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The three rules of crop yield forecasting

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Overview

Rule 1: crop yield forecasting is art as much as science

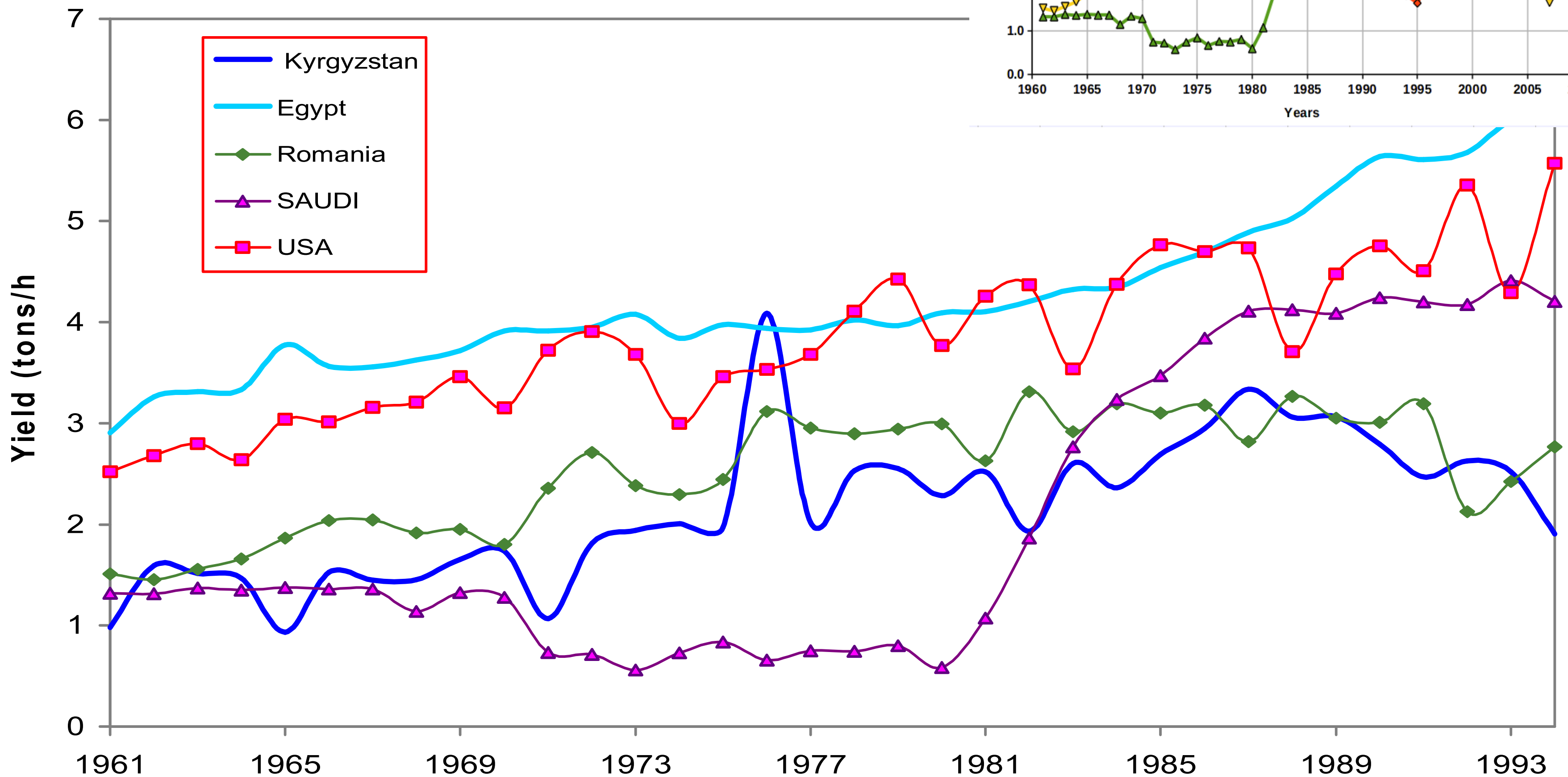
Rule 2: If statistics contradict agronomy, blame statistics; if common sense contradicts agronomy, blame yourself

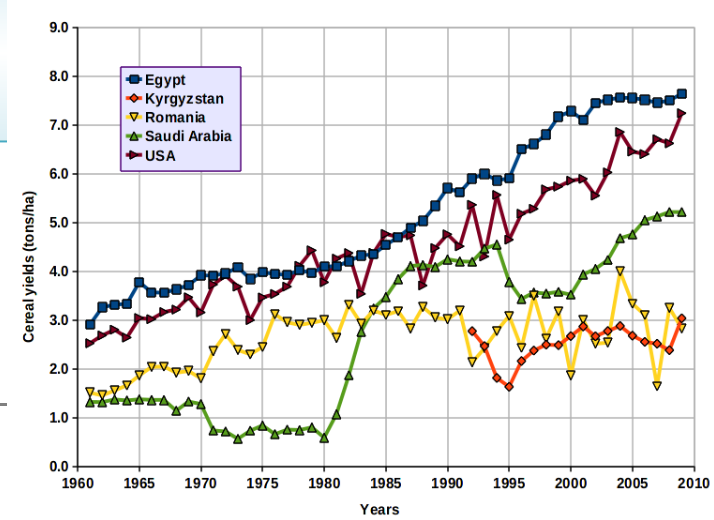
Rule 3: All crop forecasting is statistical

Rule 1: crop yield forecasting is art as much as science

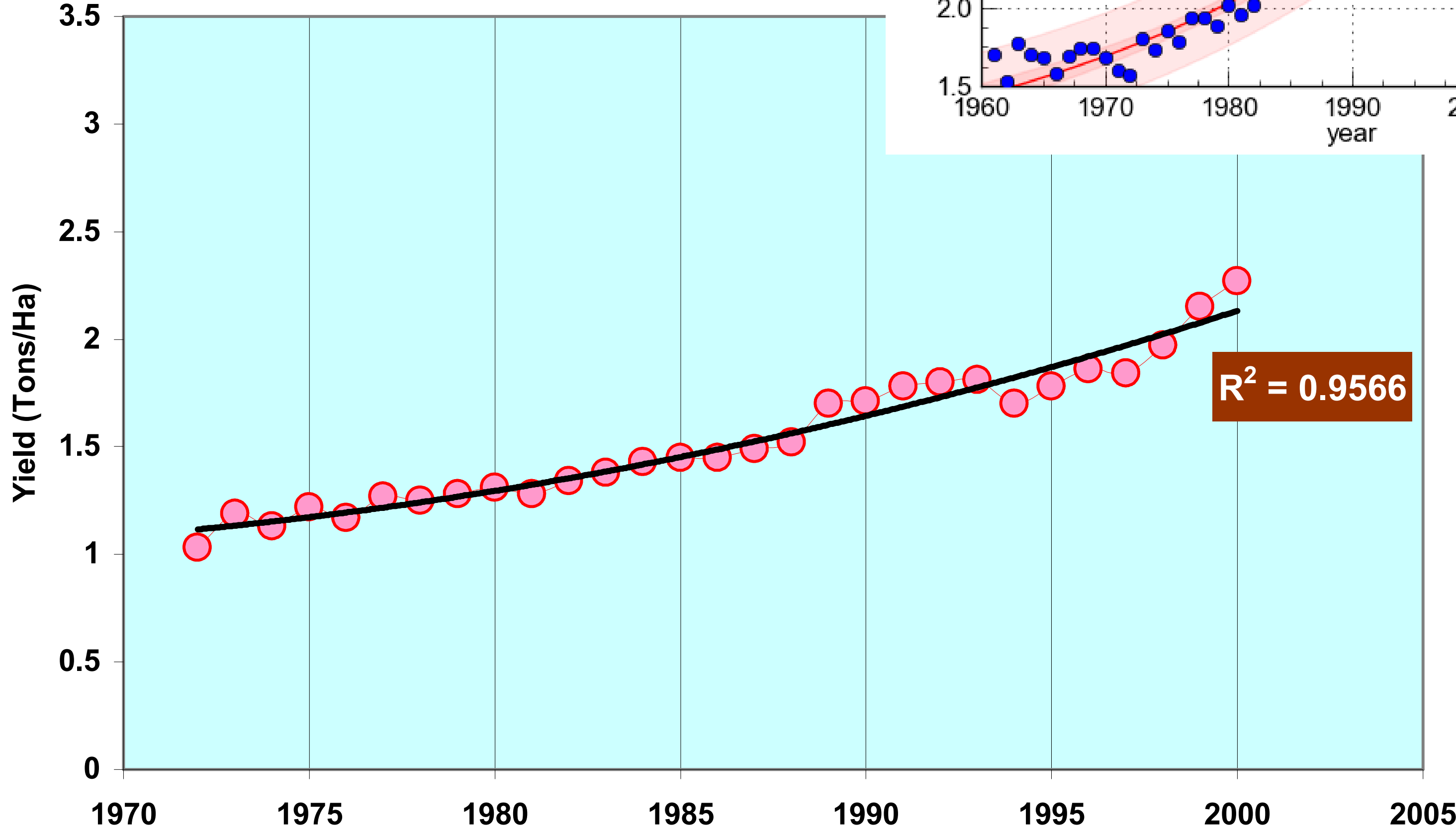
- Science and forecasting tools (e.g. software) are the servants of the forecaster, not his master
- Knowing the tools and methods is necessary, most of the time, but not sufficient
- How to define a “good method” and a “good forecast” is based on cost, ease of use (amount and type of data and tools requested), accuracy, transparency, repeatability
- A good forecaster knows when to throw in the towel

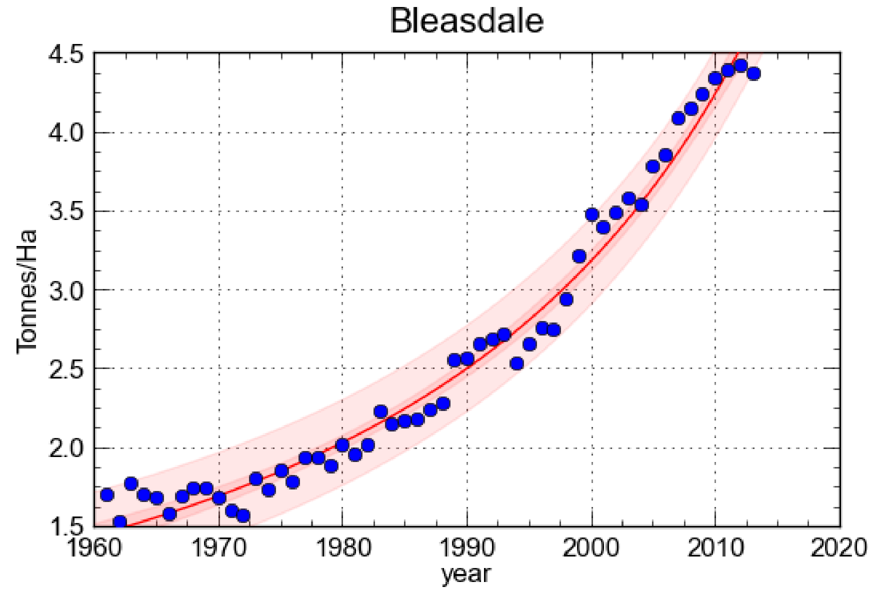
Variability…





BGD national rice yields

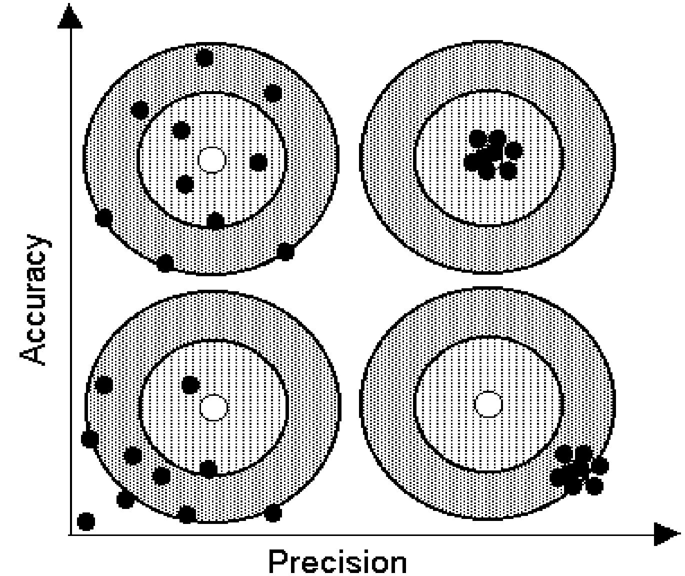




Quantifying variability

- Trends (technology/management/others) account for 80% of variability of regional yields
- In developed countries, about half of the remaining 20% is due to weather
- Pests, diseases , weeds account for the other half (up to 15% of total variability)
- In developing countries, trends are weak, which exacerbates the other factors

Accuracy, precision, transparency & repeatability



- A forecast cannot be better than the data used for calibration. This applies to inputs and outputs. In most real-world cases we forecast agricultural statistics
- The simpler the method, the more transparent & repeatable? The simpler the method, the more accurate?
- Which methods are available?

The zoo of methods (1/2)

- Subjective methods (questionnaires, “calibration of farmers”)
- Direct observation (estimation, proxies)
- Dgricultural statistics and “light” statistics
- Pollen-based methods

Source: http://speculativeevolution.wikia.com

More methods...

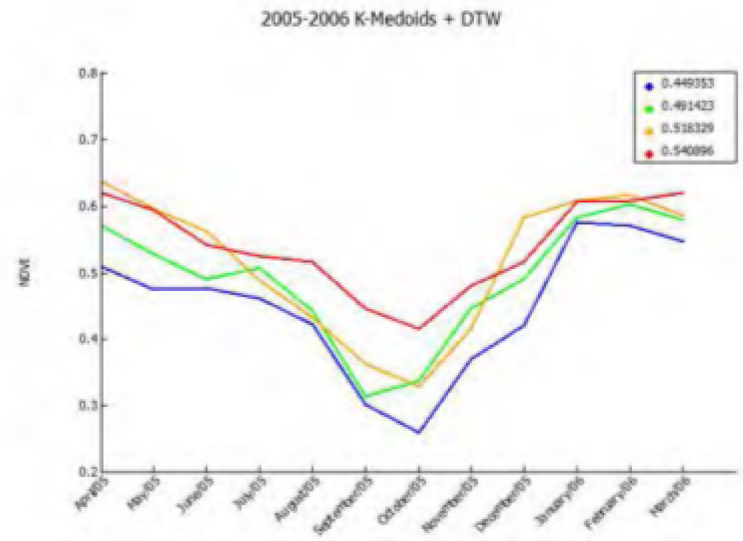
- Biometric methods
- Statistical “models” (factors Vs descriptors)

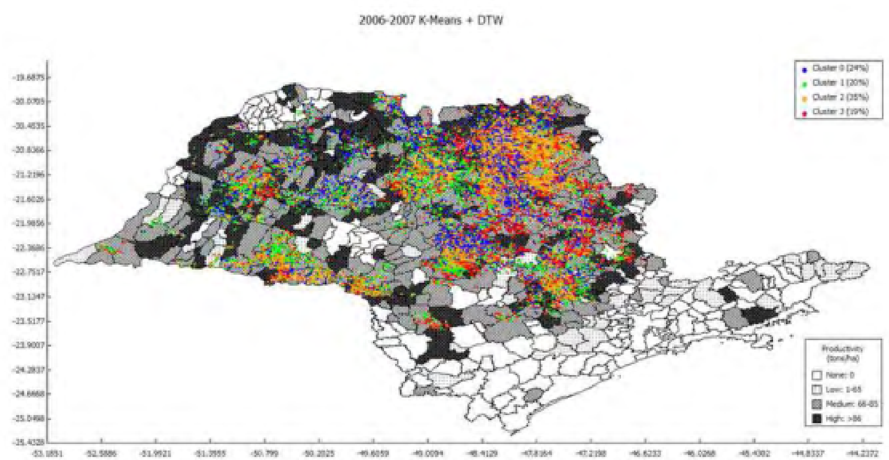
$$\text{Wheat (T/Ha)} = 15.44 + 0.0231\, R_{12} - 0.493\, T_7 + 0.332\, PAR_8$$

- CO_2 gradients
- process-oriented models
- descriptive statistics and expert systems (non-parametric)

	June average sunshine hours per day	
	6 hours and less	more than 6 hours
March total rainfall		
75 mm and less	5 ±1	6±2
More than 75 mm	8±1	10±2

Non parametric





Source: Romani et al., 2011 (EMBRAPA)

Rule 2: If statistics contradict agronomy, blame statistics; if common sense contradicts agronomy, try again!

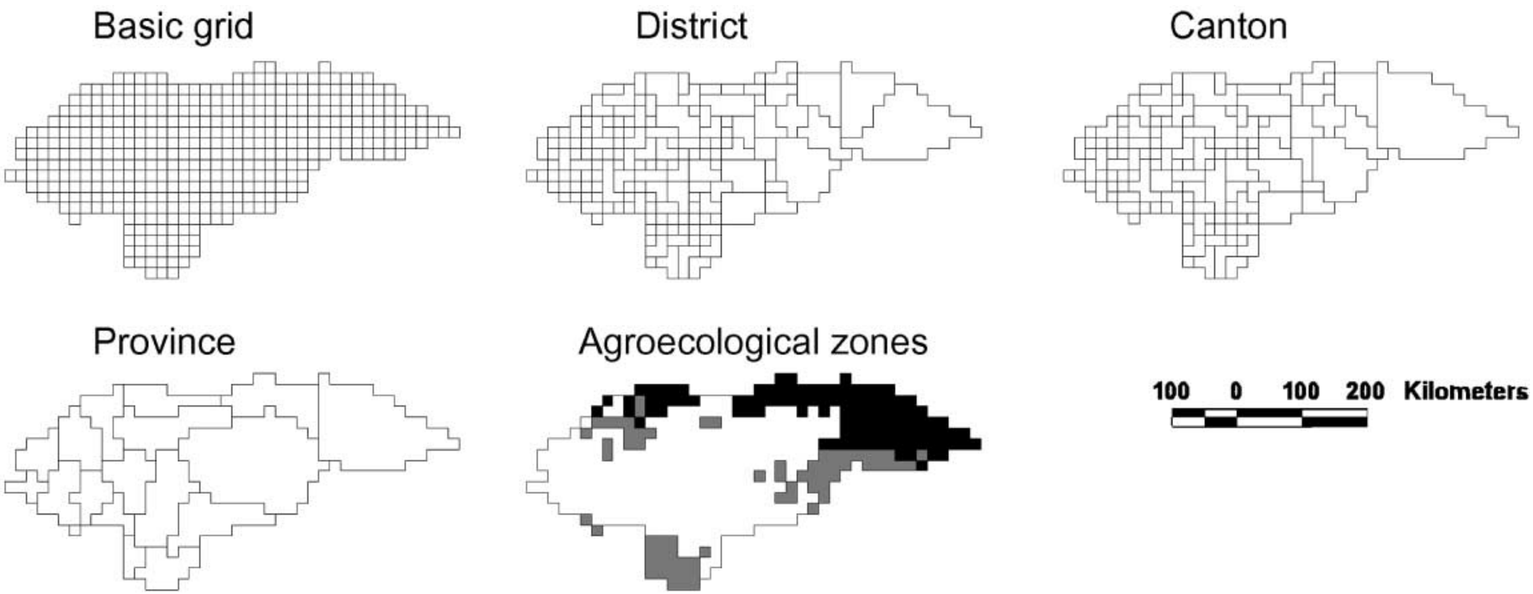
- A crop forecast is not a data processing, statistical, remote sensing, crop modelling or a GIS problem. It is an agronomic/agricultural problem!
- Methods must be adapted to the purpose (e.g. farmer advice à la QDPI, insurance, “advance statistics”).
- Whatever factors are relevant must “somehow” be brought in

Rule 3: All crop forecasting is statistical

- No model produces directly useable results. Outputs are produced for a “customer” and they must be checked (and/or calibrated) against the customers’ historical data
- Crucial issues include scale and trends
- Model parameters most of the time require fine tuning as part of validation. This not dealt with below but also requires statistics

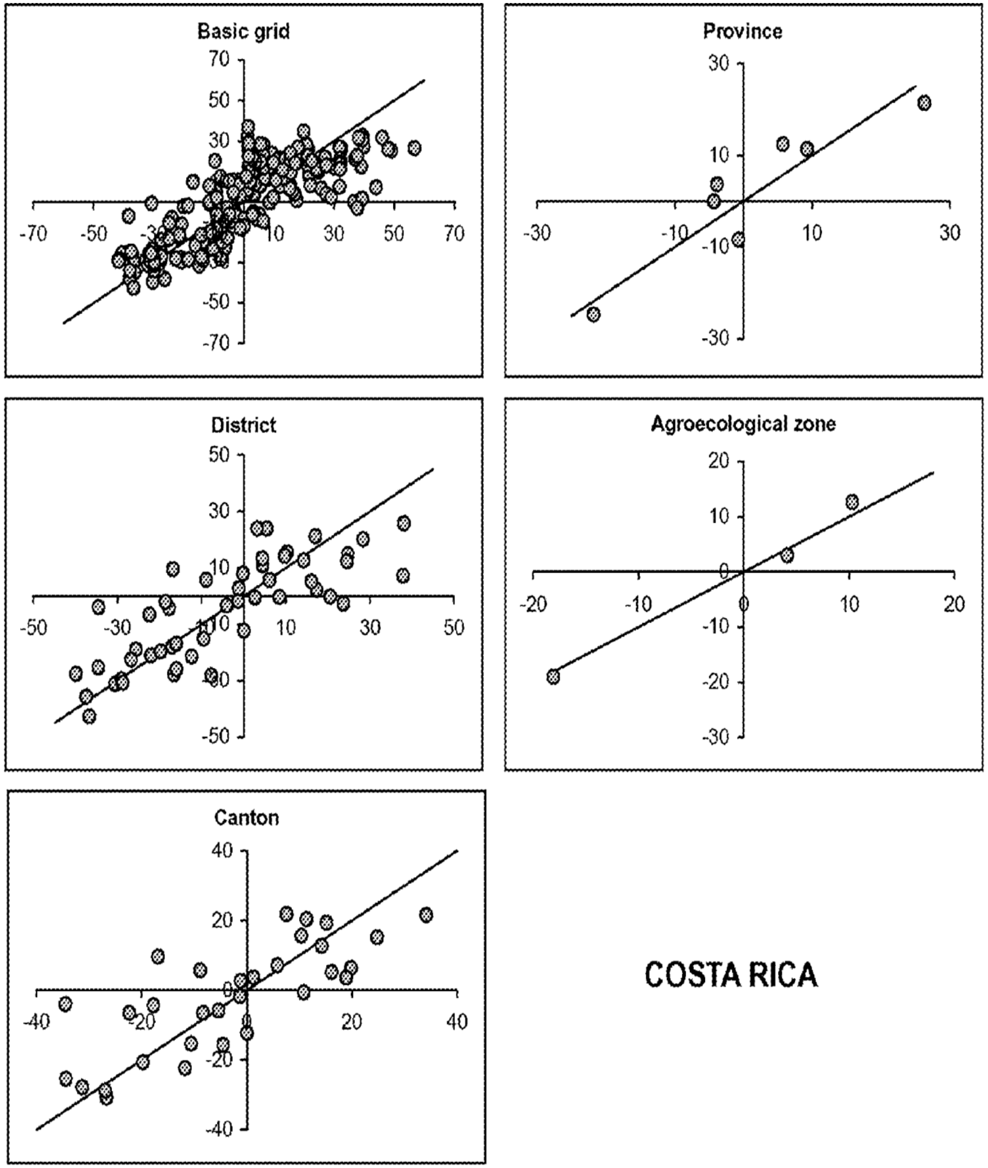
Various operational scales

(LU conversion and its effects using CLUE; Honduras)



Resolution	Number of observations	Average size of unit (km^2)	
Basic grid	431	225	$15 \times 15\,km^2$, level of analysis
District	118	822	Lowest administrative level
Canton	72	1347	Intermediate administrative level
Province	17	5704	Highest sub-national administrative level
Agroeco. zones	3	32325	Low and dry; low and wet; high
Country	1	96975	Total area is based on gridded data

Source: Kok et al., 2001.



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Various operational scales

(conversion of land use and its effects using CLUE)

Source: Kok et al., 2001.

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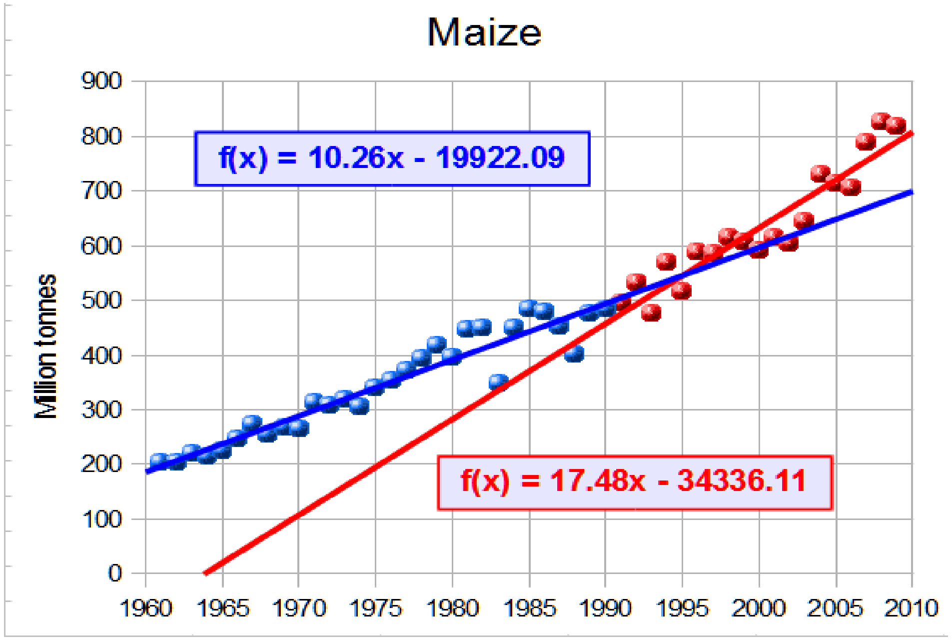
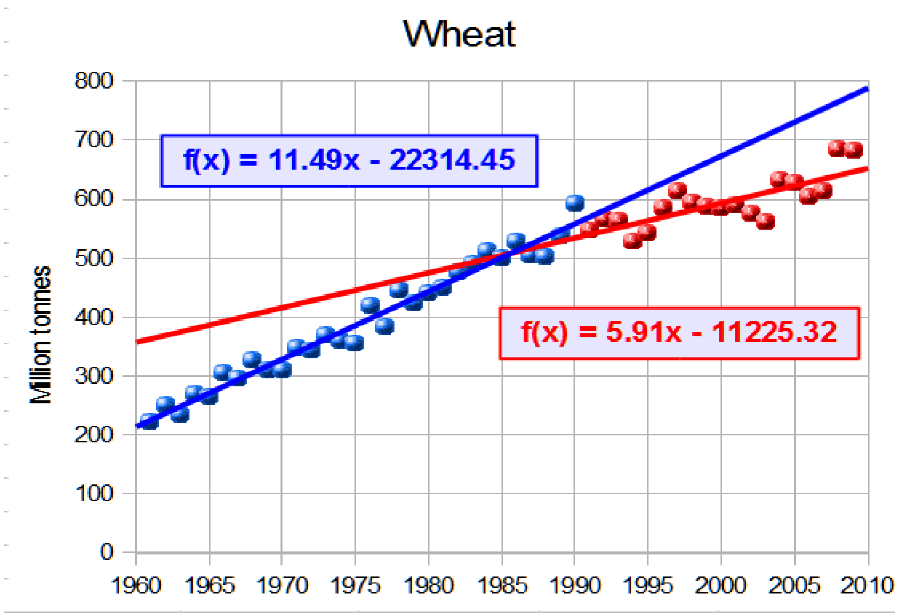
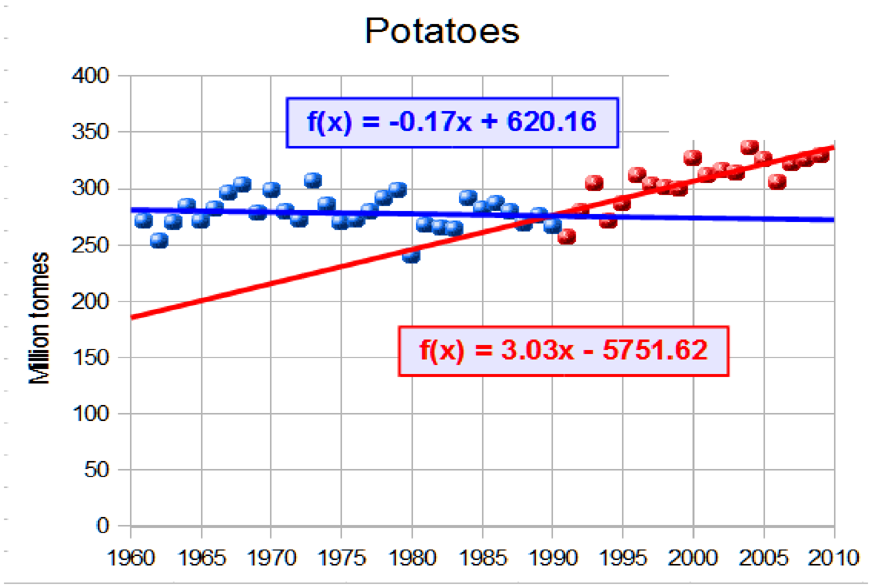
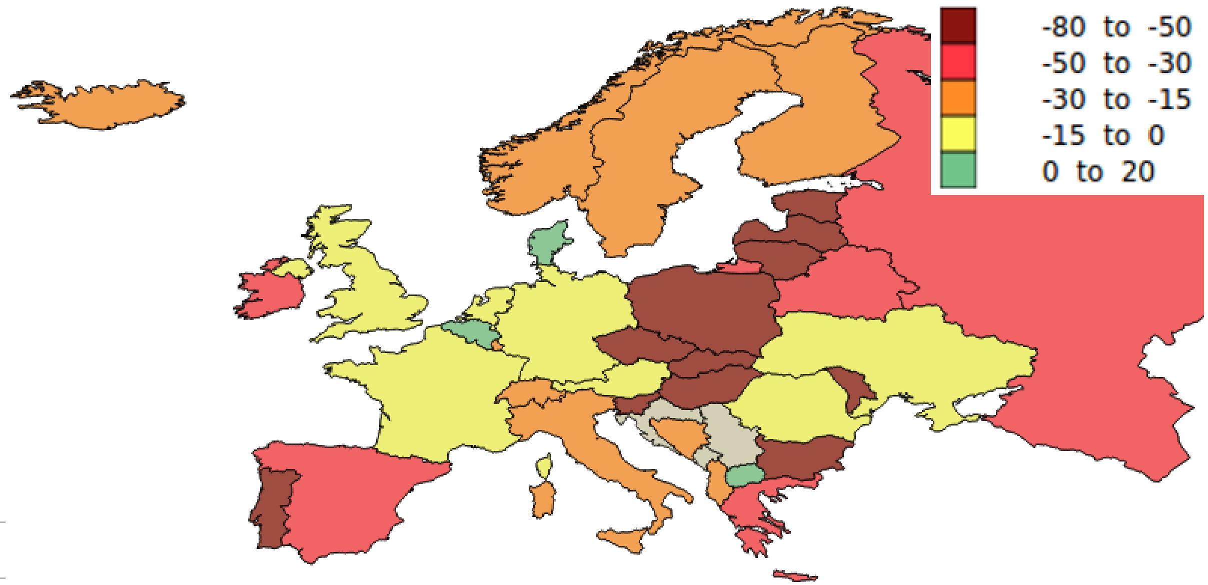
Trends are everywhere





More trends





Percent change of cultivated area between 1998-2002 and 2009-2013

Source: bulletin CropWatch 201511, http://123.56.103.213/htm/en/bulletin33.shtml

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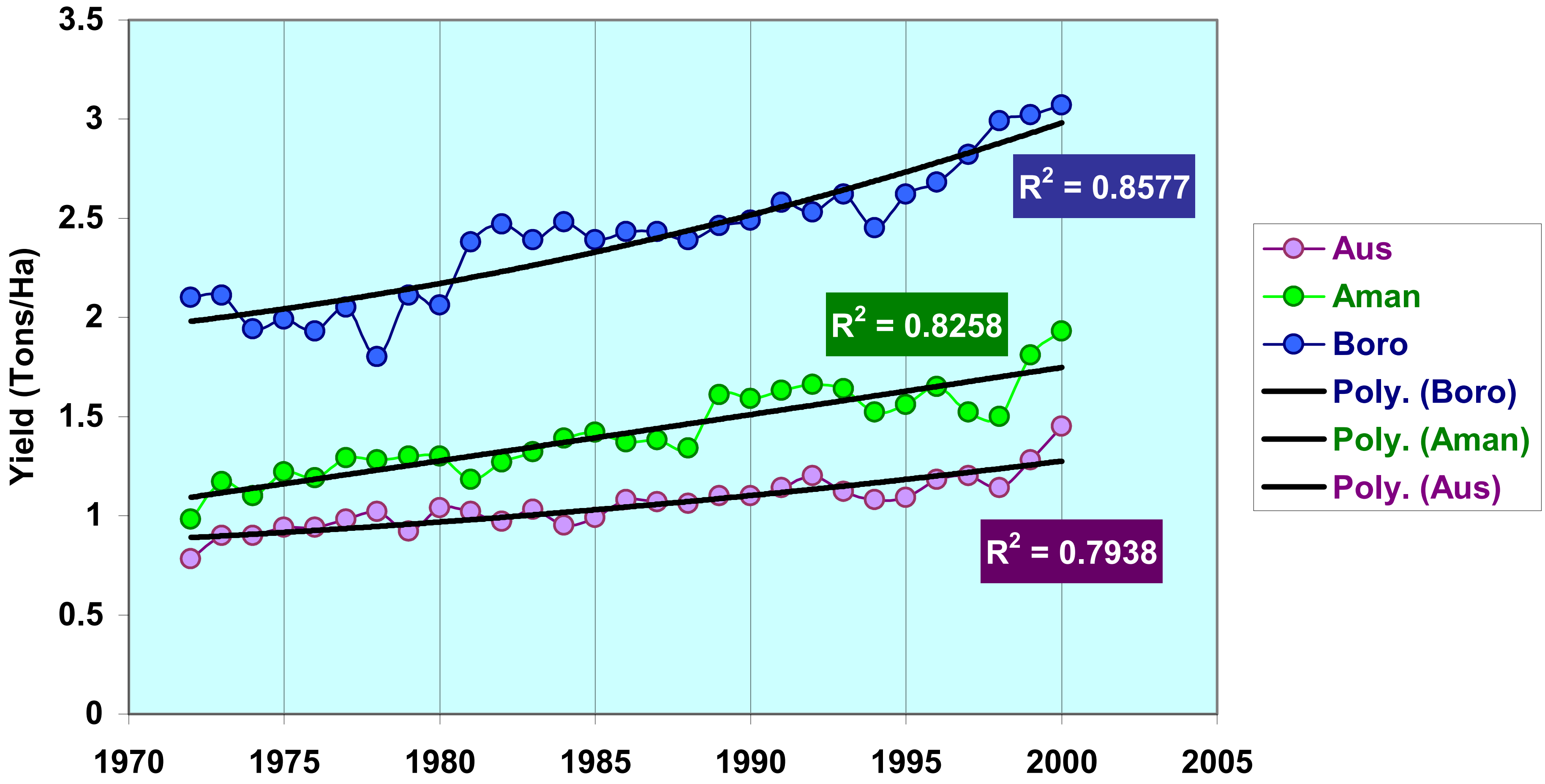
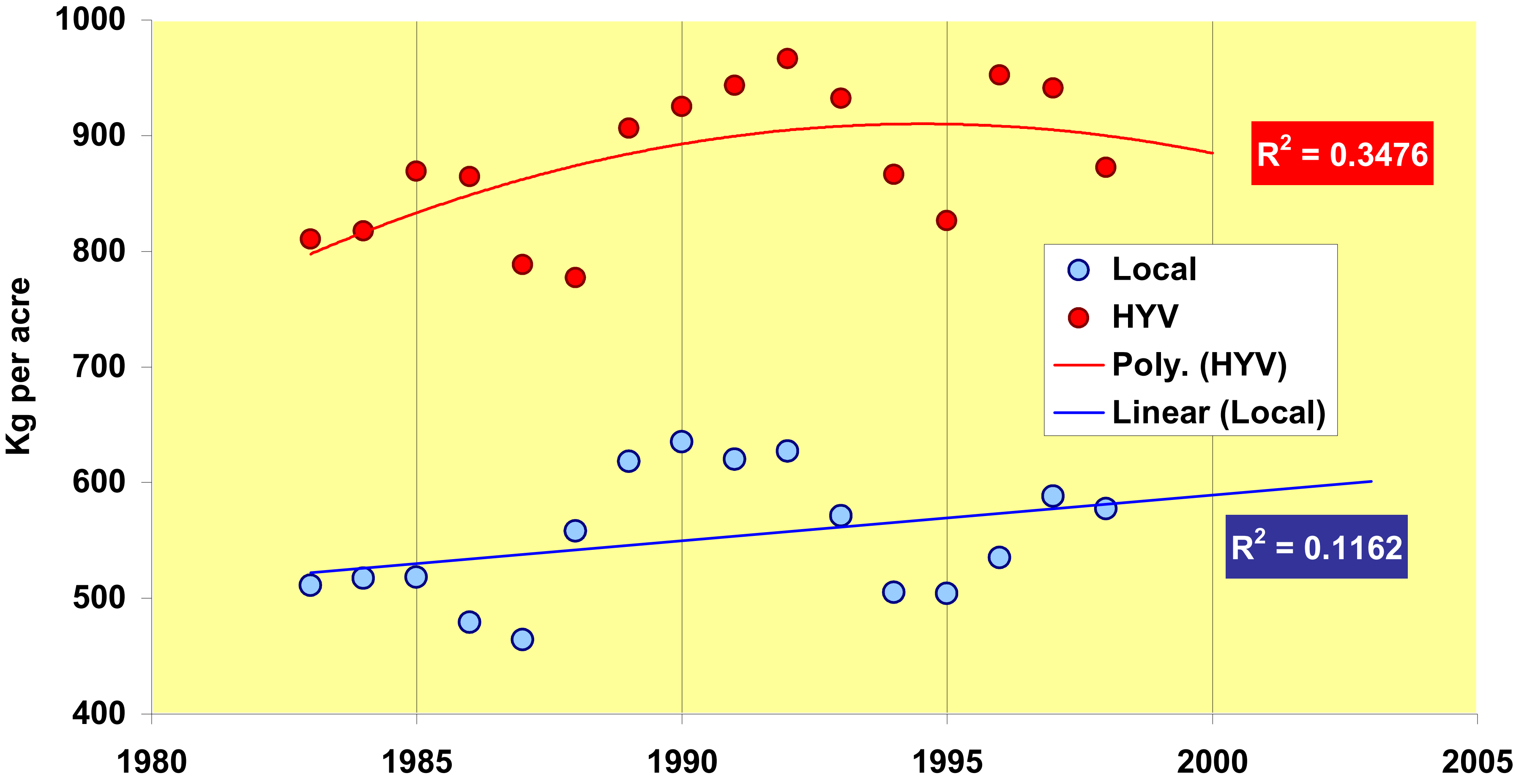
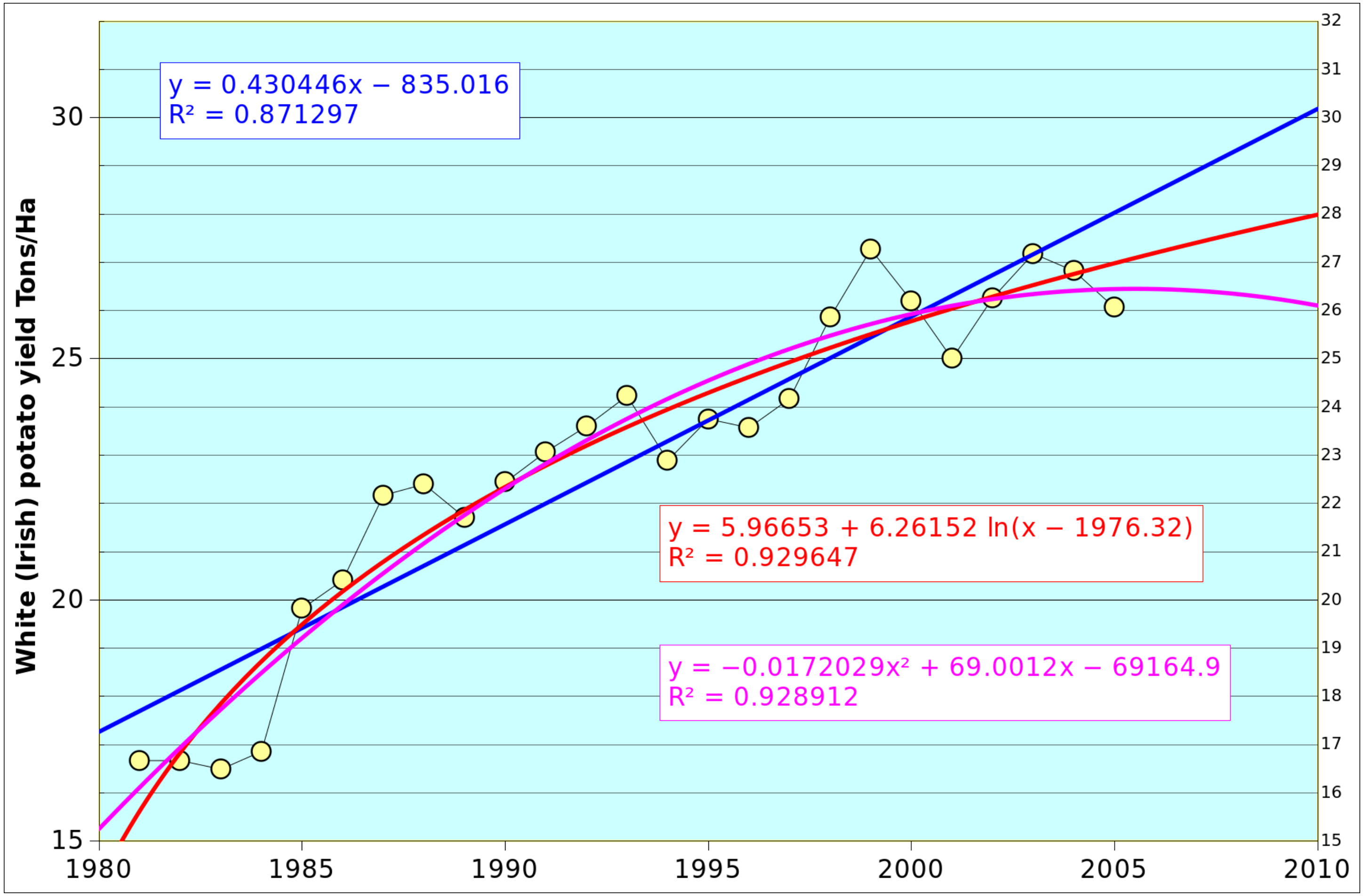
Trends are everywhere: main rice crops in Bangladesh



Trends are everywhere: BGD, Rajshahi T-Aman yield



Trends: TUR potatoes



Trends can usually not be chosen based on "numbers" only

Conclusions

- In the real world, where people take decisions based on limited money, “forecasting is no joke” (e.g. China imports for 30 billion US$ of soybeans per year)
- Models must be chosen based on data availability, timeliness and required accuracy (in US$!)
- Okam’s razor should be the main crop forecasting tool because complexity brings uncertainty
- And do not forget

Thank you!

Source of farmer: 1634 etching by Rembrandt (Het Rembrandthuis Museum, Amsterdam)

Post-scriptum: what are "Good" and "bad" forecasters?

- A "good" forecaster knows "all" forecasting methods and applies them purposely. He knows the difference between "factors" and "descriptors", "parameters" and "variables". He also knows more statistics than just regression and he knows when s/he's overstretching a method. A "good" forecaster must eventually conform to the quality criteria of his customer.

- A "bad" forecaster applies receipes (the one model he knows!) and judges the quality of foreasts only by regression of "actual yield" Vs "predicted yield"