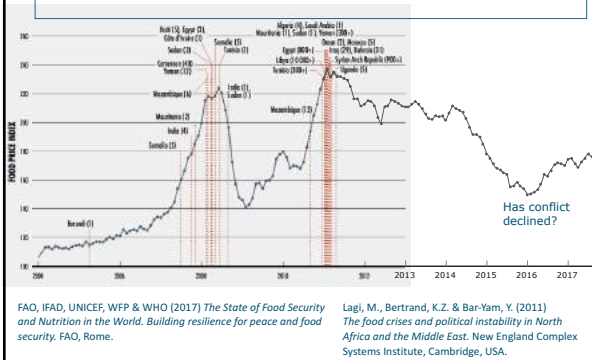


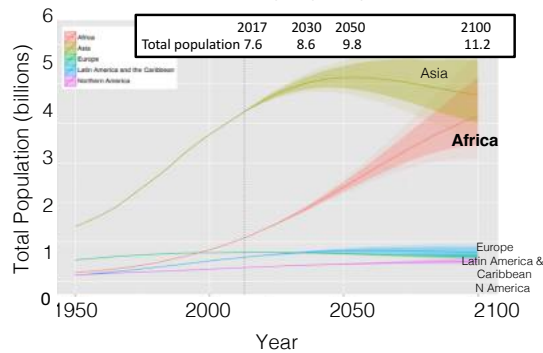
Sudden food price surges triggered conflict in more than 40 countries



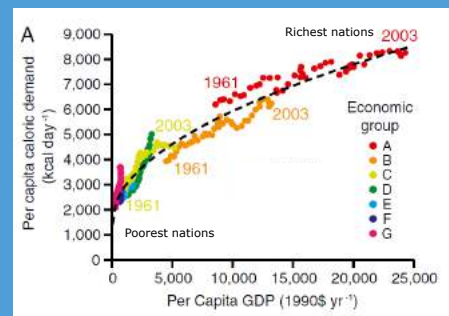
Global impacts



An extra billion people by 2030

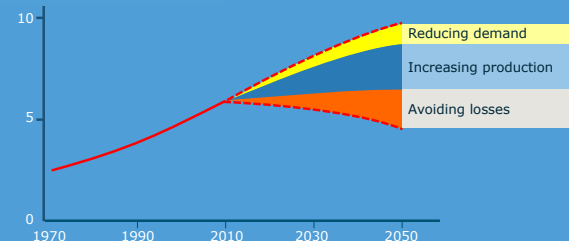


Food demand versus income (per capita)

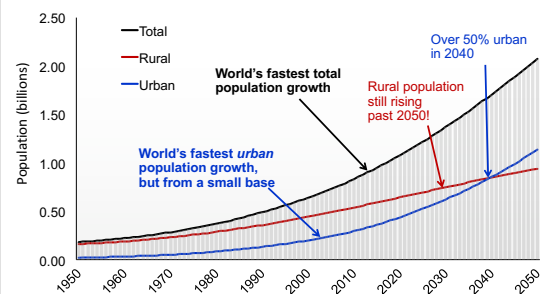


Food wedges: Pathways to +60-70% availability

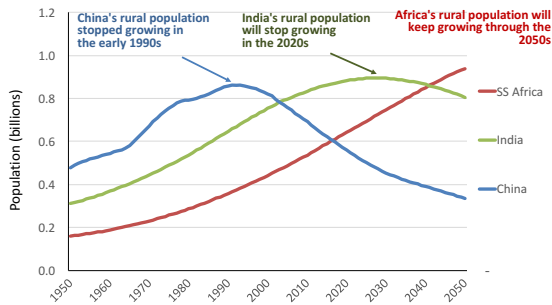
Grain equivalents per year (billion tonnes)



Africa's rural population will keep growing past 2050, despite rapid urbanization



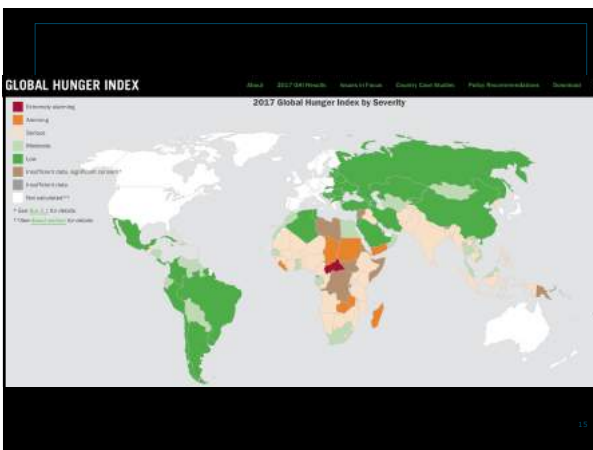
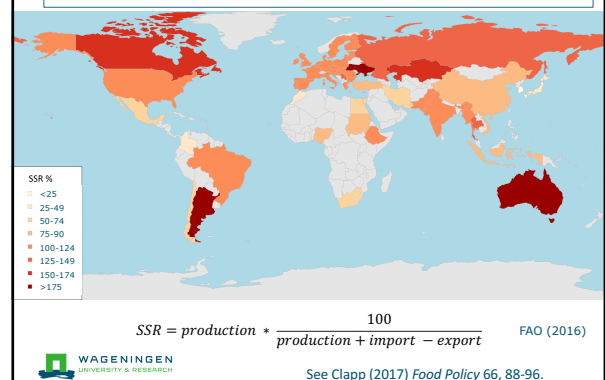
The rise and fall of rural populations drives agricultural transformation



Source: Calculated from UN World Urbanization Prospects, 2014 Revision.
Released July 2014 at <http://esa.un.org/unpd/wup/>.

Will Masters, Tufts

Cereal self-sufficiency rates (SSR) at national level



The framing of farming

- Organic, agroecological, traditional, indigenous, alternative, family farming...
- Industrial, large-scale, conventional...
- How do we define conventional agriculture?
- Almost all farms are 'conventional' family farms!

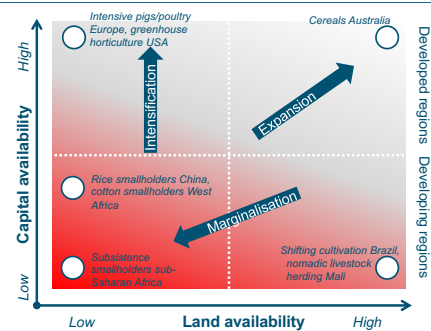


Gillier, Andersson, Sumburg & Thompson (2017) A golden age for agronomy?
In: Sumburg (ed) *Agronomy for Development*, London: Earthscan. pp. 150-160

Farming depends on:

- Labour
 - Land
- and
- Capital

(Family) farms - diversity and trends

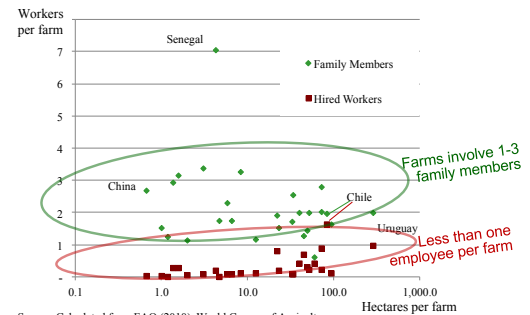


van Vliet, Schut, Reidsma, Descheemaeker, Slingerland, van de Ven & Gillier (2015)
Global Food Security, 5, 11-18.



Farming is a family enterprise at every scale

Family workers and employees per farm, latest census (1996-2003)



Source: Calculated from FAO (2010), World Census of Agriculture, Main Results and Metadata by Country (1960-2005), Rome: FAO.

Will Masters, Tufts

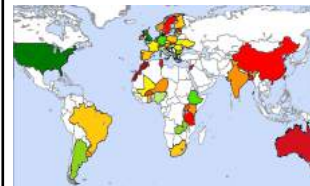
% of farmers 65 years of age or older



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Graphs based on (USDA-NASS, 2012; Barr, 2014; Uchiyama, 2014; Eurostat, 2015)

Global Yield Gap Atlas



Wageningen UR, University of Nebraska, ICRISAT, AfricaRice, CIMMYT and many regional and national partners

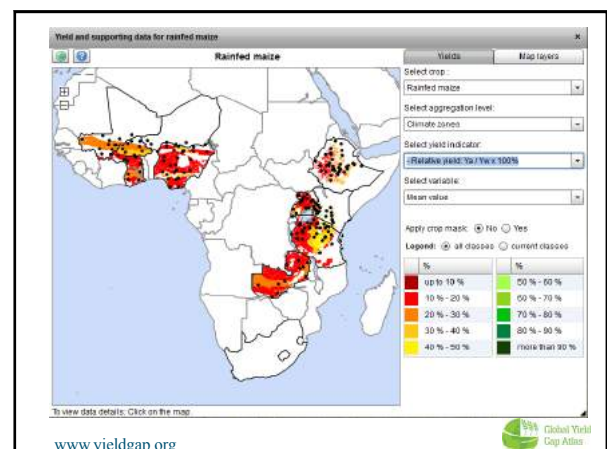
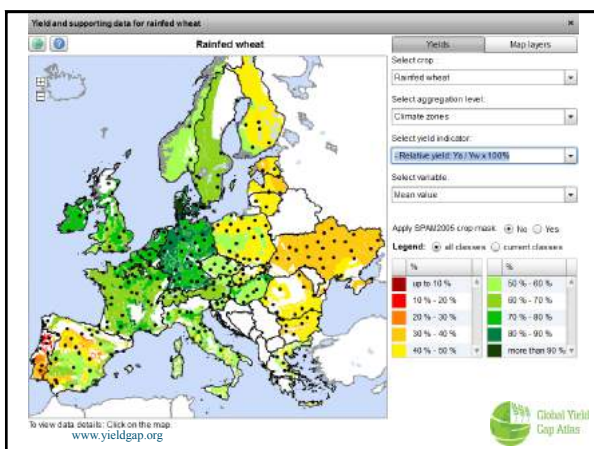
Led by Martin van Ittersum and Ken Cassman

- Major food crops in the world
- Global protocol with local application
- Local data and evaluation
- Strong agronomic foundation

www.yieldgap.org



64 countries - October 2017





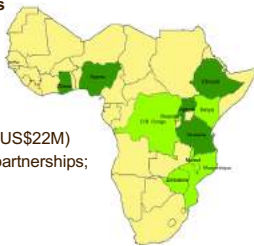
Potential solutions - Nitrogen fixing legumes



N2Africa - www.N2Africa.org



- Led by Wageningen University; with IITA, ILRI, AGRA and **many national partners**
- Implemented in 11 countries
 - Ghana, Nigeria, Ethiopia, Tanzania, Uganda (**Core countries**)
 - DRC, Kenya, Malawi, Mozambique, Rwanda, Zimbabwe (**Tier 1 countries**)
- 1st Phase 2009-2013 – Proof of concept (US\$22M)
- 2nd Phase 2014-2018 – Scaling through partnerships; institutionalisation (US\$30M)



Putting nitrogen fixation to work for smallholder farmers in Africa

Goals of N2Africa



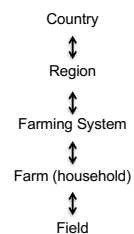
- To enhance **agricultural productivity of grain legumes and other sequential crops**
- To improve household **food and nutrition security**
- To promote grain legumes as **cash crops to improve household income**
- To build **national capacity** to fill the technology pipeline from 'development to research'

Putting nitrogen fixation to work for smallholder farmers in Africa

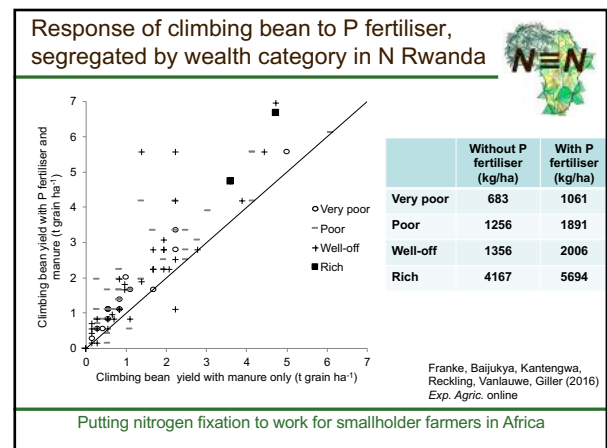
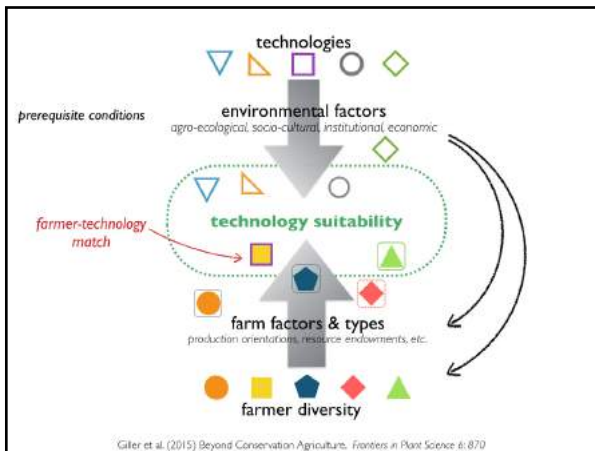
Overall research question



What works where, why, when, for whom?



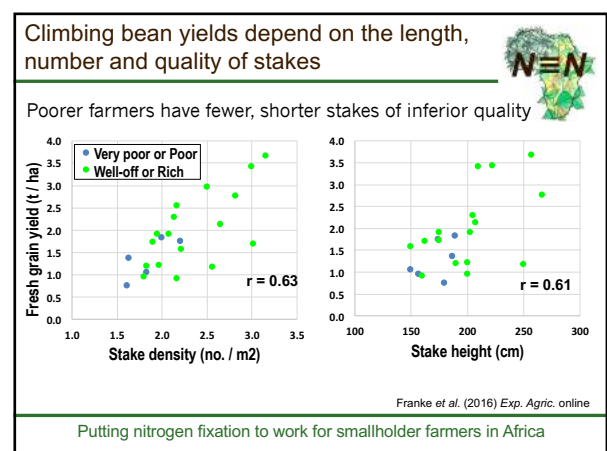
Putting nitrogen fixation to work for smallholder farmers in Africa



Soil fertility in climbing bean trials affected by resource endowment

Variable	Very poor	Poor	Well-off	Rich	Significance
pH	5.4	5.7	5.5	6.0	n.s.
C (%)	1.3	2.5	2.5	4.2	0.018
N (%)	0.12	0.25	0.24	0.43	0.020
Avail. P (mg/kg)	6.7	20.5	19.1	35.9	0.005
Sand	40.6	31.9	30.6	34.6	0.002
Silt	27.3	35.3	35.7	43.3	0.002
Clay	32.1	32.8	33.7	22.2	n.s.

Putting nitrogen fixation to work for smallholder farmers in Africa



Crop management factors that determine climbing bean productivity



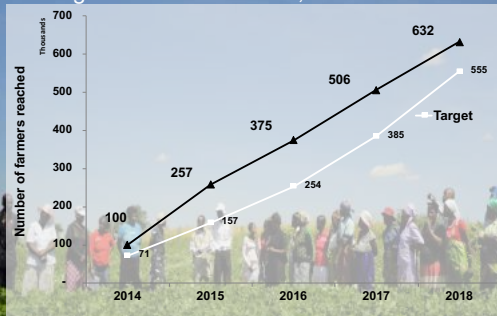
- Planting time
- Timing of 1st weeding
- Staking density
- Stake length
- Organic input use
- P fertiliser use
- Labour input

Understanding constraints of different farmers allows research feedback to tailor technologies

Putting nitrogen fixation to work for smallholder farmers in Africa



N2Africa - Large scale dissemination of legume technologies to more than 600,000 farmers

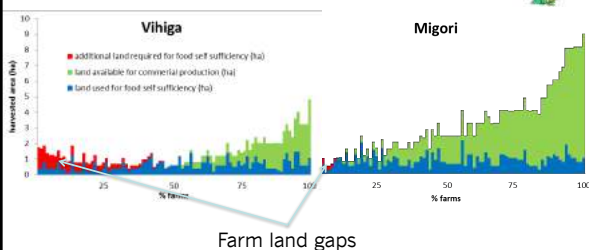


Major dissemination approaches used:

Demonstration trials: 41% Adaptation trials: 25% Field days/Media: 34%



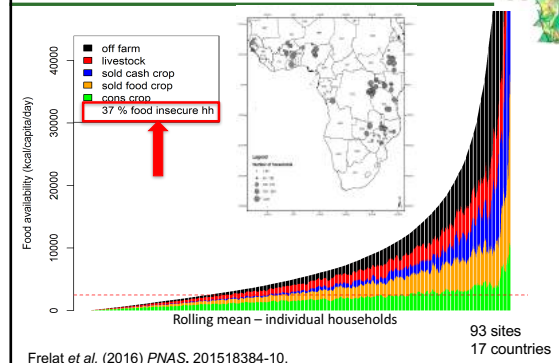
Food self sufficiency and land gaps – where will a value chains approach work?



Small farms and poor soils are double poverty traps!

Hengsdijk, Franke, van Wijk, Giller 2014. How small is beautiful? Wageningen PRI Report 68.

Food availability across >13,000 small farms



Improving food self-sufficiency – climbing beans in DRC



Long rains season 2010 in Sud Kivu, DRC

Short-duration cowpea in West Africa



- Yields during hunger period
- Allows two crops within the season
- Energy, protein, minerals and B vitamins

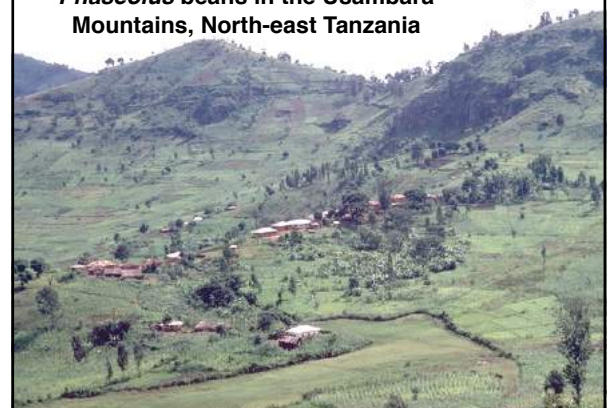
Putting nitrogen fixation to work for smallholder farmers in Africa

What is a sustainable farm size?



45

Phaseolus beans in the Usambara Mountains, North-east Tanzania



Phaseolus beans on Lushoto market

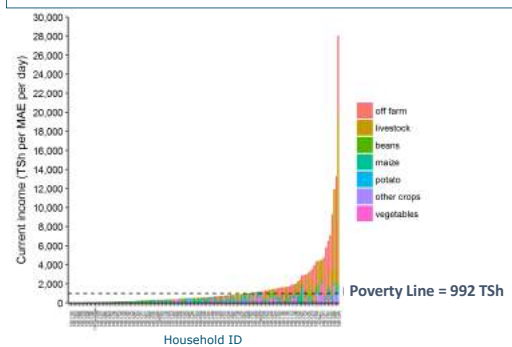
1987



2014



Household income in West Usambara, Tanzania

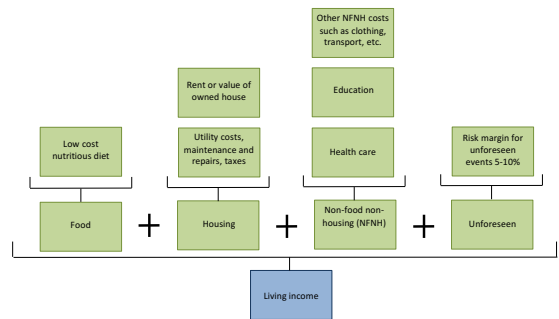


RHOMIS Survey, 2015

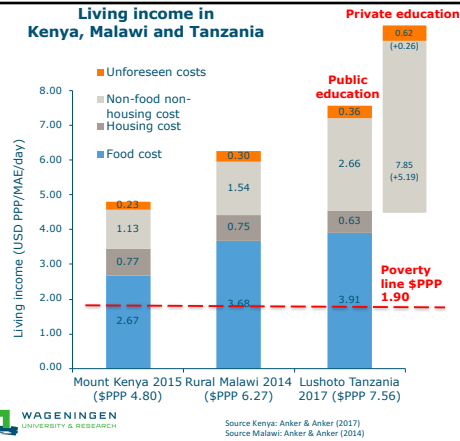
Living income

- "**Living income** is the net income a household would need to earn to enable all members of the household to afford a decent standard of living" (Anker & Anker, 2015)

Living income

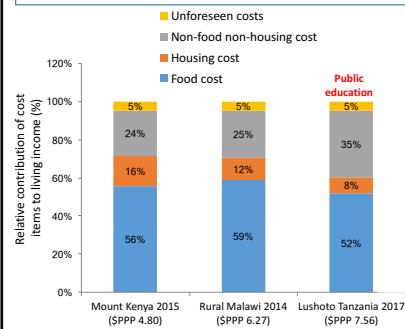


Living income in Kenya, Malawi and Tanzania



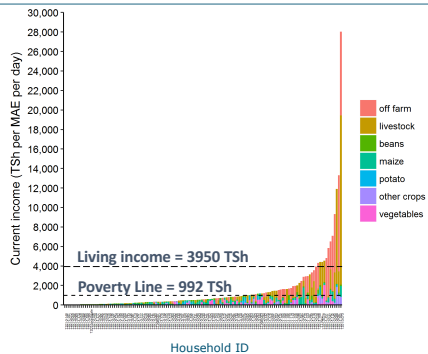
Source Kenya: Anker & Anker (2017)
Source Malawi: Anker & Anker (2014)

Relative contribution of cost items to living income



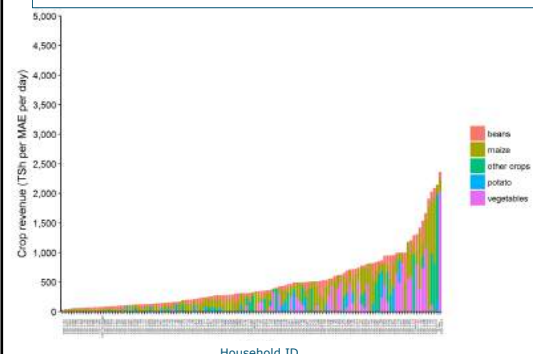
Source Kenya: Anker & Anker (2017)
Source Malawi: Anker & Anker (2014)

Household income in West Usambara, Tanzania

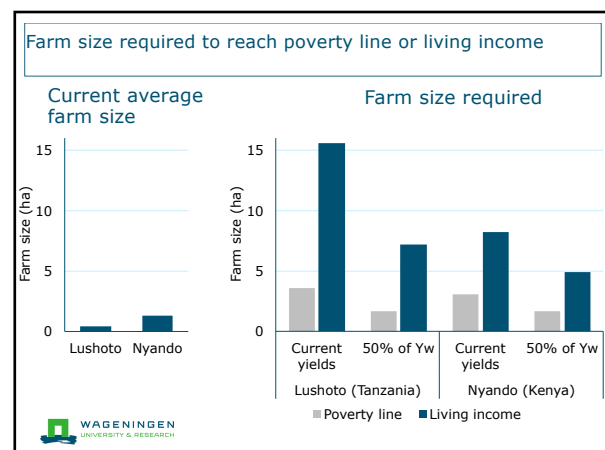
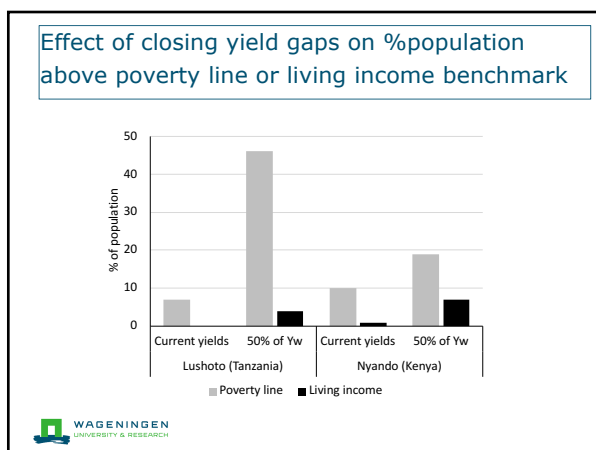
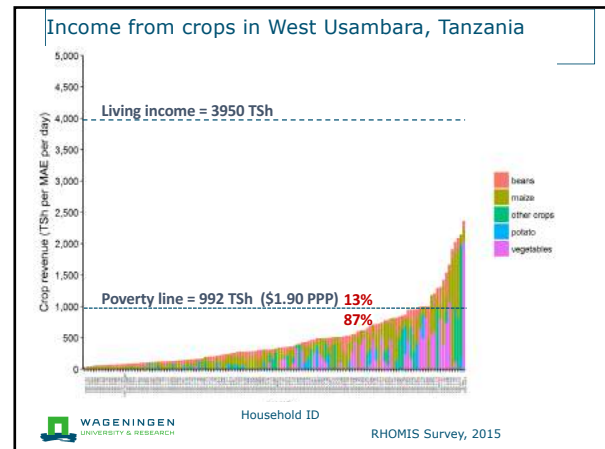
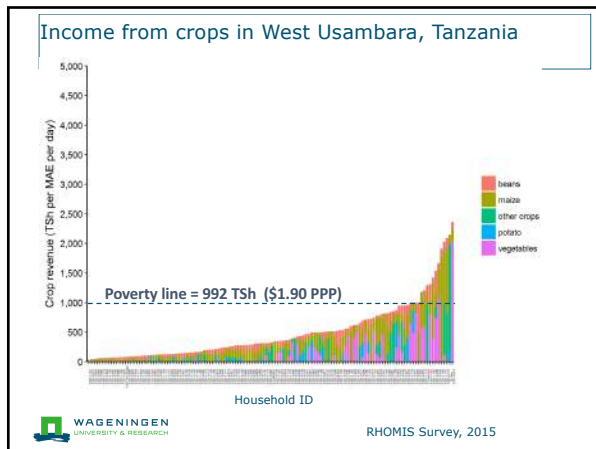


RHOMIS Survey, 2015

Income from crops in West Usambara, Tanzania



RHOMIS Survey, 2015



Learning from history – The West Usambara Mountains, Tanzania

"The mountains of what I have called the Fuga [Vuga] plateau, seem to be almost bare."

"With the bad soil conditions, locals should use year long periods of fallow. But, this land is so densely occupied, that this is no longer possible." von Schnee, 1912

Huijzendveld, F. (1997) *Die Ostafrikanische Schweiz: Plantages, Planters en Plattelandsontwikkeling in West-Usambara, Oost Afrika, ca. 1870-1930*, Verloren, Hilversum, pp. 543.

Learning from history – The West Usambara Mountains, Tanzania

"... the whole region [West Usambara] has reached a very low level of fertility owing to over-cultivation, over-grazing and failure to manure the land... these conditions can only be rectified by a vigorous soil-rehabilitation programme" TARDA, 1945

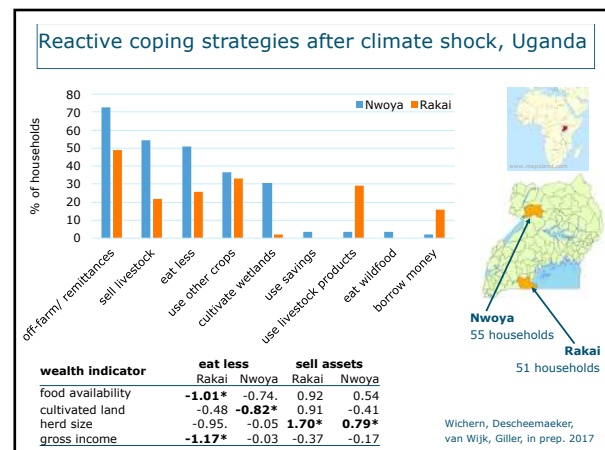
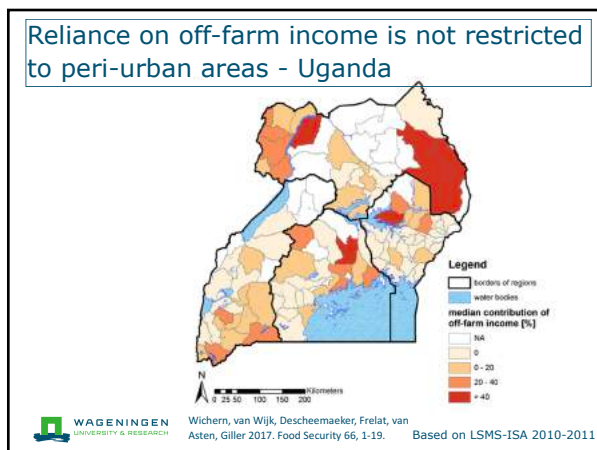
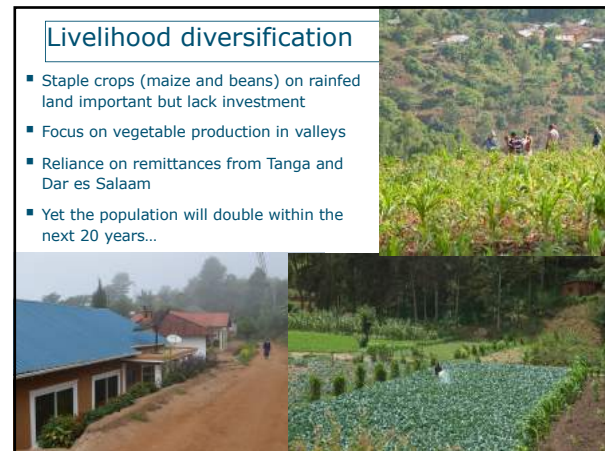
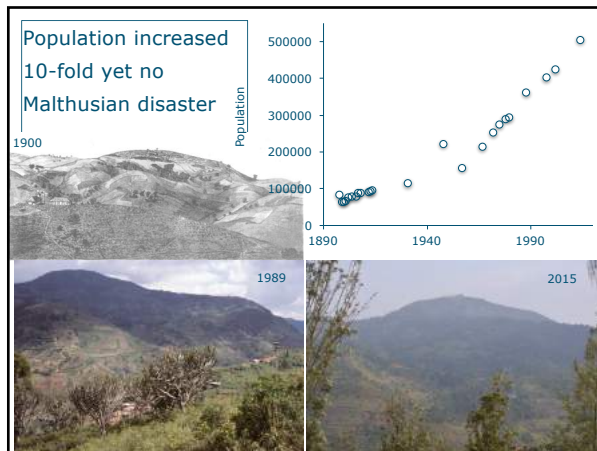
"... the people are ... living in the final stage before their overworked worn out land ceases to carry them. Every new baby is an added burden which cannot much longer be borne." Provincial Commissioner of Tanga, 1946

"In Tanzania, the West Usambara highlands are among the most affected areas [by] soil erosion" Wickama et al. 2014

"Cultivation has a strong effect on reducing SOC across the Lushoto region. ...implementing climate smart agriculture (CSA) may ...help build resilience and adaptive capacity of the overall farming system" Winowiecki et al. 2016

Huijzendveld, Bajjukya and Giller, forthcoming

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Other trends – the emergence of larger farms

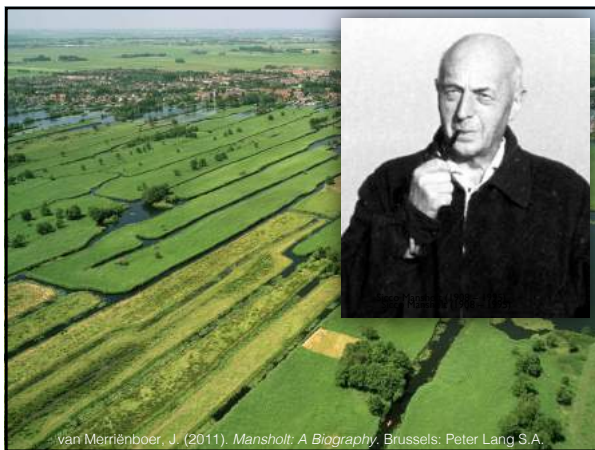
- Emergent “investor” farmers – 5-50-100 ha
- 10% of urban based households owning 35% of the arable land
- Land prices increasing rapidly with 100 km of urban centres
- Often use a small proportion of their land initially
- Can help to stimulate local input and output markets

Jayne *et al.* 2016 Agric. Econ. 47, 197-214.
 Jayne *et al.* 2014, J of Int. Affairs 67, 35-52.
 Jayne, Chamberlin, Headey 2014, J. Food Pol. 48, 1-17.

Which country was successful in achieving food self-sufficiency?

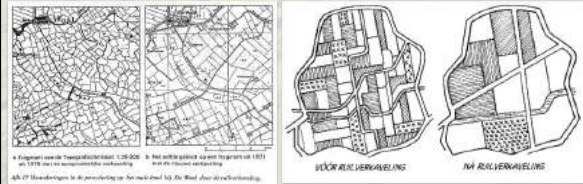
- Policies to support modernisation of agriculture and the use of new technologies
- Consolidation of fragmented fields into viable economic farm units
- Policies to encourage small, unviable farms to quit farming
- Tariffs and price support to provide a **living income** for farmers
- Special measures to support farmers on poor sandy soils

And where it was funded through a large injection of foreign aid ?

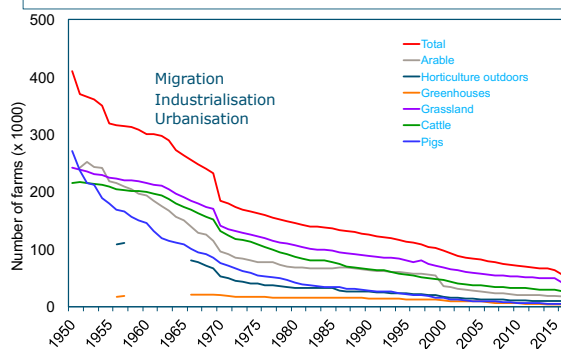


Mansholt was successful in:

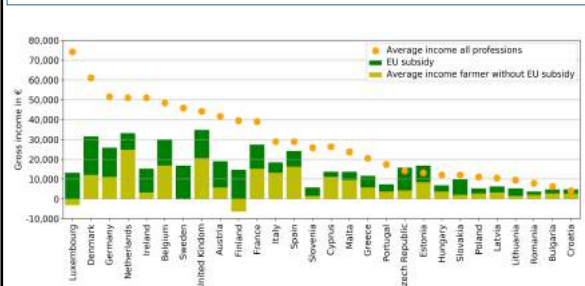
- Reducing the number of small farms
- Consolidating fragmented land
- Modernising agriculture
- Achieving national food self-sufficiency
- Turning Dutch farming into a motor for economic growth



Number of farms in the Netherlands

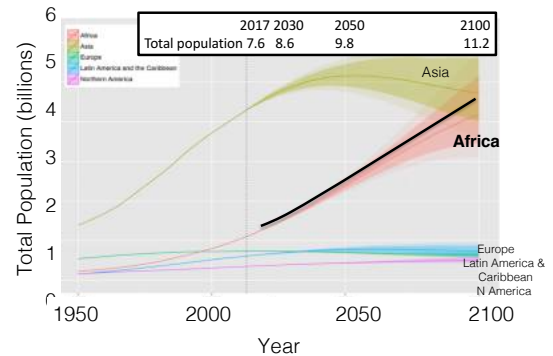


EU subsidies and farmers' income



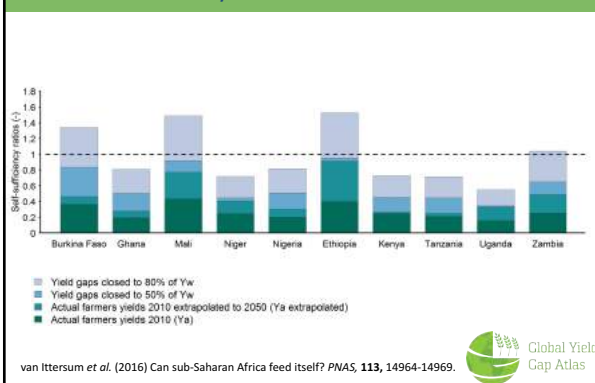


Population growth in Africa shows no sign of slowing down



Gerland et al. (2014) World population stabilization unlikely this century. *Science* 346, 6206, 234-237 + UN World Population Report (2017)

Self-sufficiency 2050: 10 countries



Betting on Africa to feed the world



Dr Akin Adesina
President African Development Bank and World Food Prize Laureate
16 October 2017

The Food Security Conundrum

- National food security requires an abundant supply of cheap and nutritious food for the burgeoning urban population
- Agriculture is a major contributor to the balance of payments for African economies
- Rural households (reluctant farmers) lack sufficient land or economic incentives to invest in agriculture

Conclusions and Questions

- Global Food Security is a key geo-political issue
- Abundance of technologies available for sustainable intensification
- Farmers need to diversify to make a living income
- Off-farm income (and/or subsidies) appear to be key for economic farming
- The capital needed for farming comes from outside the farm
- Urban employment and rural development interdependent and need to develop hand in hand

Who will produce our food?

With thanks to:

Rik Llewellyn, CSIRO

John Kirkegaard, CSIRO

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Wageningen University

Fred Baudron, CIMMYT

Thom Jayne, Michigan State
University

Will Masters, Tufts University

Krijn Poppe, Wageningen
University

