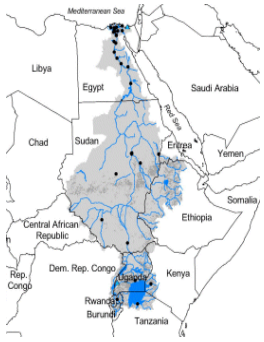



European Geosciences Union (EGU) General Assembly 2016

"Active Planet"

Session HS 7.5 / NH 1.21

Hydroclimatic extremes under change

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Technische Universität München (TUM)

Oral Presentation

Energy and the agroeconomic complexity of Ethiopia

Thursday, April 21, 2016

Energy, agriculture and civilization

Energy Paradigm: The dominant pattern of energy harvesting from the natural environment (i.e. fruit collection for body energy, animals, fossil and nuclear fuels)




Daily energy budgets per capita (based on *Kümmel 2011*):

- ✓ Gatherers' Society = **2 kWh/d** (vegetables)
- ✓ Hunters' Society ~**3-4 kWh/d** (without fire)
- ✓ Hunters' Society ~**6 kWh/d** (with fire)

} **Primitive Societies** (Muscle heat engines)

- ✓ Classical and Roman Ancestry = **20kWh/d**
- ✓ Middle Ages (1400 AC) = **30 kWh/d**

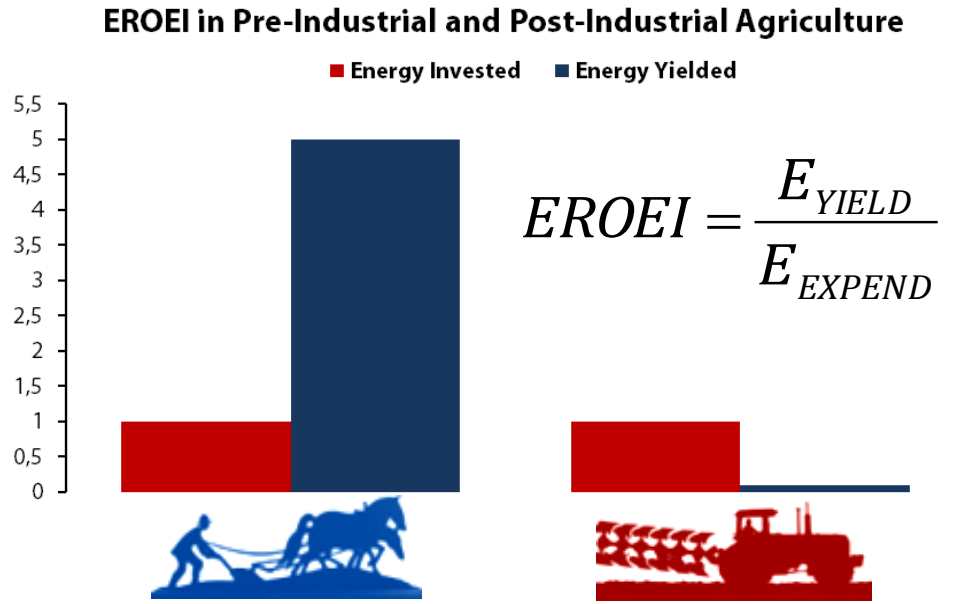
} **Agricultural Civilization** (Biochemical solar input stocks)

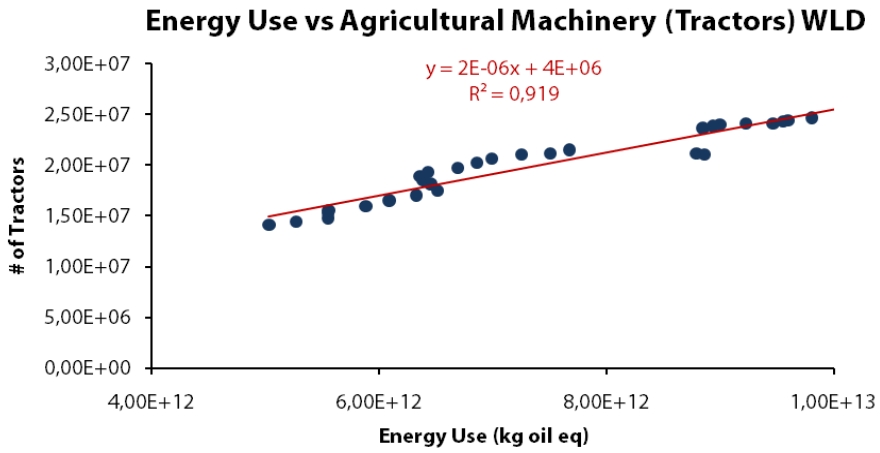
- ✓ Industrial Revolution (1850 AC) = **76 kWh/d**
- ✓ Modern Electrification Era = **112 kWh/d**

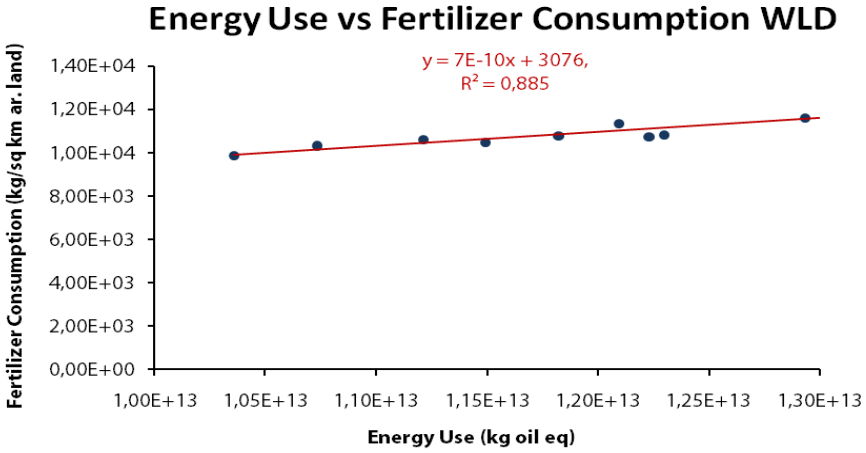
} **Fossil-fueled Civilization** (Fossil solar input stocks)

Energy returns in global agriculture

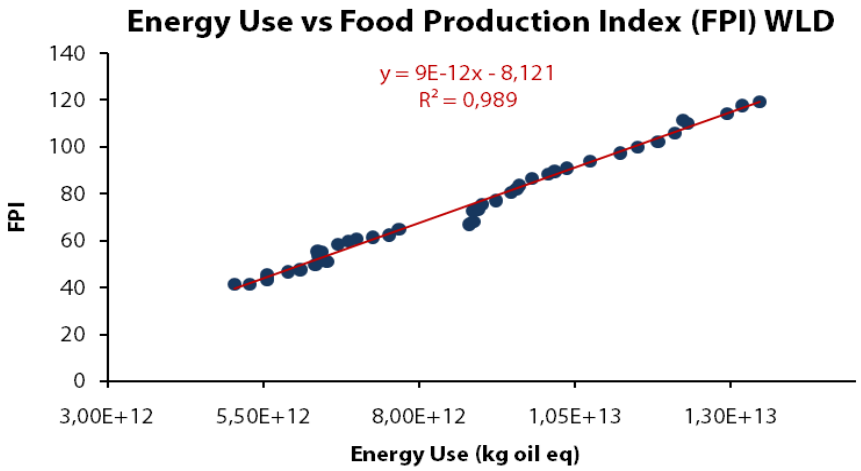
Pre-industrially, agriculture was a *net supplier* of (chemically stored solar) energy. The *Industrial Revolution* transformed global agriculture to a *net user* of energy via large-scale use of fossil fuels or *fossil-fuel intensive* fertilizers.





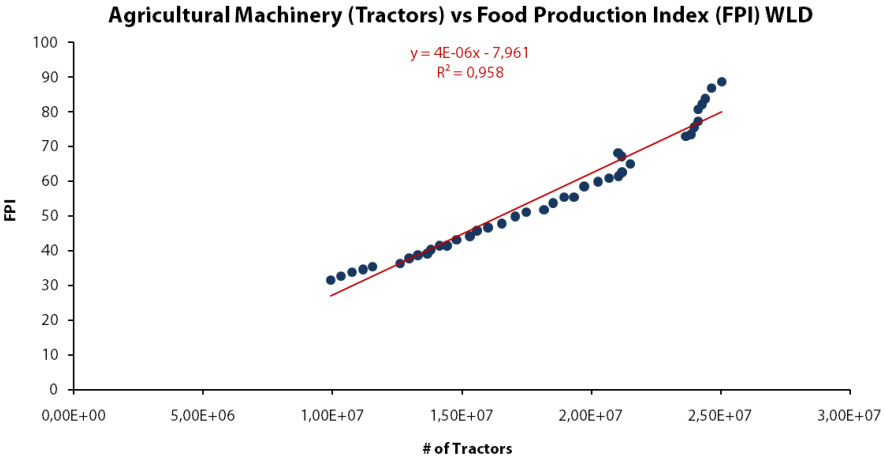


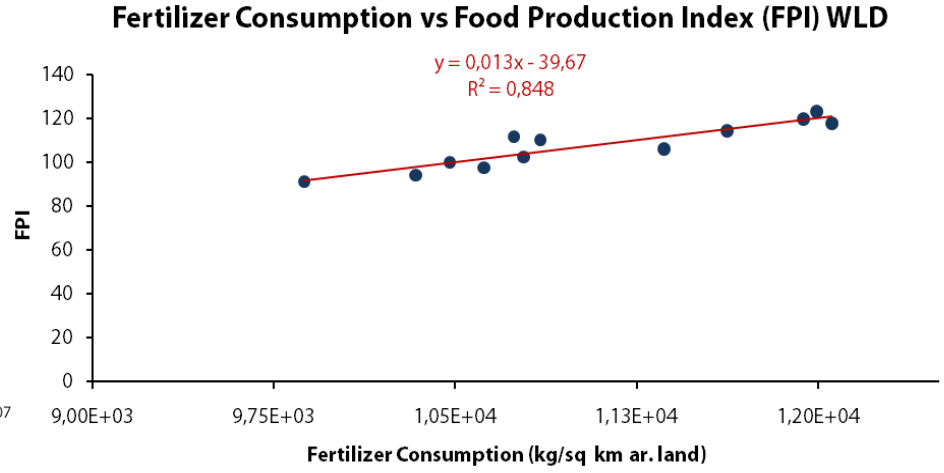
Energy and the diversification of global agriculture



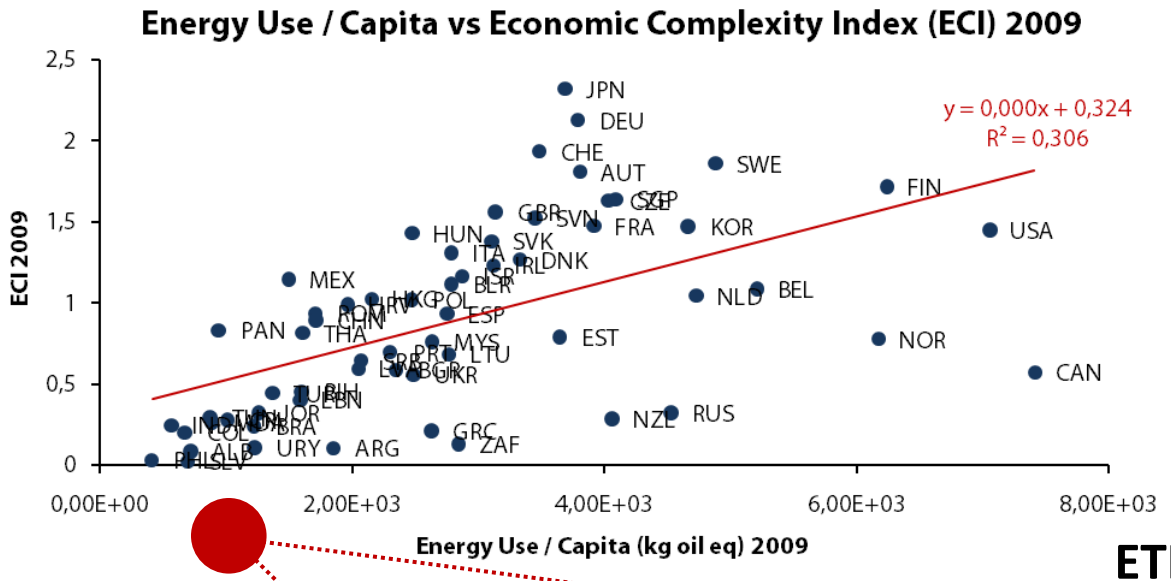
Intensification of direct *energy* and *fertilizer inputs* in global agriculture has increased not only output but also the *crop output diversification*.

$$FPI = \sum_{i=1}^{n} \frac{Output_{CurrentYear}i}{Output_{BaseYear}i} \cdot 100$$



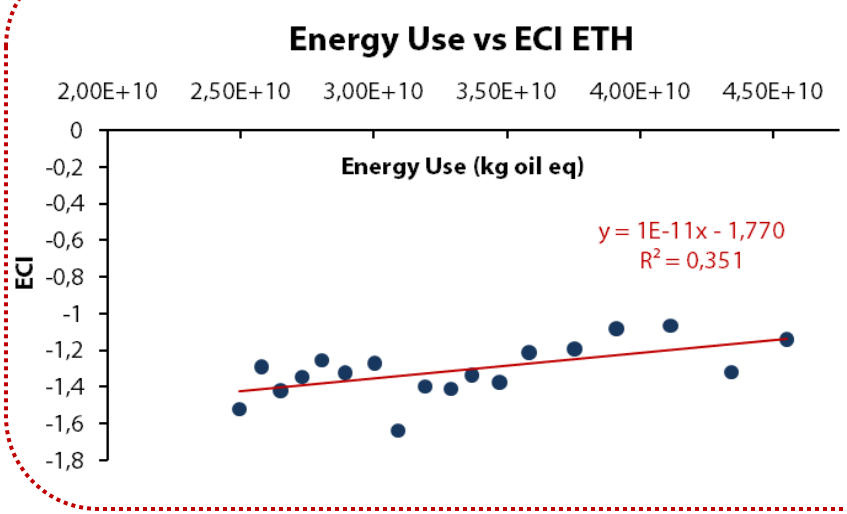


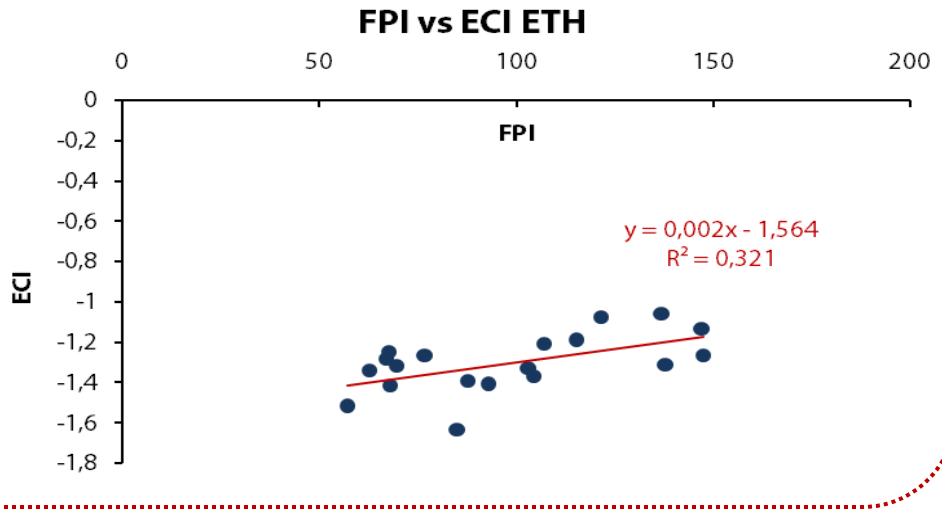
Energy and economic complexity in the world



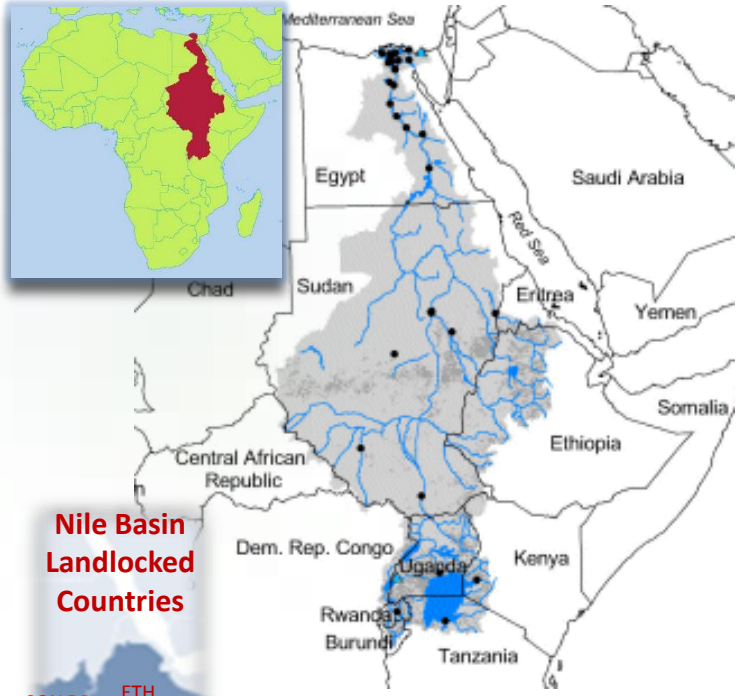
The ***Economic Complexity Index* (ECI)** *(Hausmann et al. 2011)* indicates both *economic diversification* and the *difficulty of competing* a country's output synthesis.

ETH ECI (1995-2009) = -1,3069





Ethiopia in the Nile Basin



The White and the Blue Nile conflux in the city of Khartoum (SDN)

Lake Tana (ETH) is the source of the Blue Nile

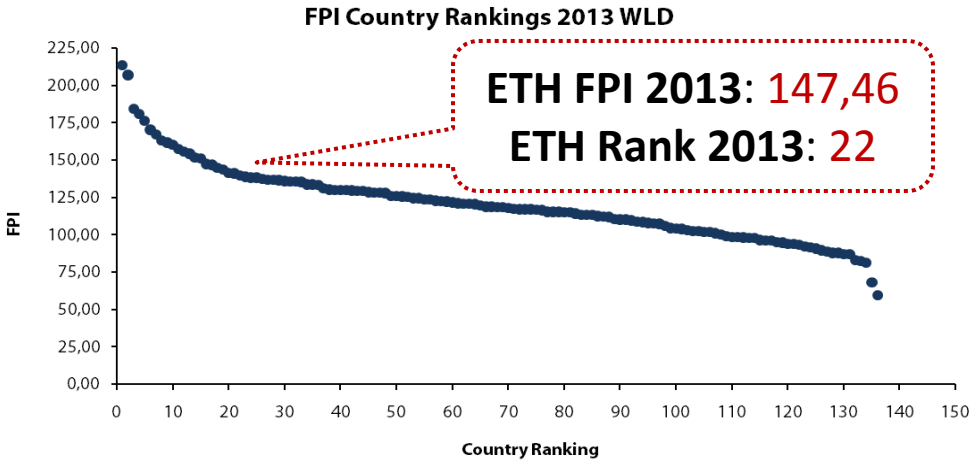
Lake Victoria is the source of the White Nile. The Lake's basin is shared by 3 countries (TAN, KEN, UGA)

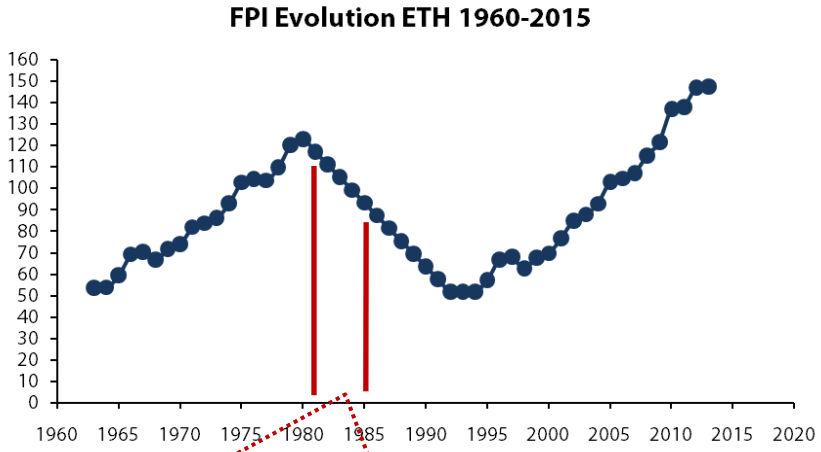
Member-Countries of the **Nile Basin Initiative (NBI)**

Note: *Eritrea also participates only as Observer*

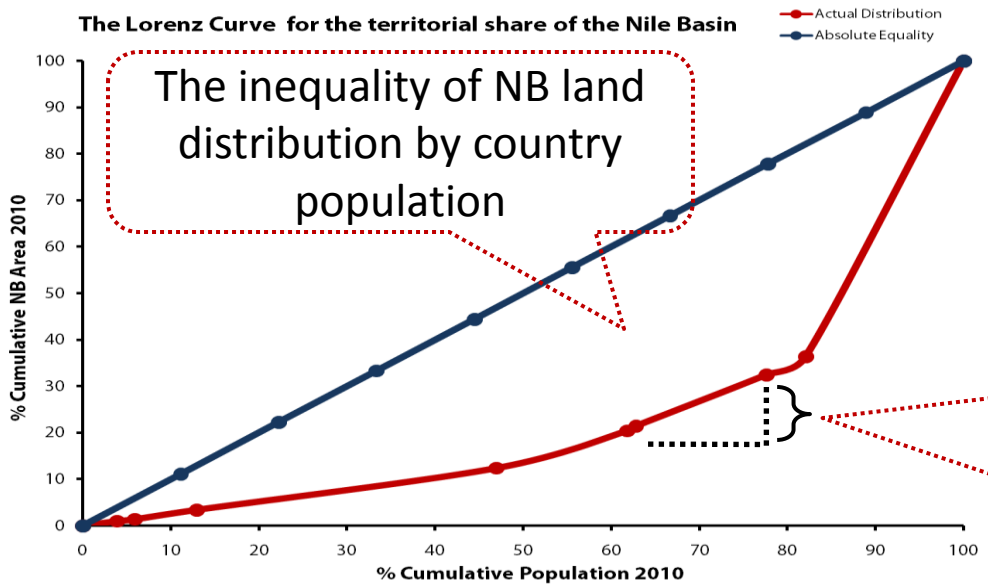
Source: http://www.nilebasin.org/

The agroeconomic state of Ethiopia



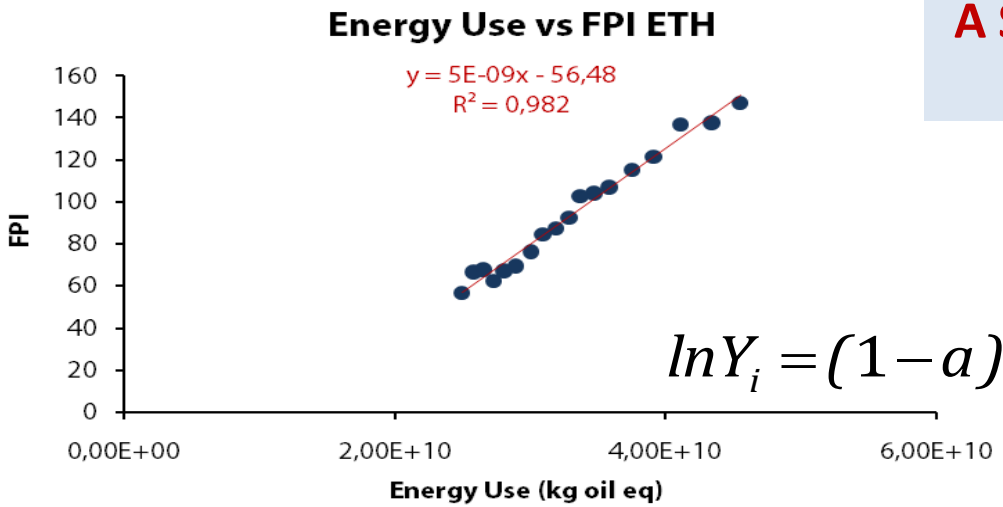


1983-85: The Ethiopian Famine



ETH with ~***10% of population*** residing in the Nile Basin (NB) ***occupies*** ~***10% of the NB area*** (SDN with 18% of the NB population occupies 62% of the NB area)

Energy, agricultural diversification and growth in Ethiopia



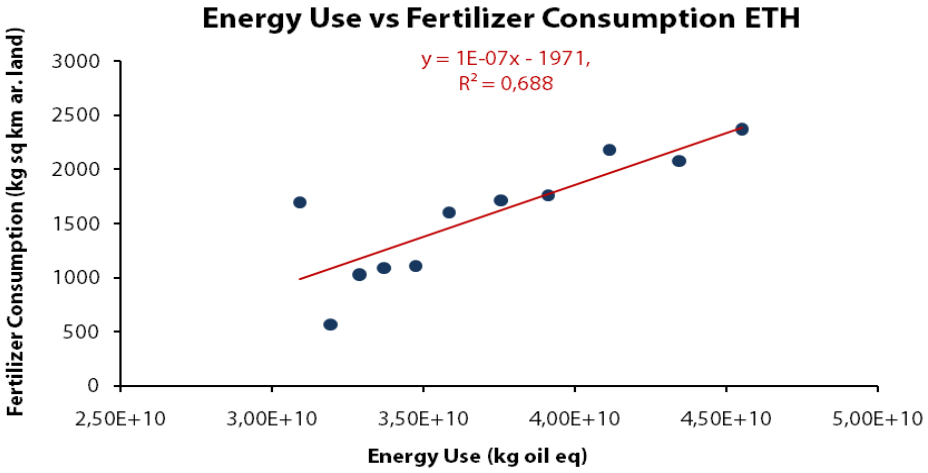
A Simple Endogenous Growth Model for Low Income Countries (LICs)

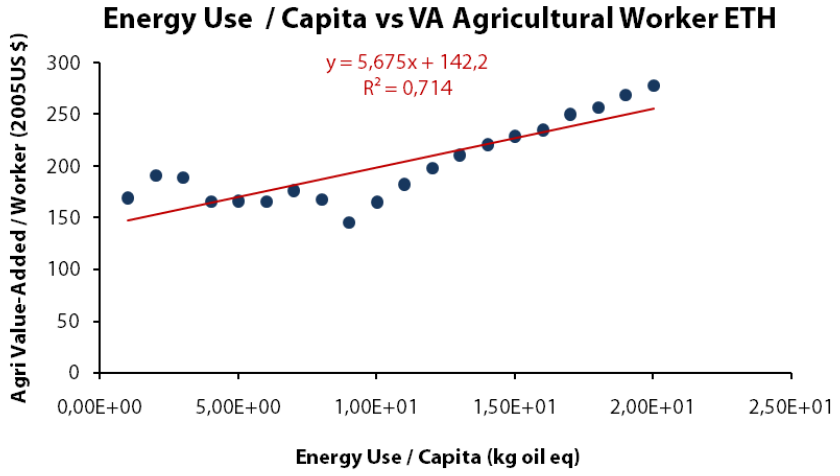
$$Y_i = L_i^{1-a} \cdot (N \cdot E_i)^a \cdot N^{1-a}$$

Linear Regression form

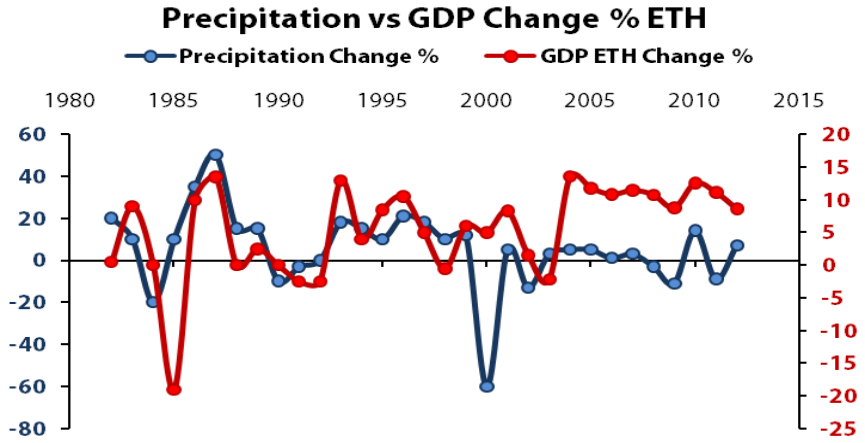
$$\ln Y_i = (1-a) \cdot (\ln L_i + \ln N) + a \cdot (\ln E_i + \ln N)$$

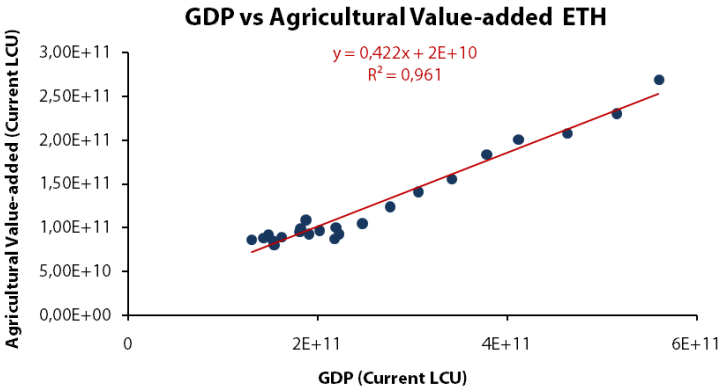
Agricultural LICs' **Income** (*Y*) depend highly on **Energy Inputs** (*E*), **Human Labor** (*L*) and the **Number of Products** (*N*).

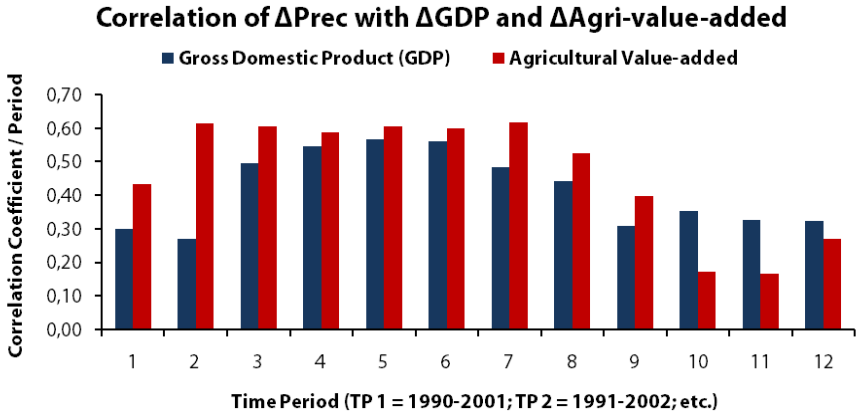


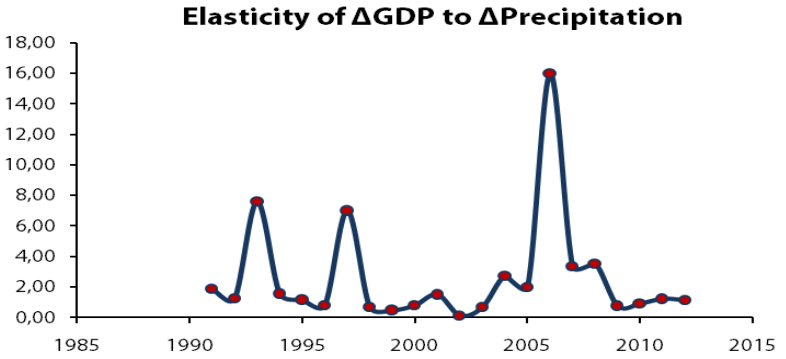


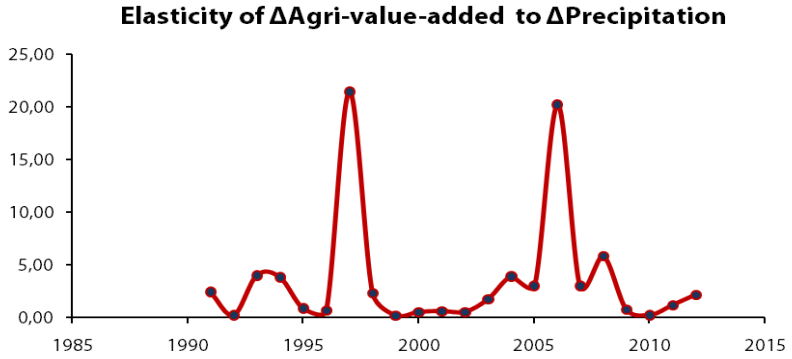
Hydroclimate and economic output in Ethiopia







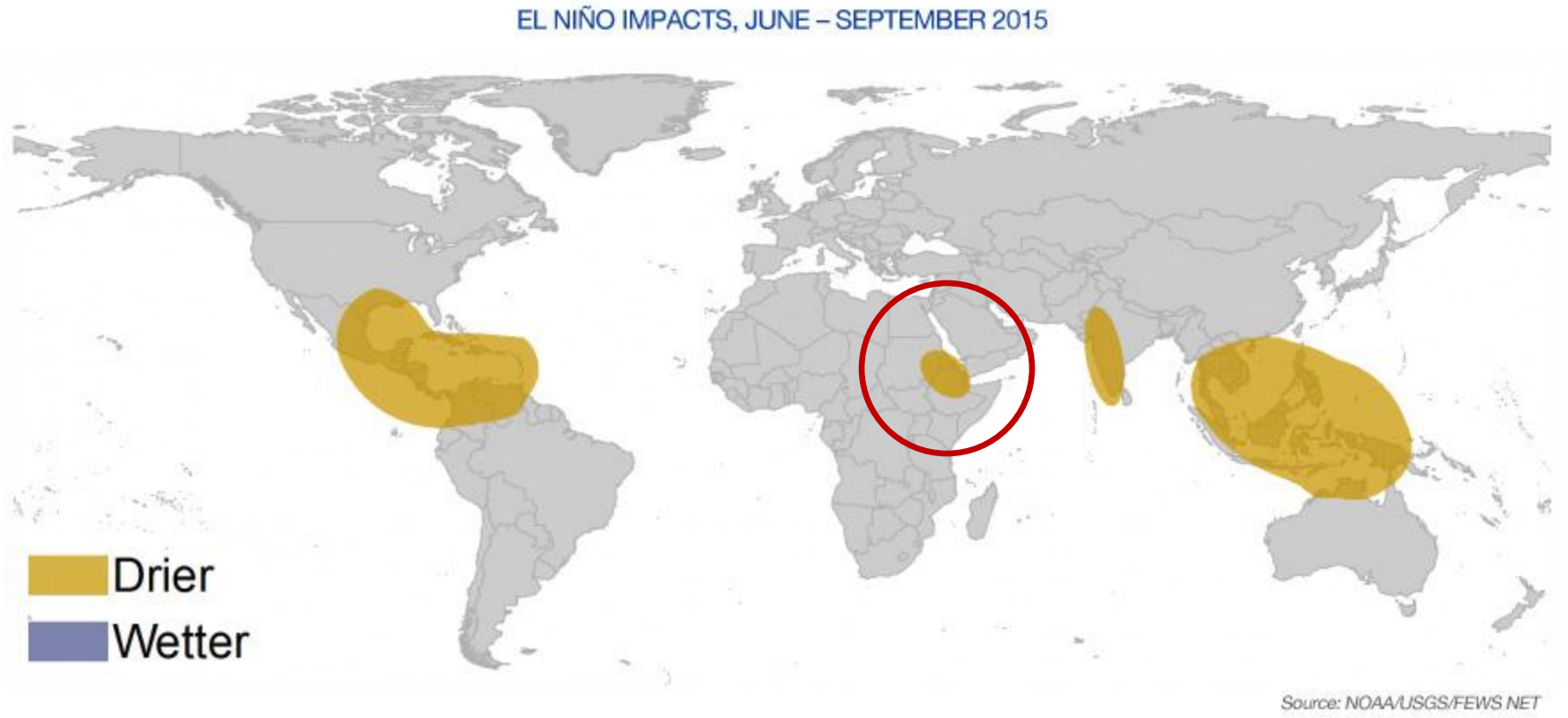




Higher correlation between ***Δ*precipitation** and ***Δ*output** for the periods 1994-2006 and lower for the period 2002-2014. Elasticities depend also on international food prices.

Global Impacts of El-Niño June - September 2015

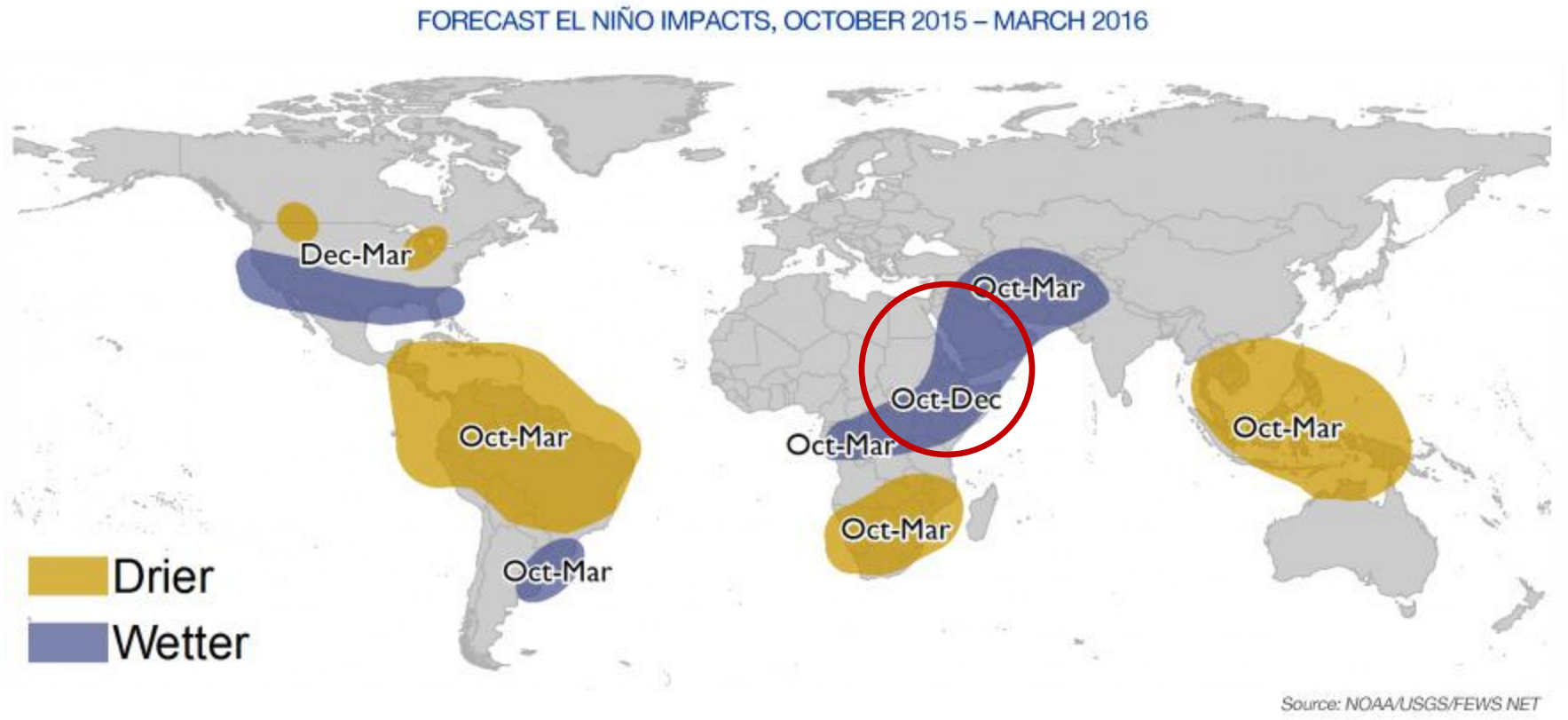
As hydroclimatic extremes are aggravated by the El-Niño effect, in less than 1y Ethiopia suffers from both types; *Droughts* and Floods, which make the mitigation cost very high -particularly for poor rural areas.



Source: http://www.fews.net/fews-net-el-ni%C3%B1o-monitoring-resources

Global Impacts of El-Niño October 2015 – March 2016

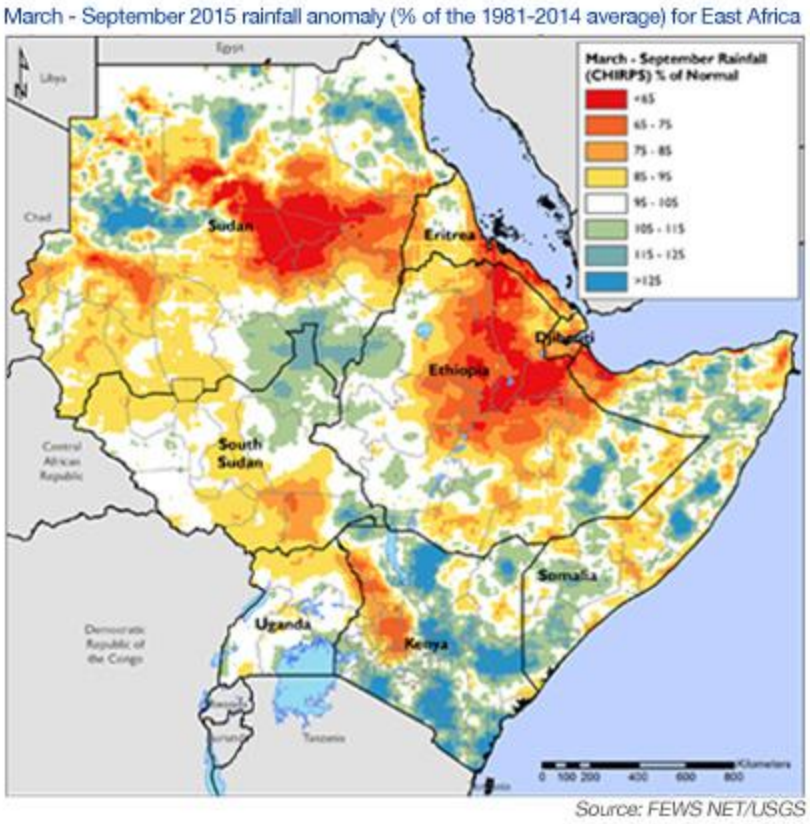
As hydroclimatic extremes are aggravated by the El-Niño effect, in less than 1y Ethiopia suffers from both types; *Droughts* and Floods, which make the mitigation cost very high -particularly for poor rural areas.

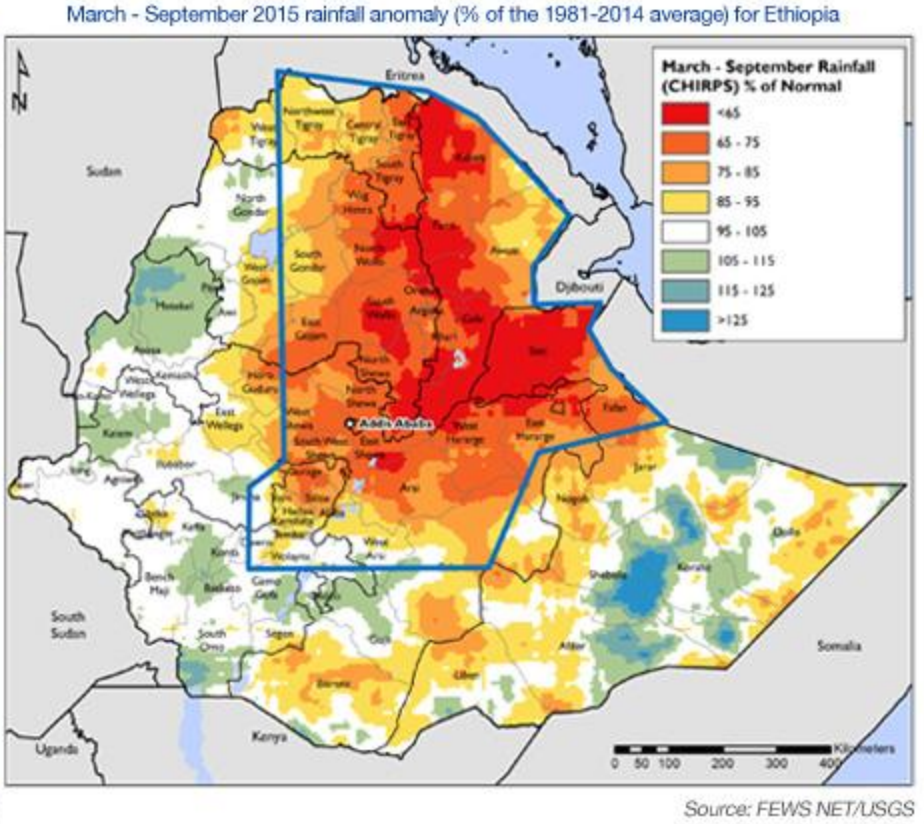


Source: http://www.fews.net/fews-net-el-ni%C3%B1o-monitoring-resources

Impact of rainfall variations in East Africa and Ethiopia

As hydroclimatic extremes are aggravated by the El-Niño effect, in less than 1y Ethiopia suffers from both types; *Droughts* and Floods, which make the mitigation cost very high -particularly for poor rural areas.

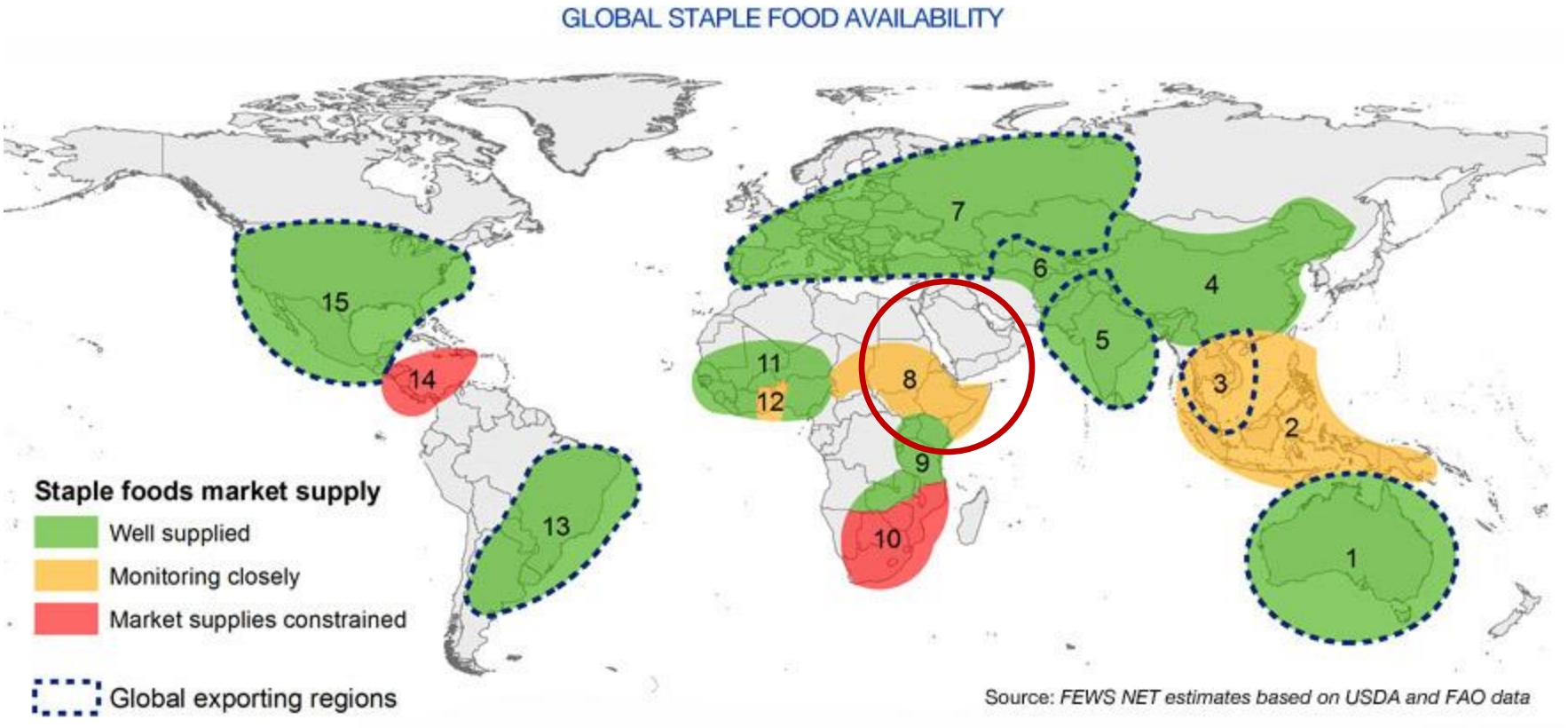




Source: http://www.fews.net/fews-net-el-ni%C3%B1o-monitoring-resources

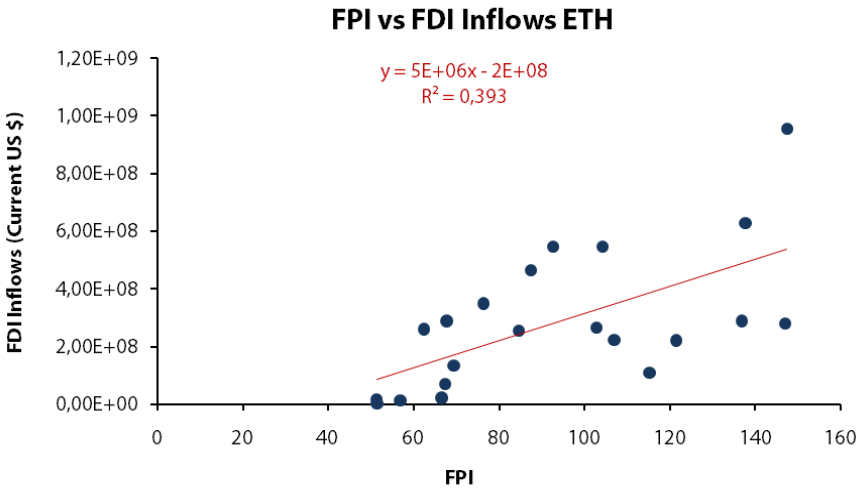
Impact of El-Niño on Food Security

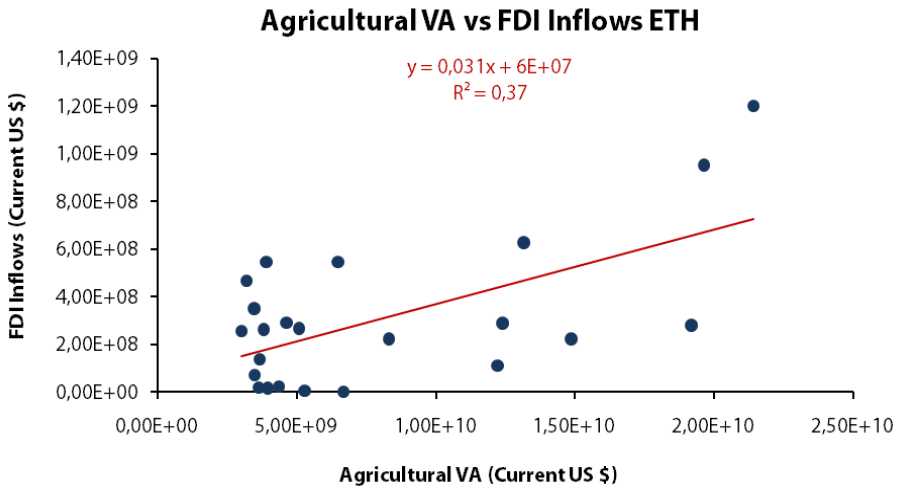
Ethiopian crop output *is heavily based in rain-fed agriculture*. As the El-Niño affects the *monsoons*, food security is closely monitored in the wider area of the African Horn, including the entire Ethiopian region.

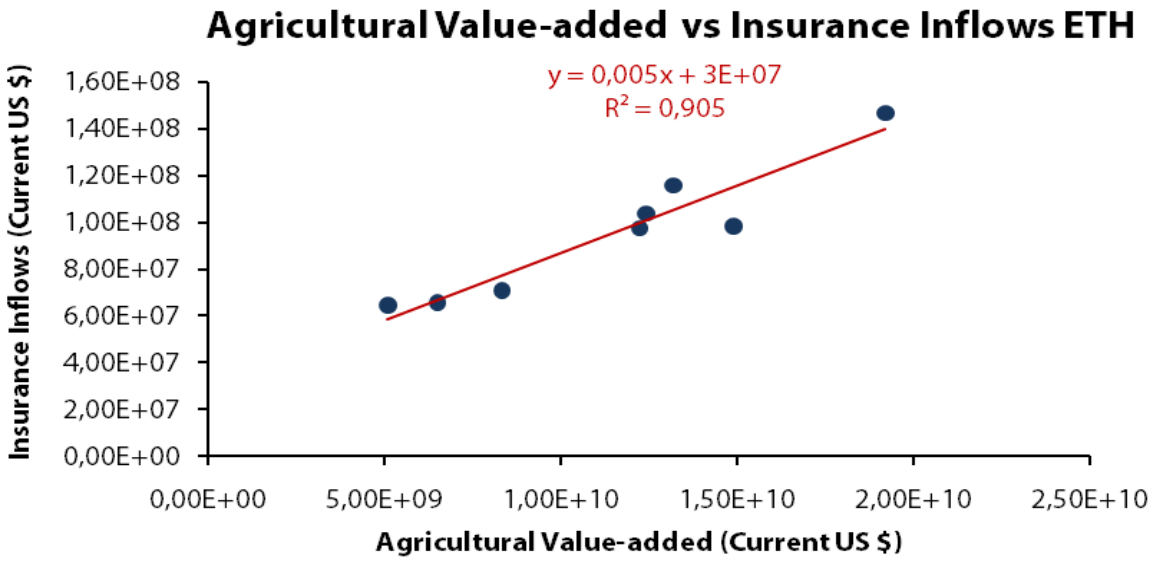


Source: http://www.fews.net/fews-net-el-ni%C3%B1o-monitoring-resources

The future of investments and agrifinance in Ethiopia







Agricultural Foreign Direct Investment (AFDI) inflows concern ~80% of total FDI inflows; *with financial inflows (Insurances)* accompanying them.

Conclusions

- ✓ The pattern of post-industrial global agriculture consists in its transformation from *net energy supplier* to a *net energy user*.
- ✓ The energetic transformation of global agriculture consists in: (a) *mechanization*, (b) extensive use of *fossil-fuel intensive fertilizers* and (c) *crop output differentiation*.
- ✓ Energy use increase per capita comprises an important factor not only for the growth of output, but also for *economic differentiation and complexity*.
- ✓ Ethiopia, as *Low Income Country* (LIC) follows the same path of agricultural transformation.
- ✓ With *human labor* and *energy* as major production factors –while lacking significant technological inputs- *crop output differentiation* is the optimal path of value maximization.
- ✓ The value of Ethiopia's agri-sector is still *heavily depended on hydroclimate conditions*, although with a decreasing trend as industry gains share in the GDP.
- ✓ Ethiopia's agri-sector attracts an *increasing value of FDIs*, concerning utilization of arable land.
- ✓ FDI inflows are expected to be accompanied by adequate *inflows of special financial instruments* in order to secure their future value against hydroclimate risks.

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Invitation

For more information and discussion, please visit my poster at the slot

A.200

"Energy and the agroeconomic complexity of Ethiopia"

I'd be delighted to see you there!

Thank you for your attention!

Ready to discuss your remarks…