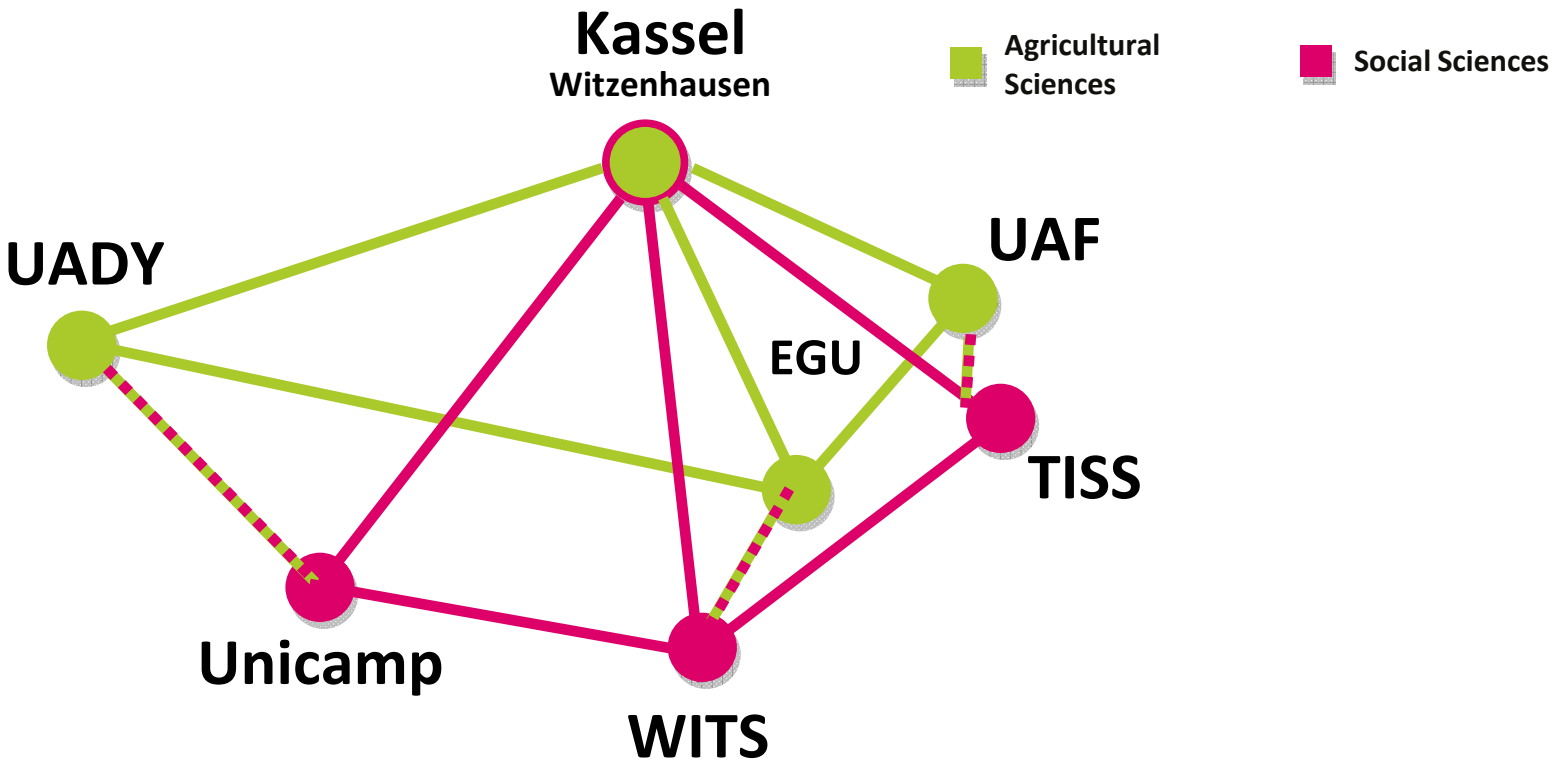

Civil society partners: FES, HBS, DGB, COSATU, CUT, SEWA, ITUC, WIEGO, RESPECT et al.

Unicamp:	Universidade Estaduale de Campinas (BRA)
WITS:	University of Witwatersrand (RSA)
TISS:	Tata Institute of Social Science (IN)

UADY:	Universidad Autónoma de Yucatán (MEX)
EGU:	Egerton University (KE)
UAF:	University of Agriculture Faisalabad (PAK)

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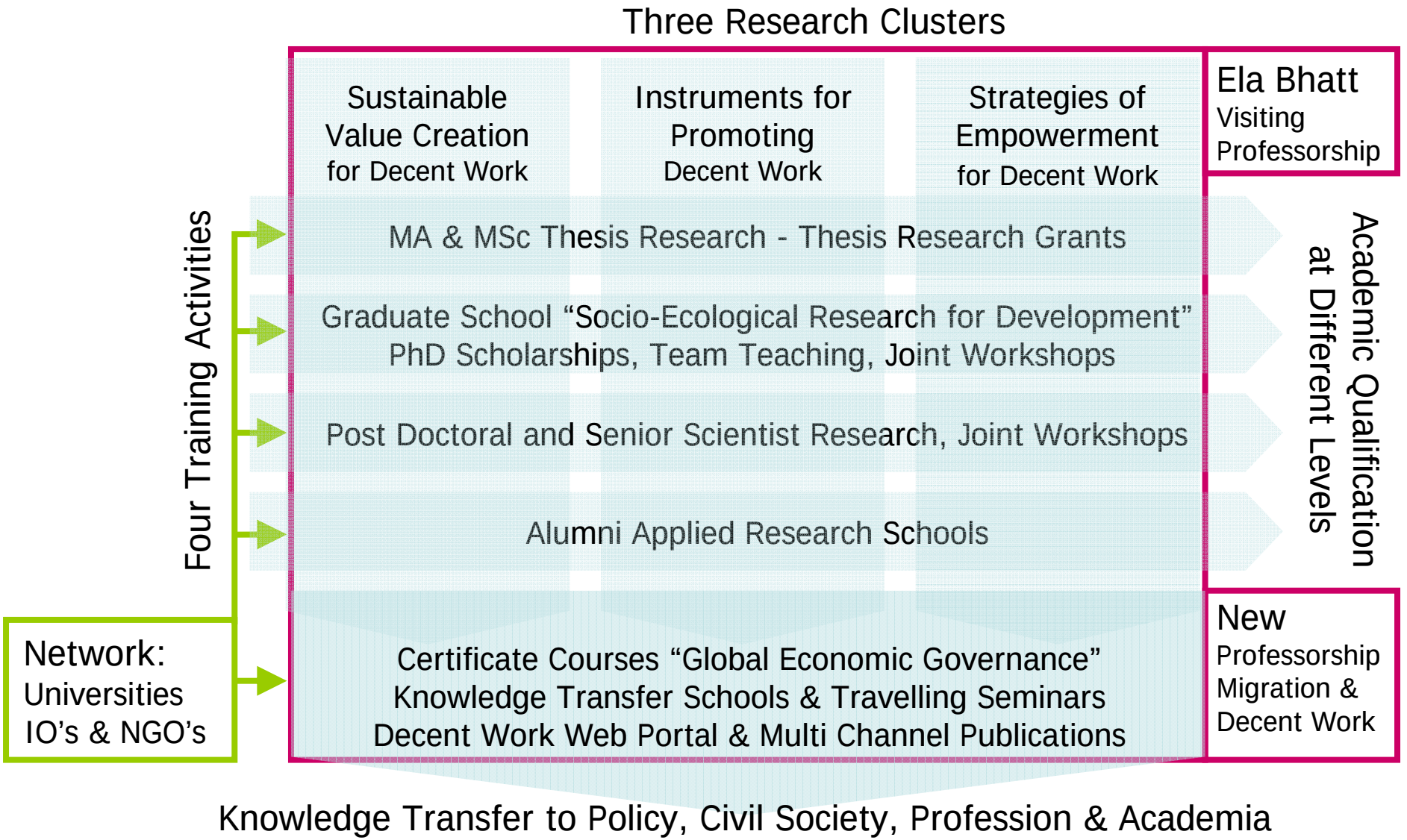

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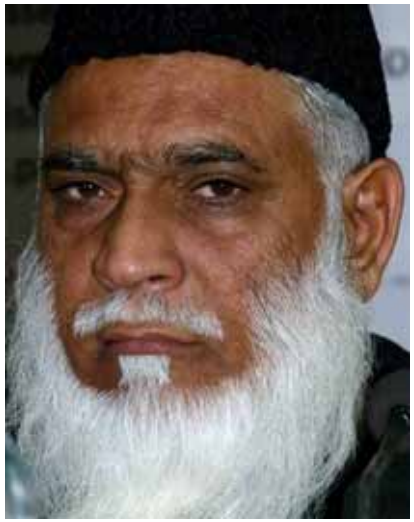
Professor Dr. **Juan Jimenez-Orsonio**,
Universidad Autonoma de Yucatan

Professor Dr. **Sakhela Buhlungu**
University of Pretoria



Natur | Nature
Technik | High Tech
Kultur | Culture
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Campus Witzenhausen

Faculty of Organic Agricultural Sciences

1898 Foundation as a Colonial School

Greenhouse of Tropical Crops

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Agrobiodiversity and nutrient fluxes

Merida, 15 February 2012

Andreas Buerkert, Martina Predotova, and Martin Wiehle

Organic Plant Production and Agorecosystems Research in the Tropics and Subtropics (OPATS)

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Oases of Oman
livelihood systems at the crossroads

www.oases-of-oman.org

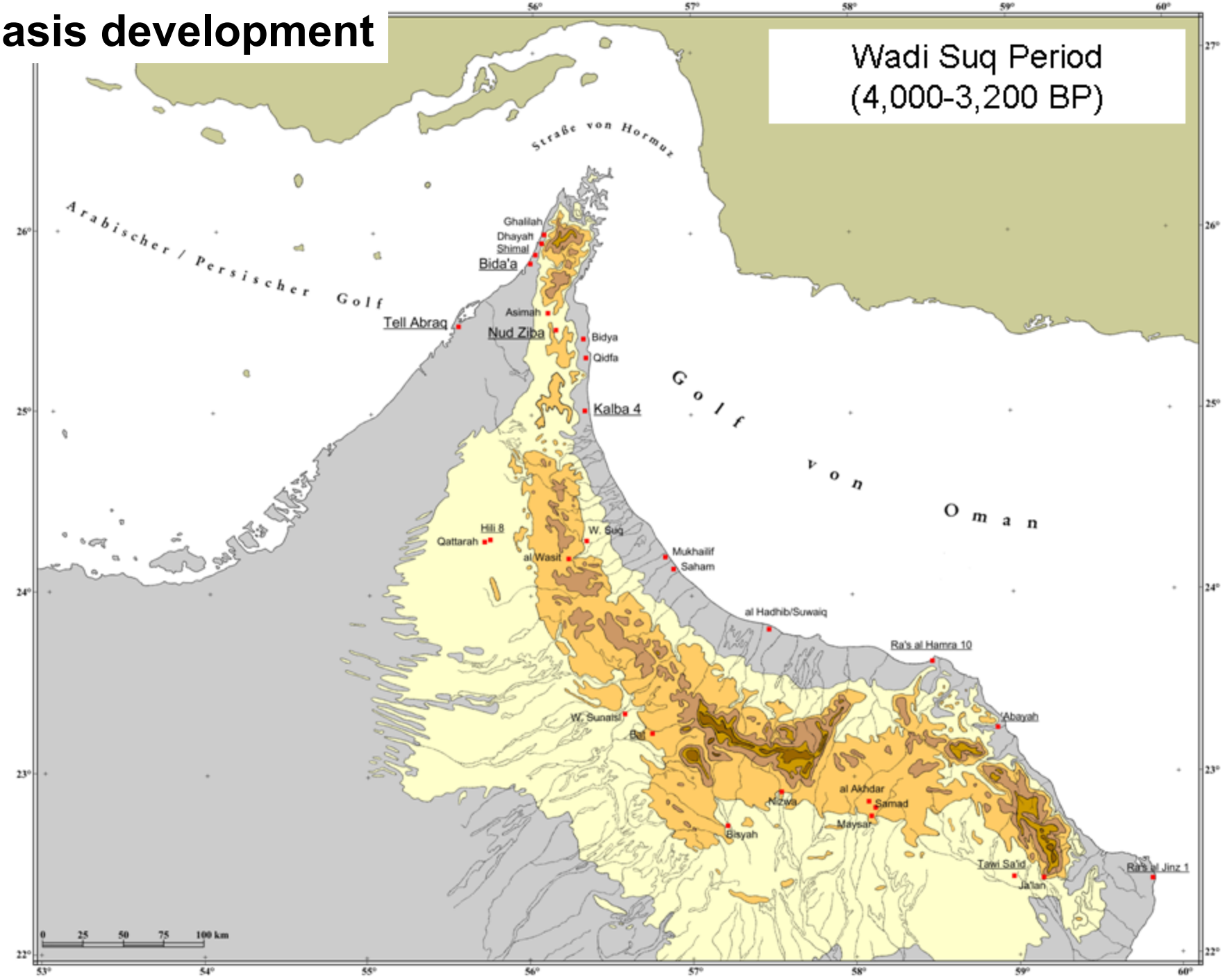
Agrobiodiversity and nutrient fluxes

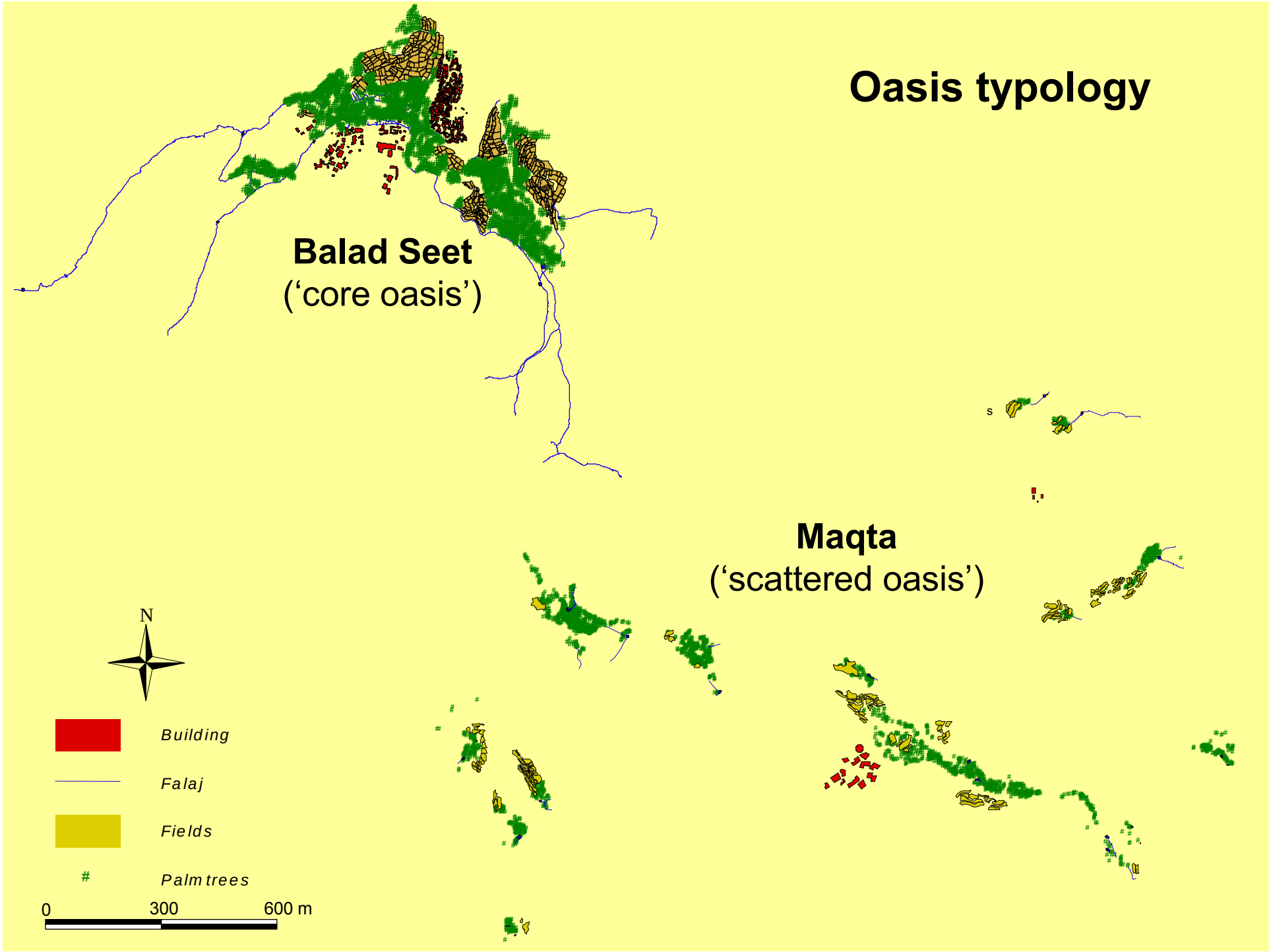
Merida, 15 February 2012

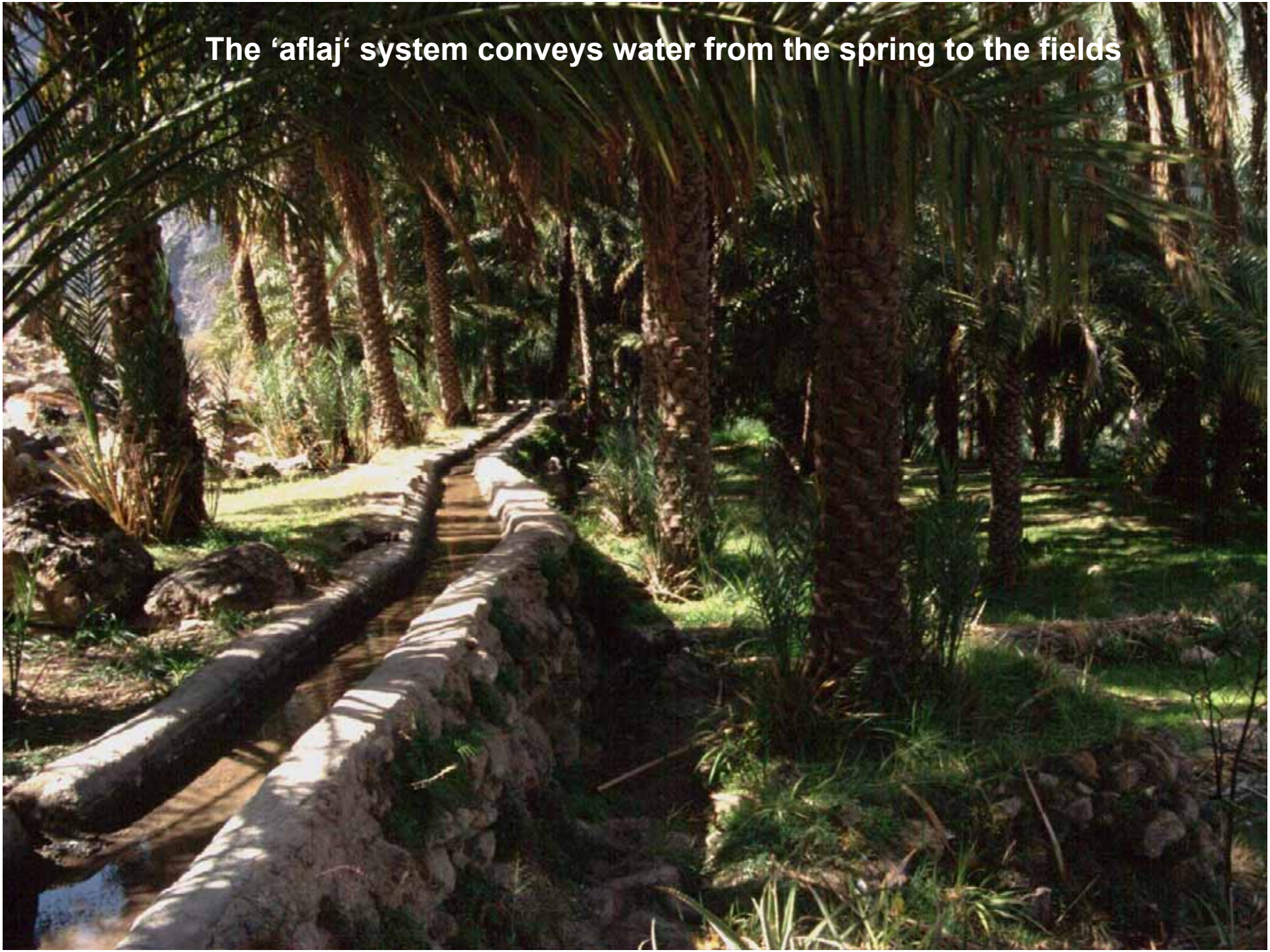
Andreas Buerkert, Eva Schlecht, Martina Predotova, and Martin Wiehle

Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics (OPATS)

Oasis development



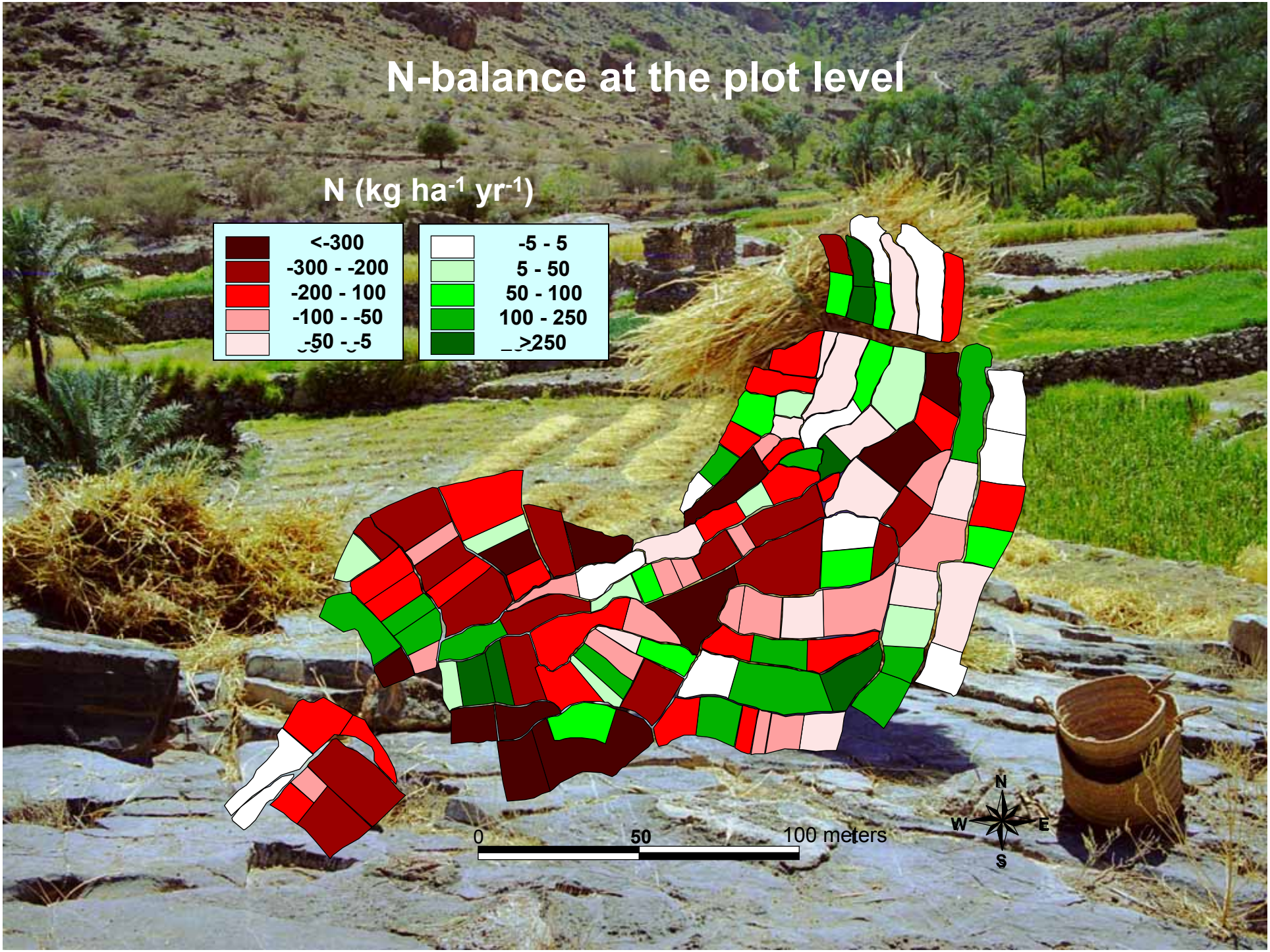

Oasis typology
Balad Seet
('core oasis')
Maqta
('scattered oasis')
N
Building
Falaj
Fields
Palm trees
0
300
600 m


The ‘aflaj‘ system conveys water from the spring to the fields


Age of the spring water (SF_6-method): 6.4 – 7.9 years






N-balance at the plot level
N (kg ha-1 yr-1)
<-300
-300 - -200
-200 - 100
-100 - -50
-50 - -5
-5 - 5
5 - 50
50 - 100
100 - 250
>250
0
50
100 meters
N
W
E
S

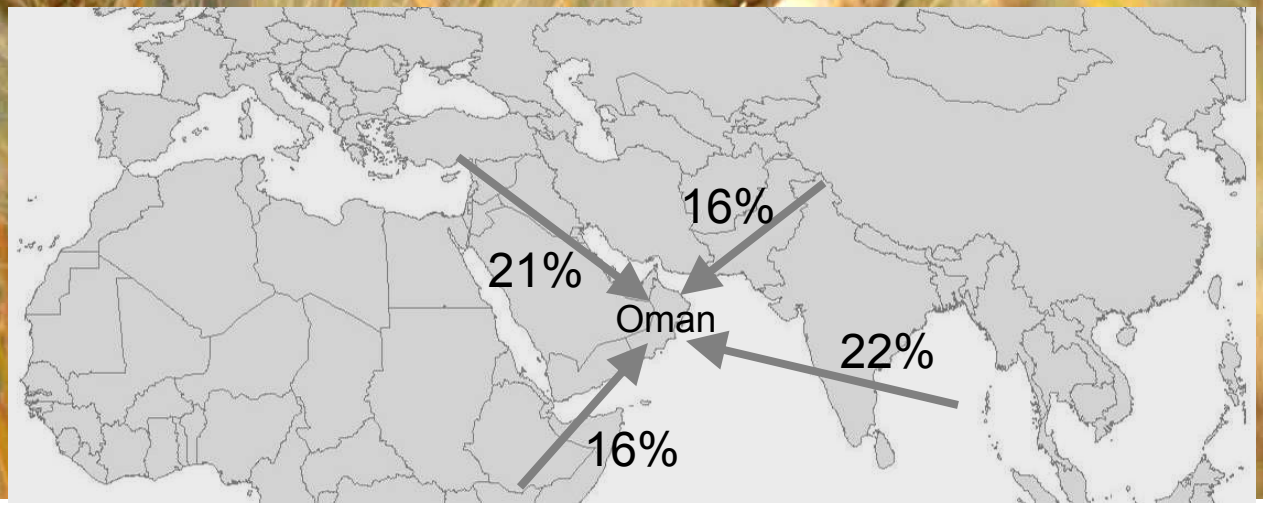
Partial oasis balance at Balad Seet

Landuse System	Source / Process	Amount (kg ha^{-1} yr^{-1})†			Balance (kg yr^{-1})†		
		N	P	K	N	P	K
Palm groves (8.8 ha)	Synthetic fertilizer	59	1.8	4	519	15.8	35
	Animal manure + ashes	141	8.0	289	1241	70.4	2543
	Irrigation water	10	5.2	17	88	45.8	150
	Human faeces	170	37.0	50	1496	325.6	440
	Date palm harvest (dates+stems+leaves)	-63	-12.7	-176	-554	-111.8	-1549
	Harvested understory fodder	-14	-1.5	-11	-123	-15.8	-97
	Balance	**303**	**37.8**	**173**	**2632**	**324.1**	**1469**
Oasis (13.4 ha)	**Total balance**	**244**	**37.4**	**142**	**3235**	**501.9**	**1855**

† Positive values indicate gains and negative ones losses

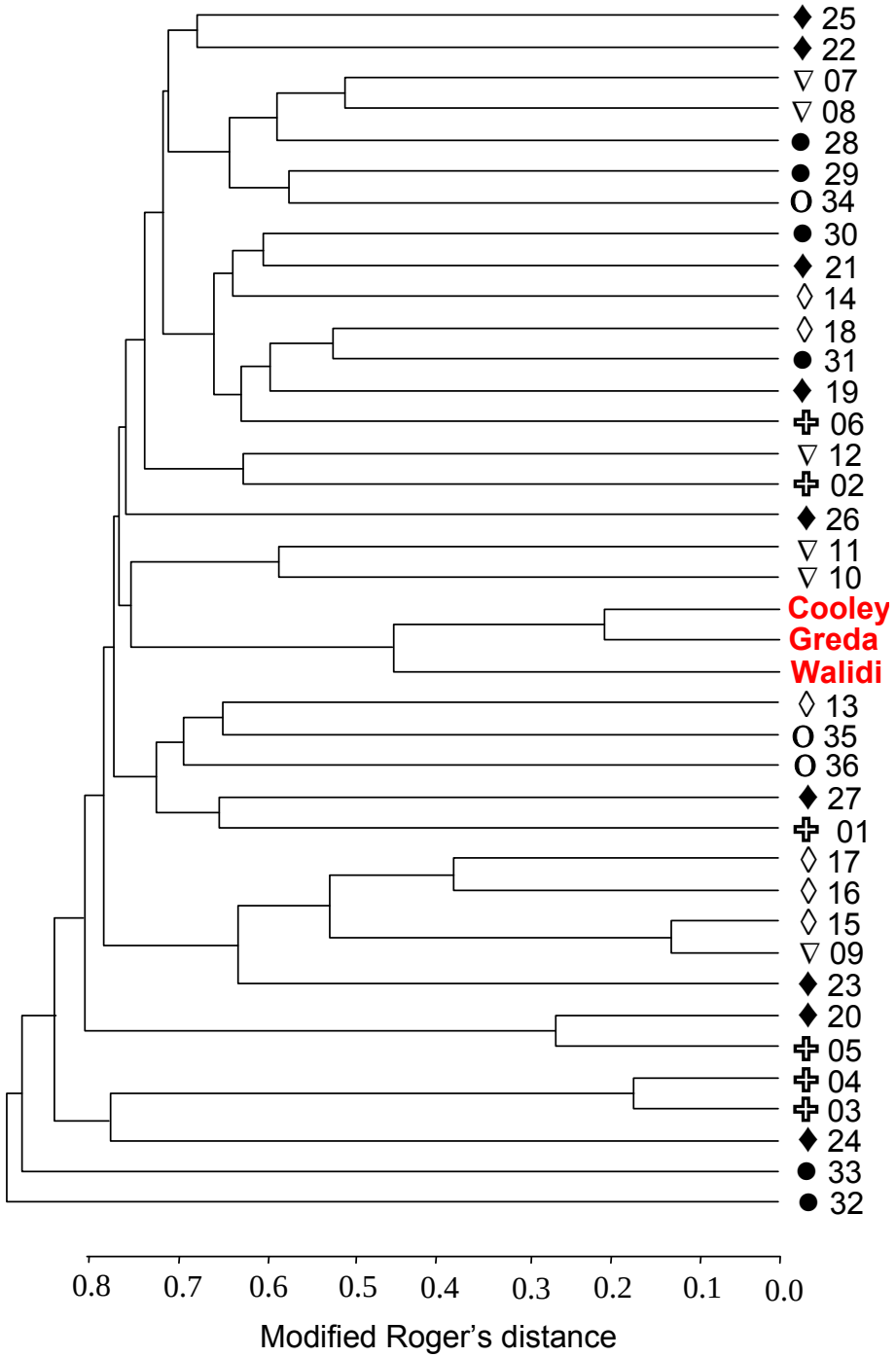
Buerkert, A., Nagieb, M., Siebert, S., Al-Maskri, A. and Khan, I. 2005. Nutrient cycling and field-based partial nutrient balances in two mountain oases of Oman. *Field Crops Research* 94(2-3), 149-164.

Omani wheat landraces are unique and provide evidence of Oman‘s successful trading history



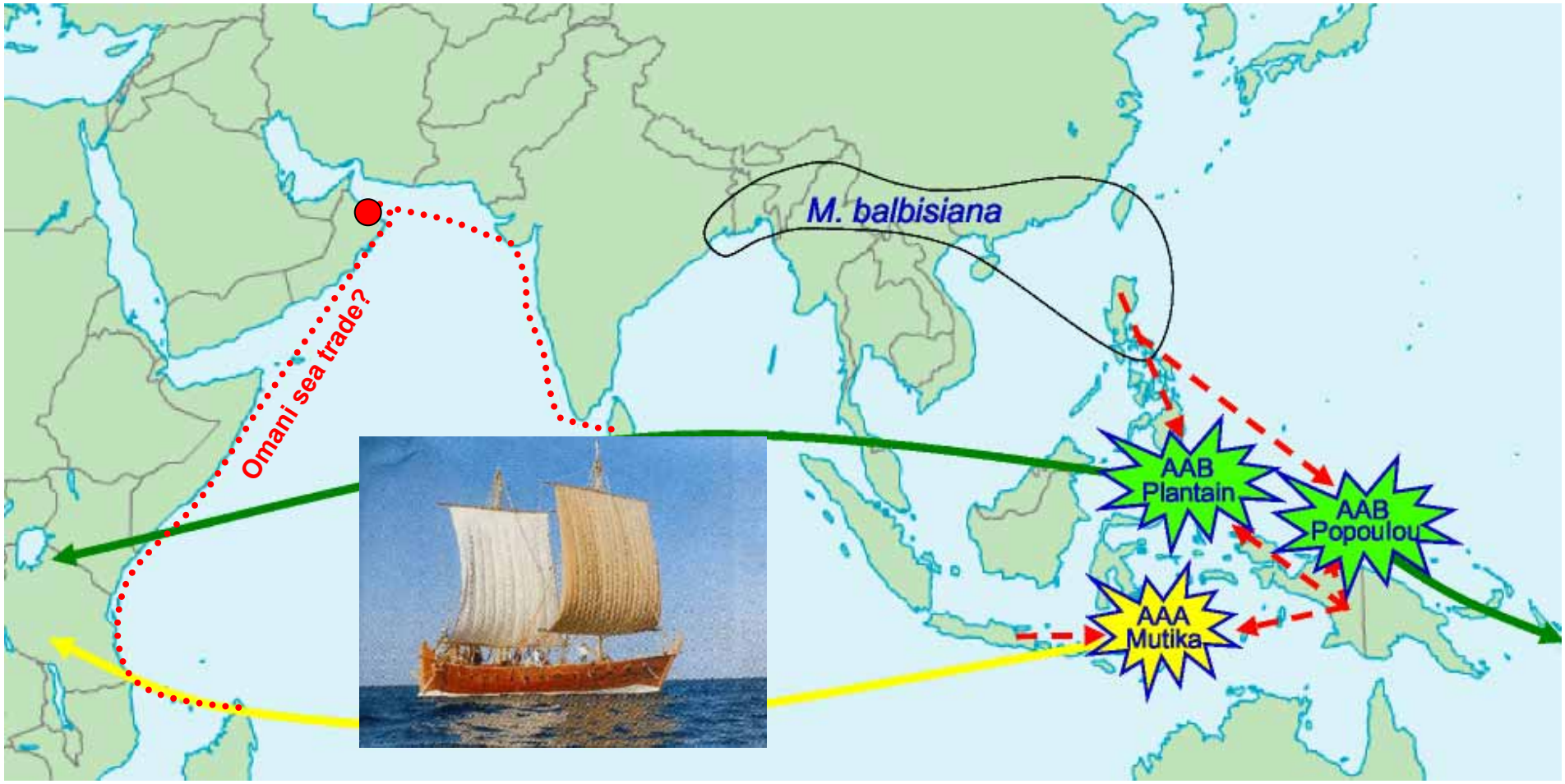
Omani wheat landraces

Left: Terraces with Omani wheat landraces and date palm near a spring in Maqta (Jabal Bani Jabir). **Right:** Dendrogram of three Omani bread wheat landraces and 36 other landraces from West Europe (◊), Turkey (▽), Africa (+), Central America (●), South America (O) and Asia (▽) based on UPGMA cluster analysis of modified Rogers' distance calculated from 19 common SSRs (numbers refer to landraces in Dreisigacker et al., 2005).



Musa triploids, creation and geographical diffusion

Plain arrows indicate long term migrations of triploids subgroups: Plantain and Mutika triploids to Africa or Popoulou to Oceania. Dotted arrows illustrate the contacts between diploids at the origin of these triploids.

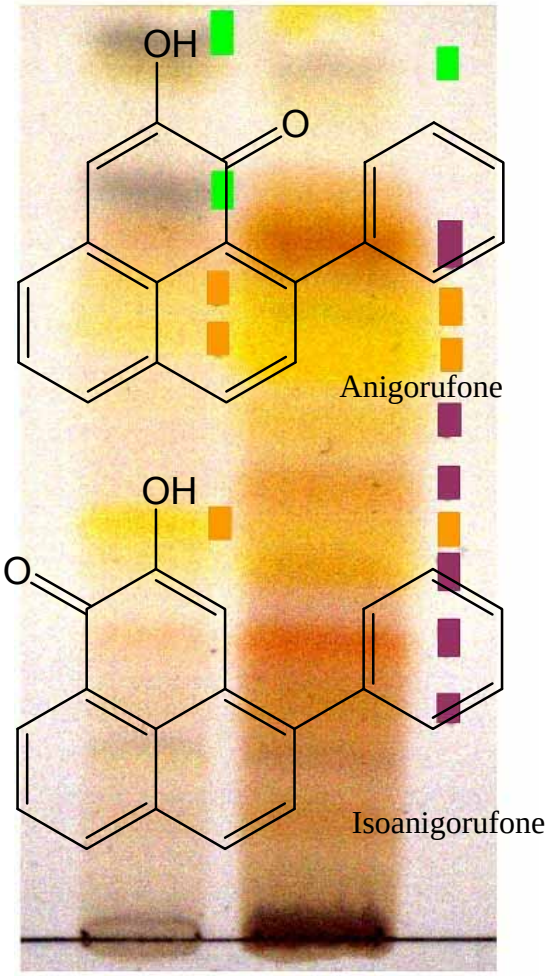


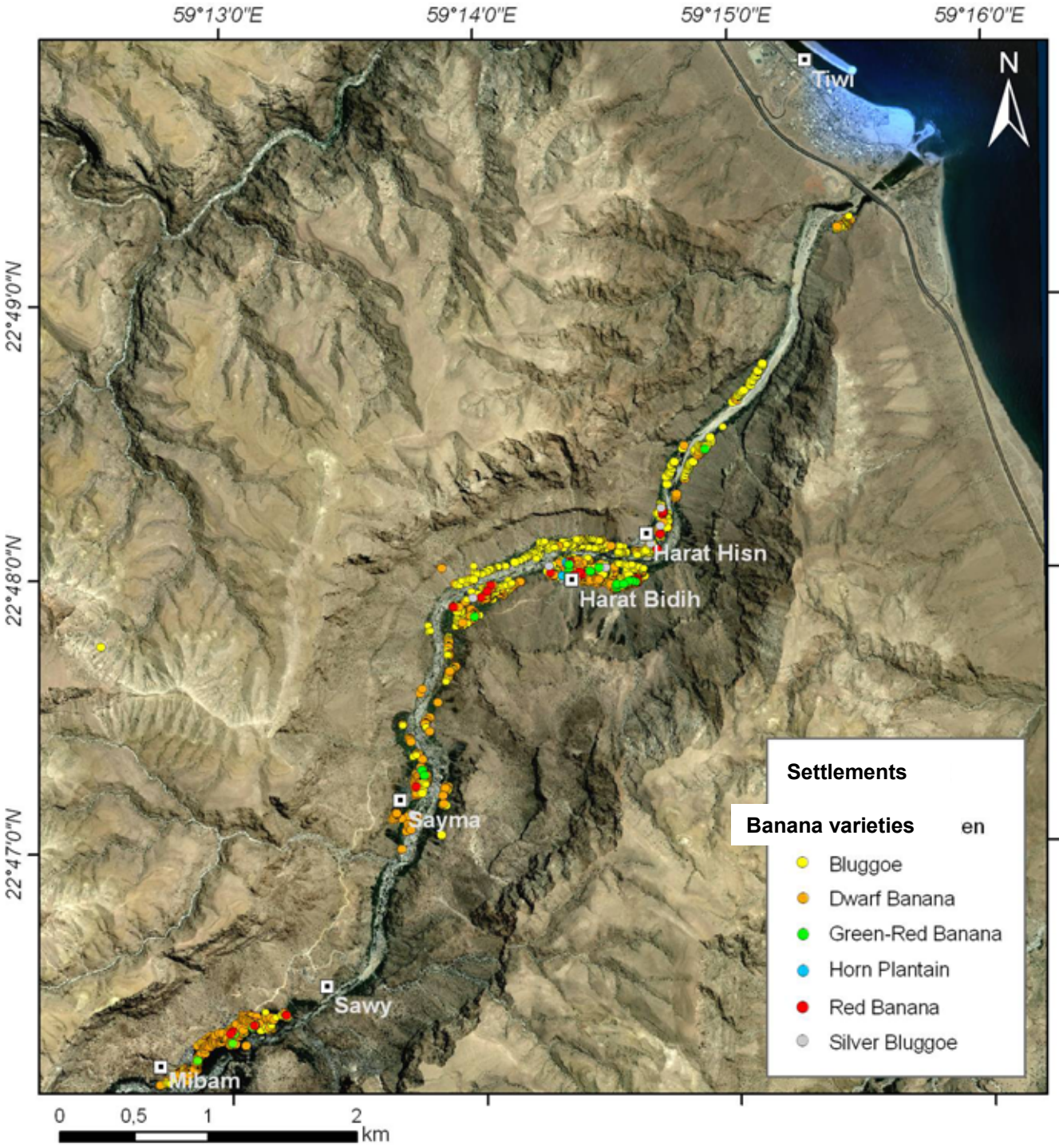
Perrier et al. 2009. Ethnobotany Research & Applications 7, 199-216.

Oasis ecosystem of Umq Bi‘r, head oasis of Wadi Tiwi


1 cm

Banana varieties in Wadi Tiwi






2. Urban and peri-urban agriculture (UPA)

Deutsche Forschungsgemeinschaft DFG

VolkswagenStiftung

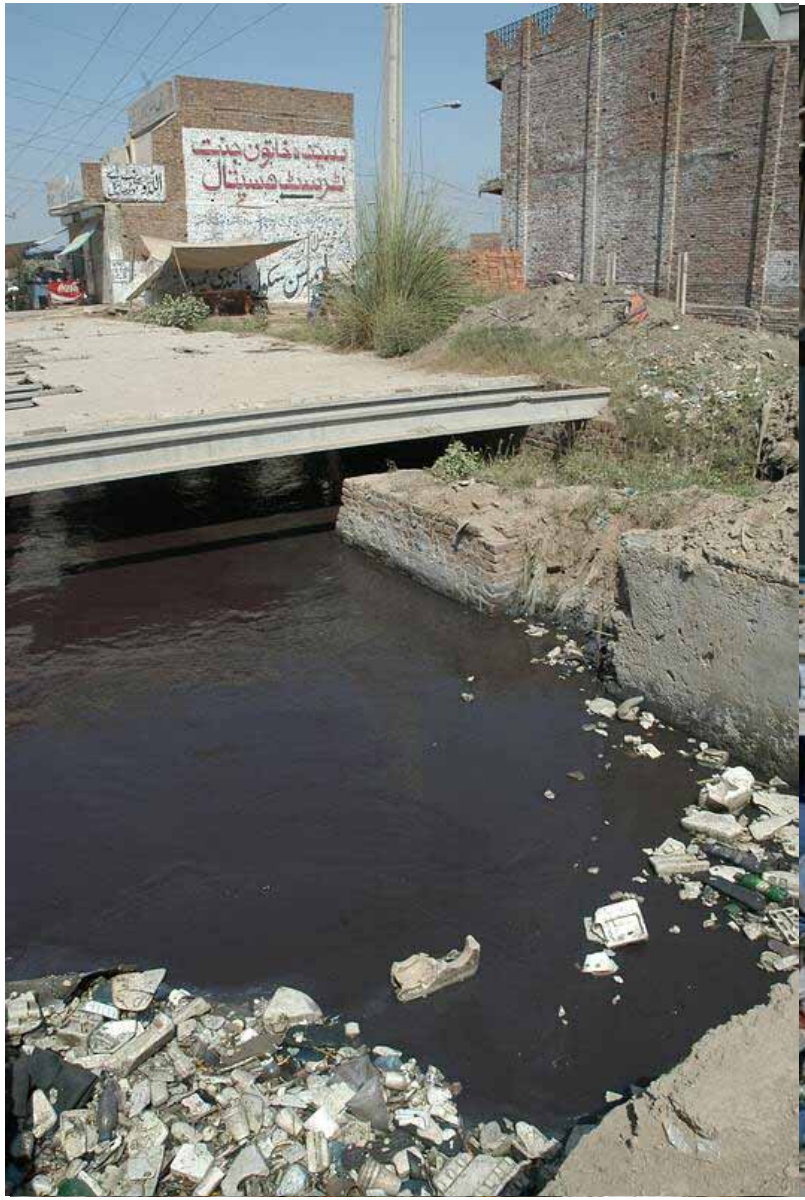
DAAD

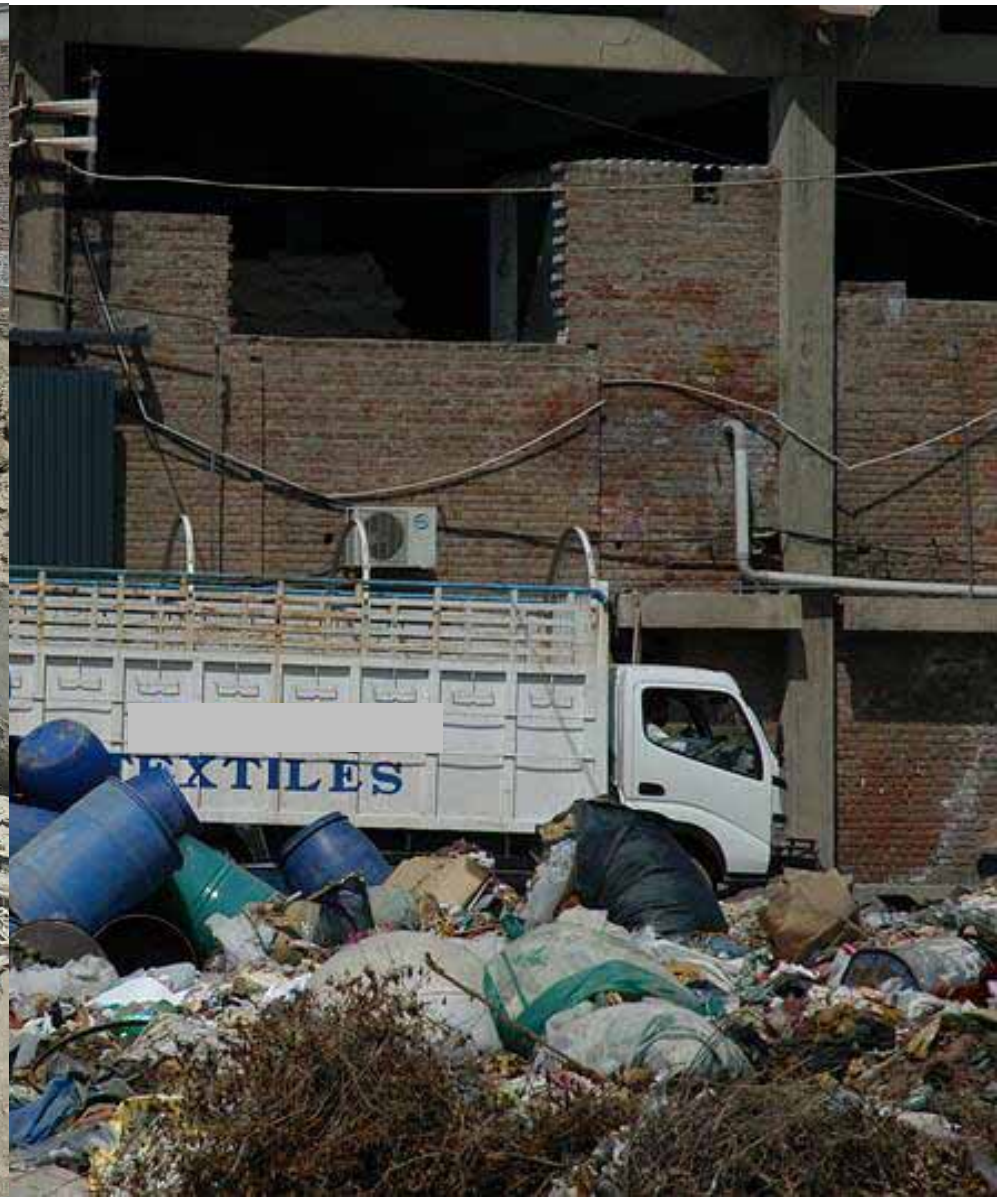
Alexander von Humboldt Stiftung/Foundation

UrbanFood – a collaborative research network research network in Niger, Burkina Faso, Mali, Nigeria, Sudan, Afghanistan, and Pakistan

The irrigation water issue

UPA – Quality of irrigation water

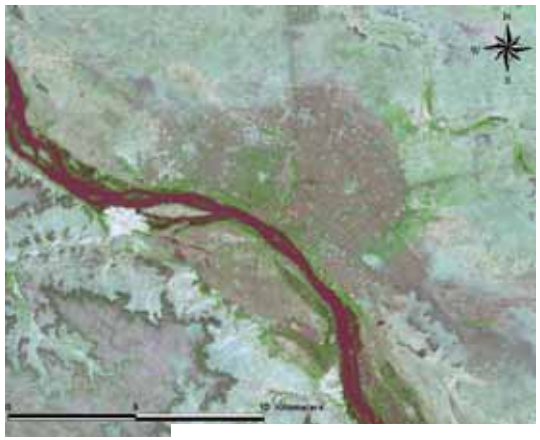


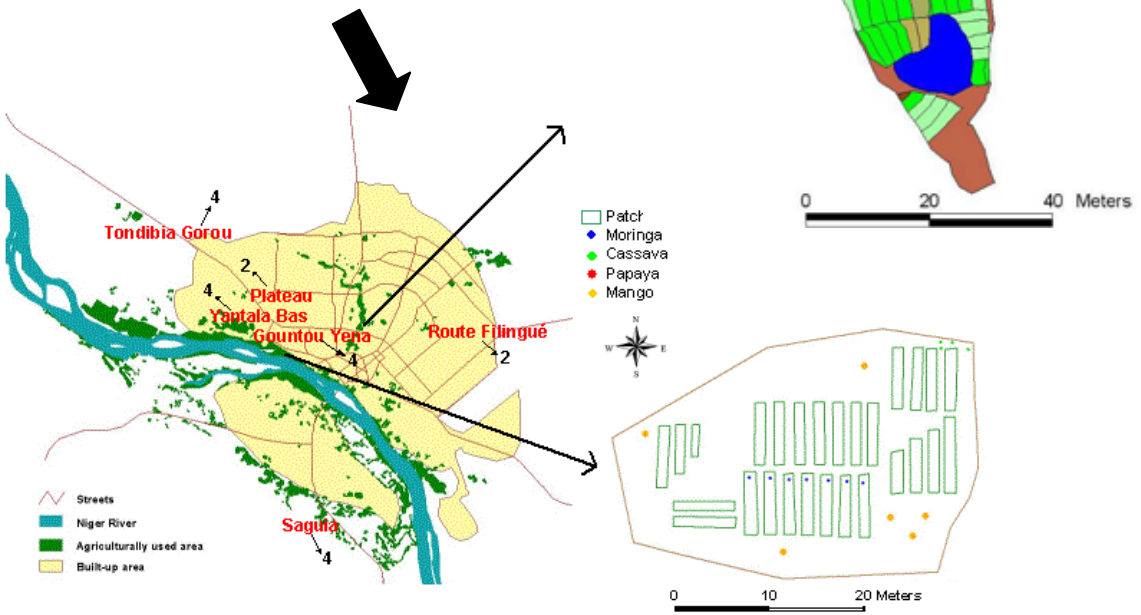


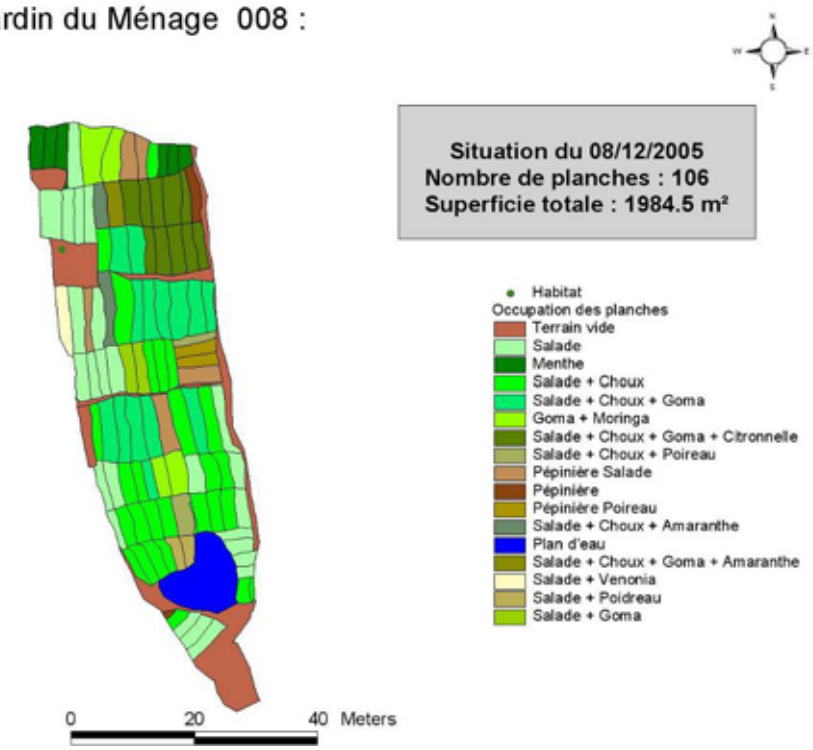
Sustainability

UPA in West Africa

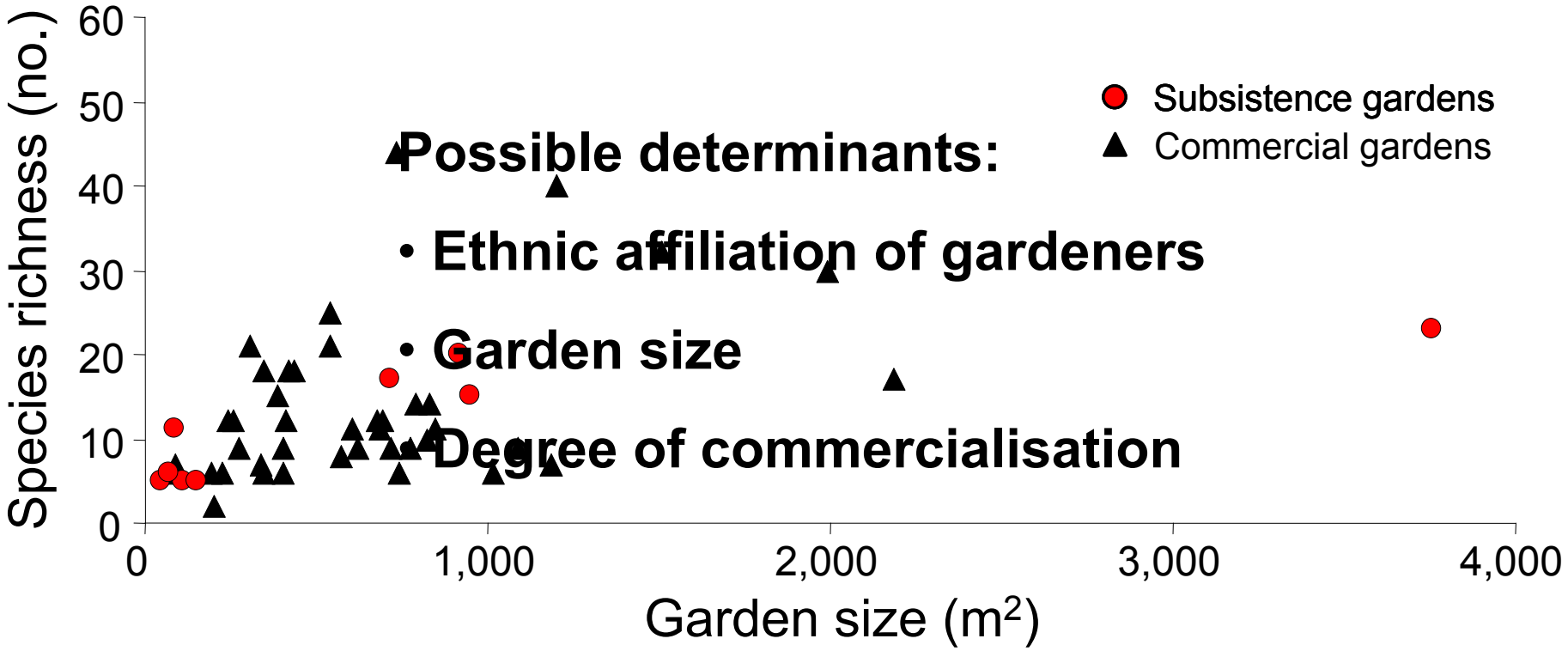
UPA mapping: GIS







Plant biodiversity in UPA gardens of Niamey, Niger



Bernholt et al. Agroforestry Systems 77(3), 159-179.

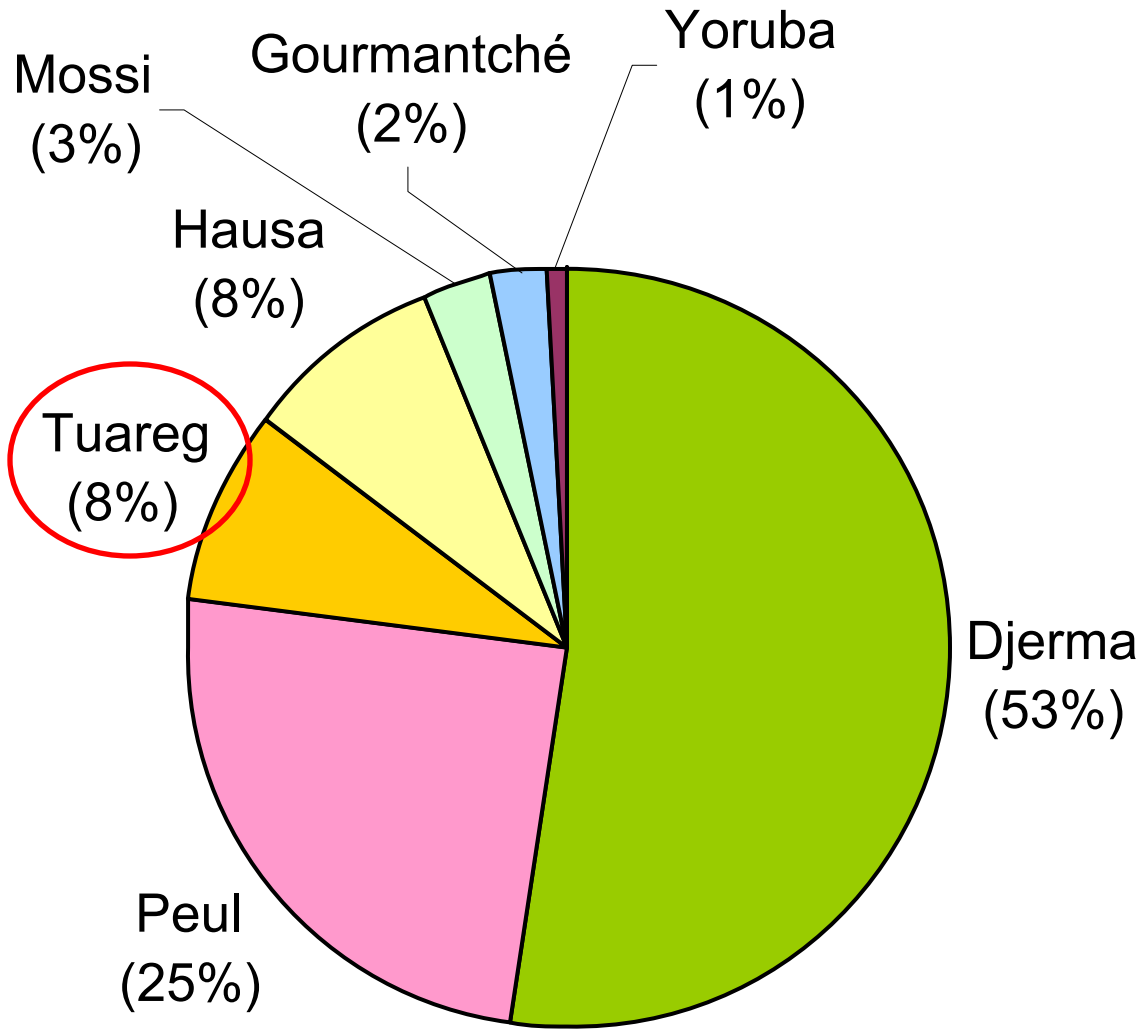
Plant biodiversity in UPA gardens of Niamey, Niger

Mean values (ranges in brackets) of plant species diversity parameters in the cold, hot and rainy season of gardens in Niamey (Niger), 2007.

Characteristic	Cold season (n=51)	Hot season (n=51)	Rainy season (n=45)
Species richness	14.1	9.8	6.7
Species density	15.0	10.2	6.8
Shannon index	1.0	0.8	0.5

Bernholt et al. Agroforestry Systems (accepted).

Ethnic affiliation of UPA gardeners in Niamey (2004, n = 130)



Highest species diversity in gardens of classical nomads!

Bernholt et al. Agroforestry Systems (accepted).

Determination of nutrient fluxes at the field-scale

Gaseous losses

CH_4, CO_2, NH_3, N_2O

Inputs

Manure,

mineral fertilizer

Outputs

Exported harvest

Leaching losses

NO_3, P_{org}

Measurement of gaseous C and N losses with a photo-accoustic multigas monitor

Closed chamber system

Methods: Surveys – Experiments – Analyses

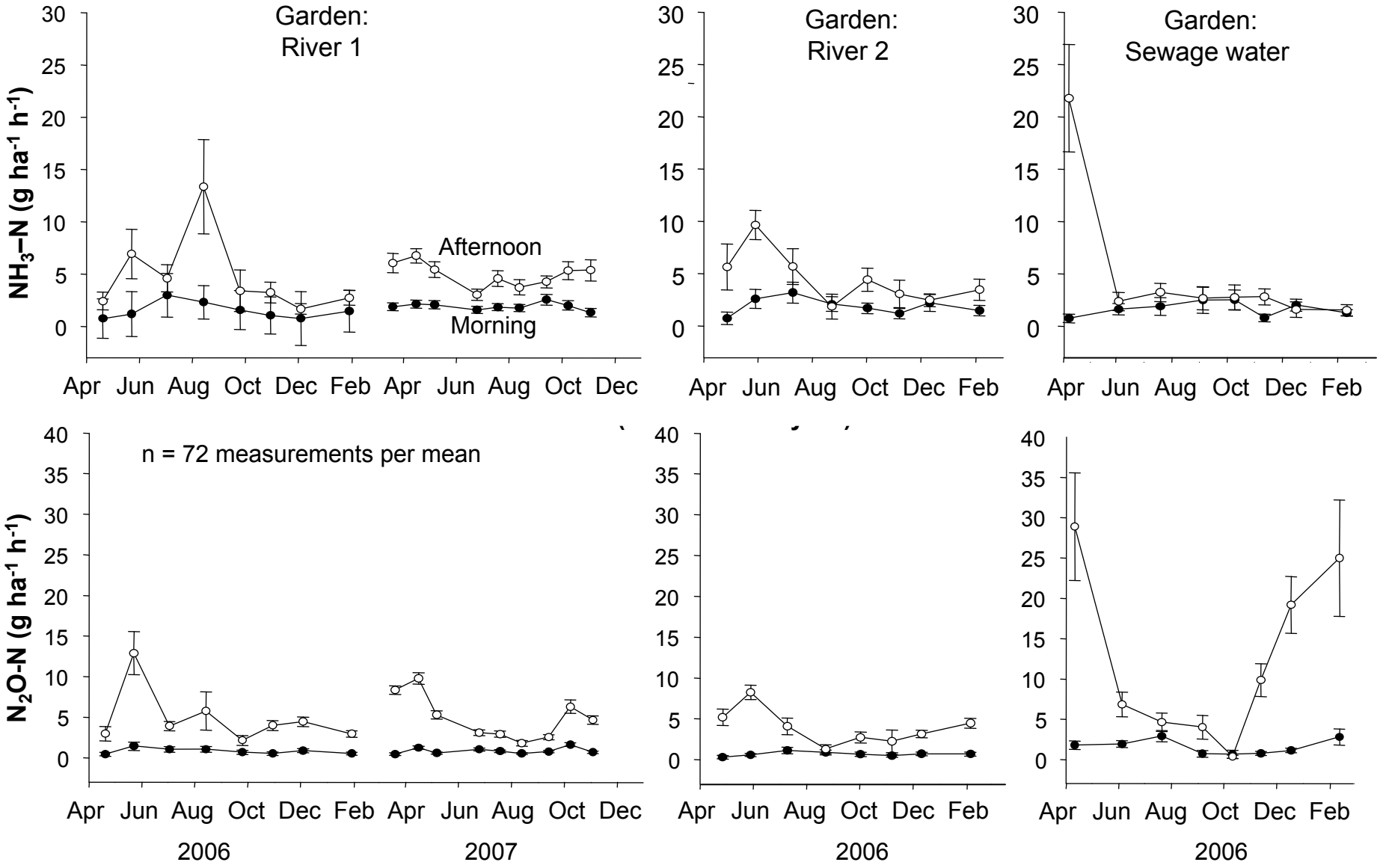





Leaching with cation / anion exchange resins

UPA in West Africa

Gaseous N losses patterns in vegetable production of Niamey, Niger



Predotova et al. (2010). Field Crops Research 115, 1-8.

UPA in West Africa

Total N balances in vegetable production of Niamey, Niger

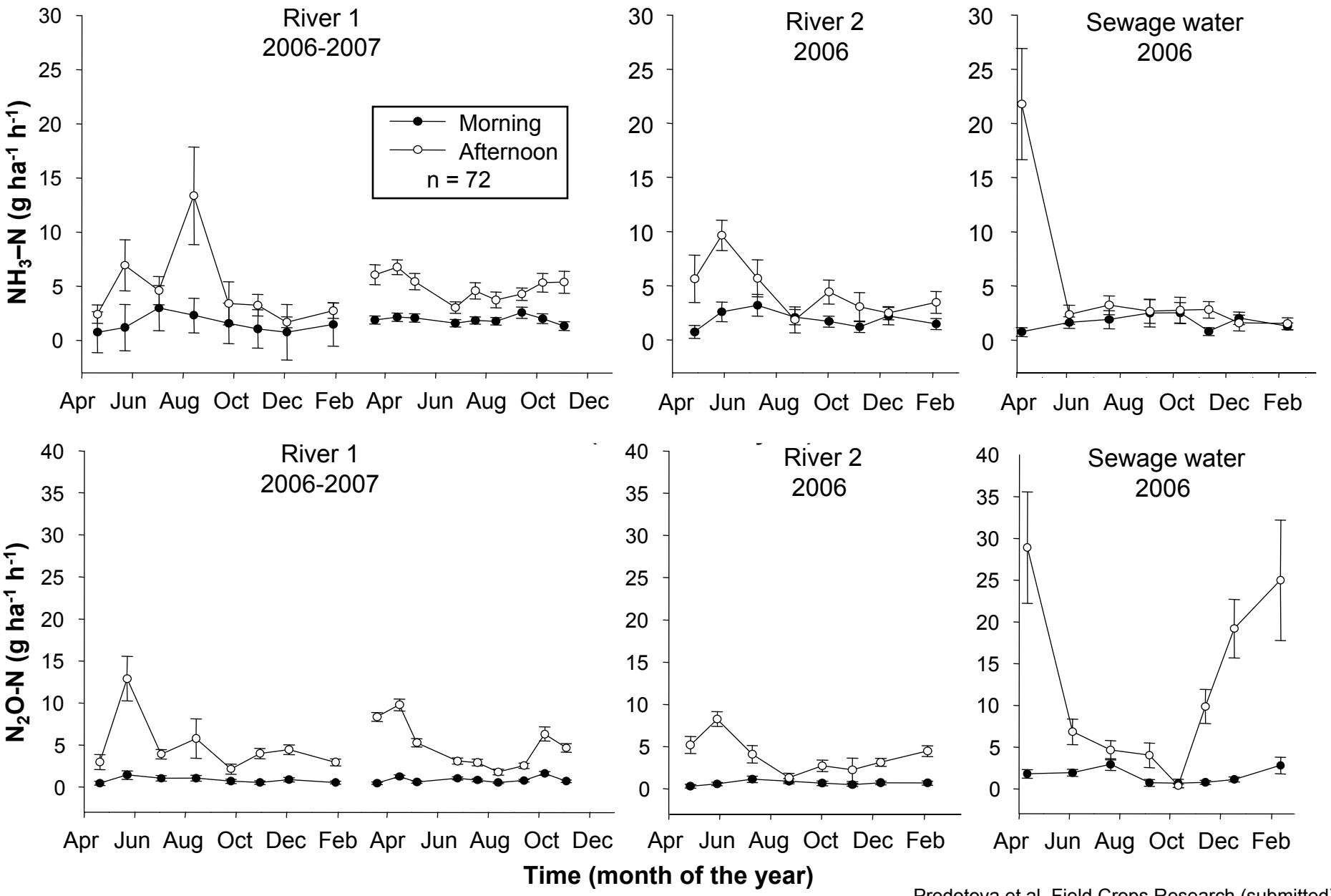
	Horizontal N fluxes		Gaseous N losses			N leaching	Total N balance
Garden	Input	Output	Total	NH_3	N_2O	NO_3-N	
	(kg ha^{-1} a^{-1})		(kg ha^{-1} a^{-1})	(%)		(kg ha^{-1} a^{-1})	(kg ha^{-1} a^{-1})
River 1	470	100	53	52	48	6*	310
River 2	780	190	48	59	41	2*	540
Sewage water	3,820	830	92	32	68	7*	2,890

* values of rainy season 2007



Diogo et al. (2010). Nutrient Cycling in Agroecosystems 87(1), 81-102.

Gaseous N losses from three UPA gardens in Niamey



Predotova et al. Field Crops Research (submitted).

3. Fruit trees in homegardens of the Nuba Mountains, Central Sudan

Martin Wiehle[1], Sven Goenster[1], Katja Kehlenbeck[2], Jens Gebauer[1], Ramni Jamnadass[3], A.M. Ali[3], Andreas Buerkert[1]

[1] University of Kassel, Organic Plant Prod. and Agroecosystem Research in the Tropics and Subtr., Germany;
[2] World Agroforestry Centre (ICRAF), Tree Genetic Resources and Domestication, Nairobi, Kenya;
[3]University of Khartoum, Department of Horticulture, Sudan.

Fruit consumption very low in Eastern Africa

Average daily consumption of fruits (FAOSTAT, 2004)

Region	Fruit consumption (g/day)
EU	288
N. America	286
Latin America	194
Eastern Europe	150
Asia (developing)	99
Western Africa	90
Southern Africa	89
Central Africa	40
East Africa	36

Minimum: 200 g

→ Mwingi district, Kenya: Consumption of indigenous fruits was only 19 g/day (Simitu et al. 2009)

High nutritional value of many indigenous fruits

Nutrient concentrations of selected fruits

Species	Vit C (mg/100 g)	Vit A (mg/100 g)	Iron (mg/100 g)	Calcium (mg/100 g)
Adansonia digitata	150-500	0.03-0.06	1.7	360
Grewia tenax	N.A.	N.A.	7.4	610
Tamarindus indica	3-9	0.01-0.06	0.7	260
Ziziphus spina-christi	30	N.A.	3.0	140
Orange	51	0.07	0.2	54

Sources: Freedman (1998) Famine foods. http://www.hort.purdue.edu/newcrop/FamineFoods; Fruits for the Future Series, ICUC; Fineli (http://www.fineli.fi/), etc.

Importance of fruits

- High potential for income generation, particularly for women from indigenous fruits



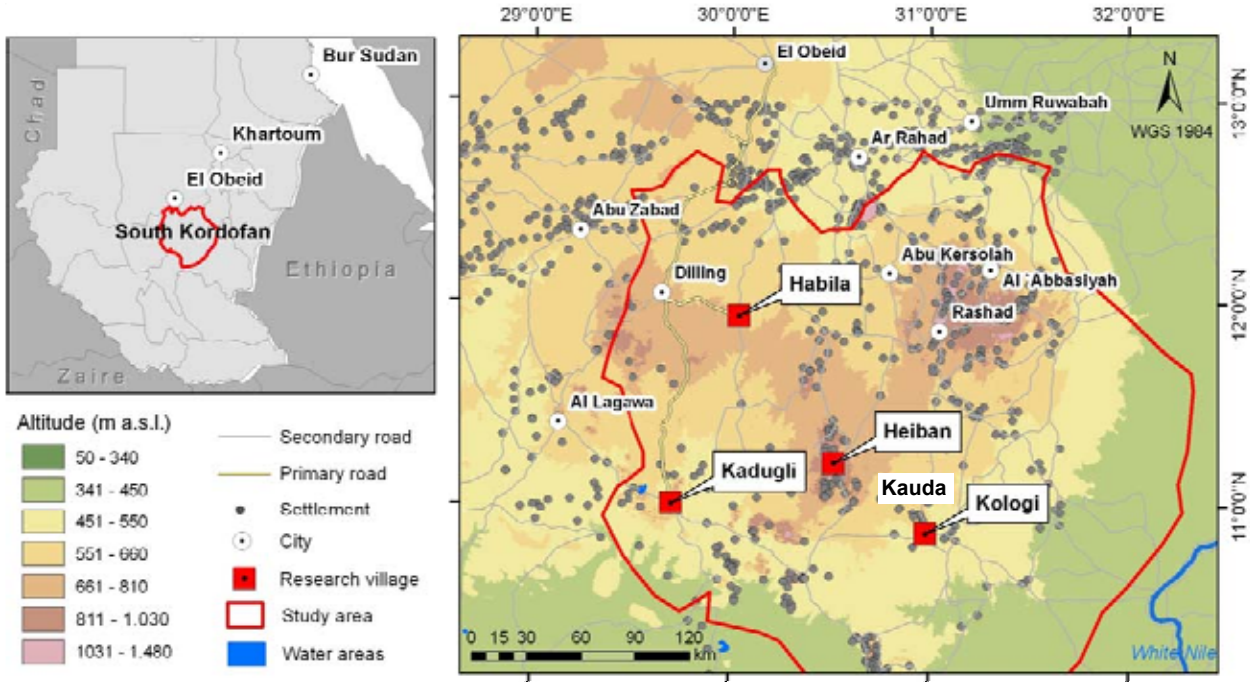
- Harvest of different fruits possible year-round due to high species diversity→ filling the 'hunger gap' before harvest of staples
- Fruit trees more tolerant against droughts than annual crops→ food security, climate change adaptation

Possible threats to diversity

1. Transformation of mixed HGs to commercial irrigated vegetable gardens (promoted by NGOs)

2. Outside HGs: Transformation of parklands to mechanically cultivated staple fields

Research area: Nuba Mountains, Central Sudan



- Precipitation: 400-800 mm/year
- LUS: homegardens, parkland agroforestry, rangelands

Variable	Kadugli	Kologi	Kauda	Habila
Size	Very large	Small	Small	Intermediate
Altitude (m asl.)	500	500	850	700
Market access	Very good	Poor	Poor	Intermediate
Ethnicity	Mixed	Nuba	Nuba	Mixed

Survey

- 17 and 19 homegardens (HG) randomly selected in Kadugli (Sama) and Kologi
- Inventory of fruit tree diversity: Species numbers and abundance
- Interviews on basic socio-economic household data
- Interviews on fruit yields and use
- Market surveys for assessing fruit prices→ calculate mean potential monetary value of fruits
- Statistics: T-test, multivariate regression analysis

Results

- Fruit tree diversity in HGs was high:
  - Total: 22 species, including 13 IFT species

  - Mean: 3 species per garden

- Mean fruit tree density: 10 trees per 1000 m^2
- Most abundant species:
  Hyphaene thebaica, Azadirachta indica, Ziziphus spina-christi, Balanites aegyptiaca

Maturity of fruits

Harvest season of fruits ■, cropping season ■

Species	J	F	M	A	M	J	J	A	S	O	N	D
Adansonia digitata									■	■	■	
Annona squamosa							■	■	■	■		
Balanites aegyptiaca											■	■
Borassus aethiopum				■	■	■	■					
Cordia africana	■	■	■									
Ficus sycomorus						■	■					
Grewia tenax											■	■
Mangifera indica	■	■	■							■	■	■
Sclerocarya birrea				■	■	■	■					
Tamarindus indica		■	■	■								
Ziziphus spina-christi										■	■	■

➔ Fruits available year-round

Monetary fruit value

	Potential monetary value of fruits (USD/year)
Adjusted R^2	**0.51**
Independent variables	
Garden size per household member (m^2)	**++** **
Location (0=Kalogi, 1=Sama)	ns
No. of old household members (>67 years)	**++** ***
No. of children (<15 years)	ns
Mean age of adults in household (years)	ns
Gender of gardener (0=Male, 1=Female)	ns
Level of commercialisation (0=Subsistence, 1=Commercial)	ns
No. of fruit tree species	ns
Density of fruit tree individuals	ns

Note: *, **, ***: P≤ 0.05,≤ 0.01,≤ 0.001, respectively.

➔ No effect of fruit tree number

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