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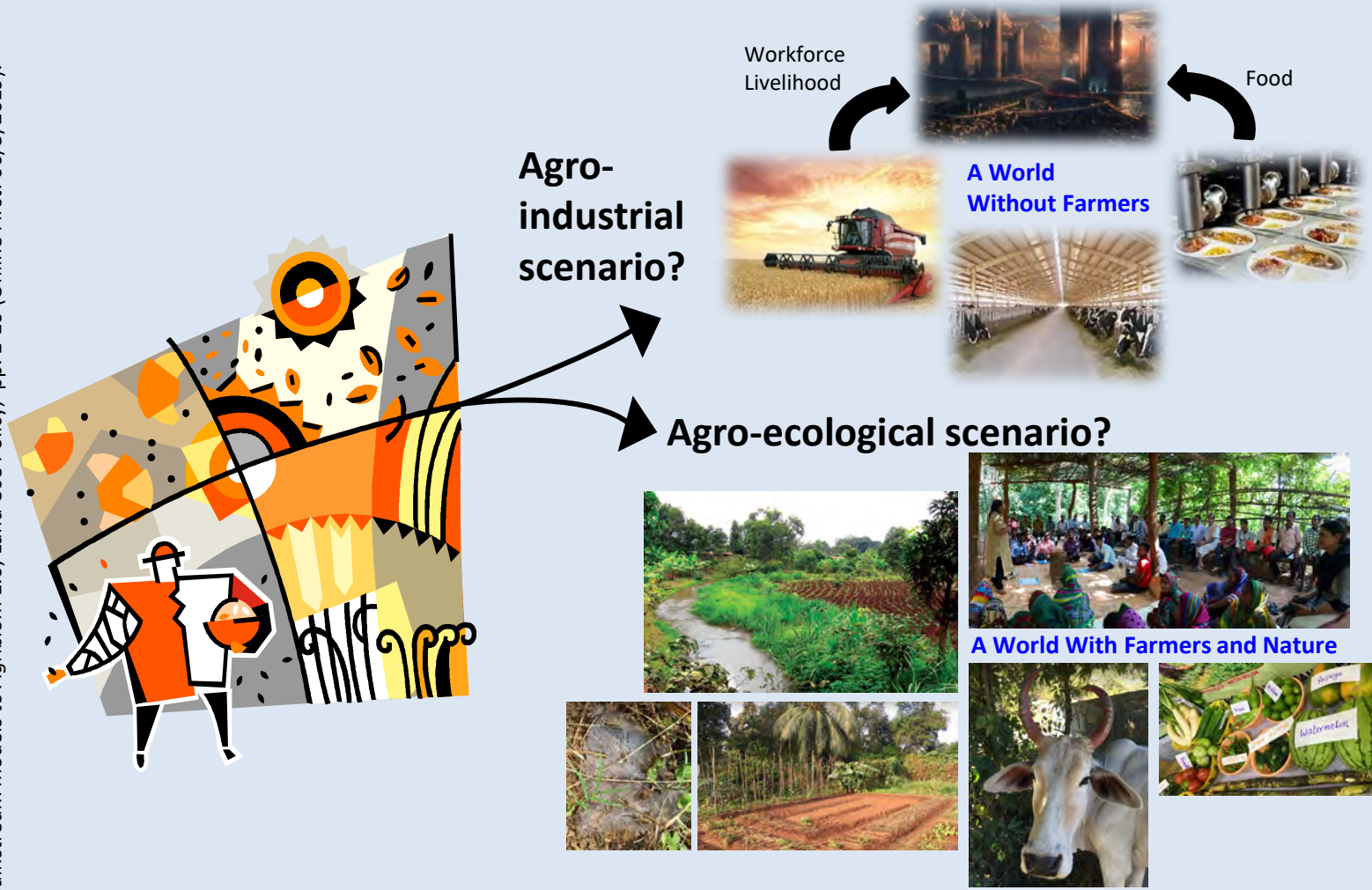
Structural transformation with limited supply of land

Dynamics of land, livestock and farm labour productivities in India

Provisional results

Bruno DORIN (CIRAD-Montpellier, CIRED-Paris, CSH-Delhi)



(1) Dorin B., Hourcade J.-C., Benoit-Cattin M. (2013). *A World without Farmers?*, CIRED WP 47, Paris, 26 p.
(2) Dorin B., Aubron C., 2016. *Croissance et revenu du travail agricole en Inde*, Economie Rurale, 352, 41-65.
(3) Dorin B., 2017. *India and Africa in the Global Agricultural System (1960-2050)*, EPW, LII:25-26, 5-13.
(4) Dorin B., Joly P.-B., 2019. *Modelling world agriculture as a learning machine? From mainstream models to Agriom 1.0*, Land Use Policy, pp. 1-10 (Online First: 06/3/2019).

International seminar "Milk and Dairy in India's Development Path"
New Delhi, 17-18 December 2019

Key messages

1. Green Revolution (GR) and industrial agriculture
are part of a “modern growth” agenda
that can very hardly (or very costly) be replicated in a country like India
for historical and land-constrains reasons

2. GR increased dramatically land productivity of plant food,
but labour productivity at a much slower rate since the 1990s,
and it favoured plant carbohydrates (starch, sugar), not proteins and fats

3. The livestock/milk (fats and proteins) revolution in India
has been a way to further boost land productivity with cheap inputs (crop residues)
and partially offset the slowdown in farm labour productivity
while consumers could access more proteins and fats

4. With an active population that continues to grow
and prospects for non-agricultural jobs far below needs,
we see no other option than a deep agroecological revolution
to sustain both land and farm labour productivities.

1 Introduction

The paradigm of "modern economic growth"

"Modern Economic Growth" or "Structural Transformation"

Farm/Rural Sector
analysed as:
- "Traditional", "Backward"
- "Uneducated", "Unskilled"
- Unorganized, Informal
- Low productivity, Poverty

Employment & Value

industrial inputs

Non-Farm/Urban Sector(s)
analysed as:
- "Modern", "Developed"
- "Educated", "Skilled", "Innovating"
- Organized, Formal
- Capital accumulation

Economist
Agronomist
.../...

Research, Technical progress

Higher yield with "modern" inputs (genetics, chemistry...)

Infrastructure

MARKET growth

Education

Non-farm jobs

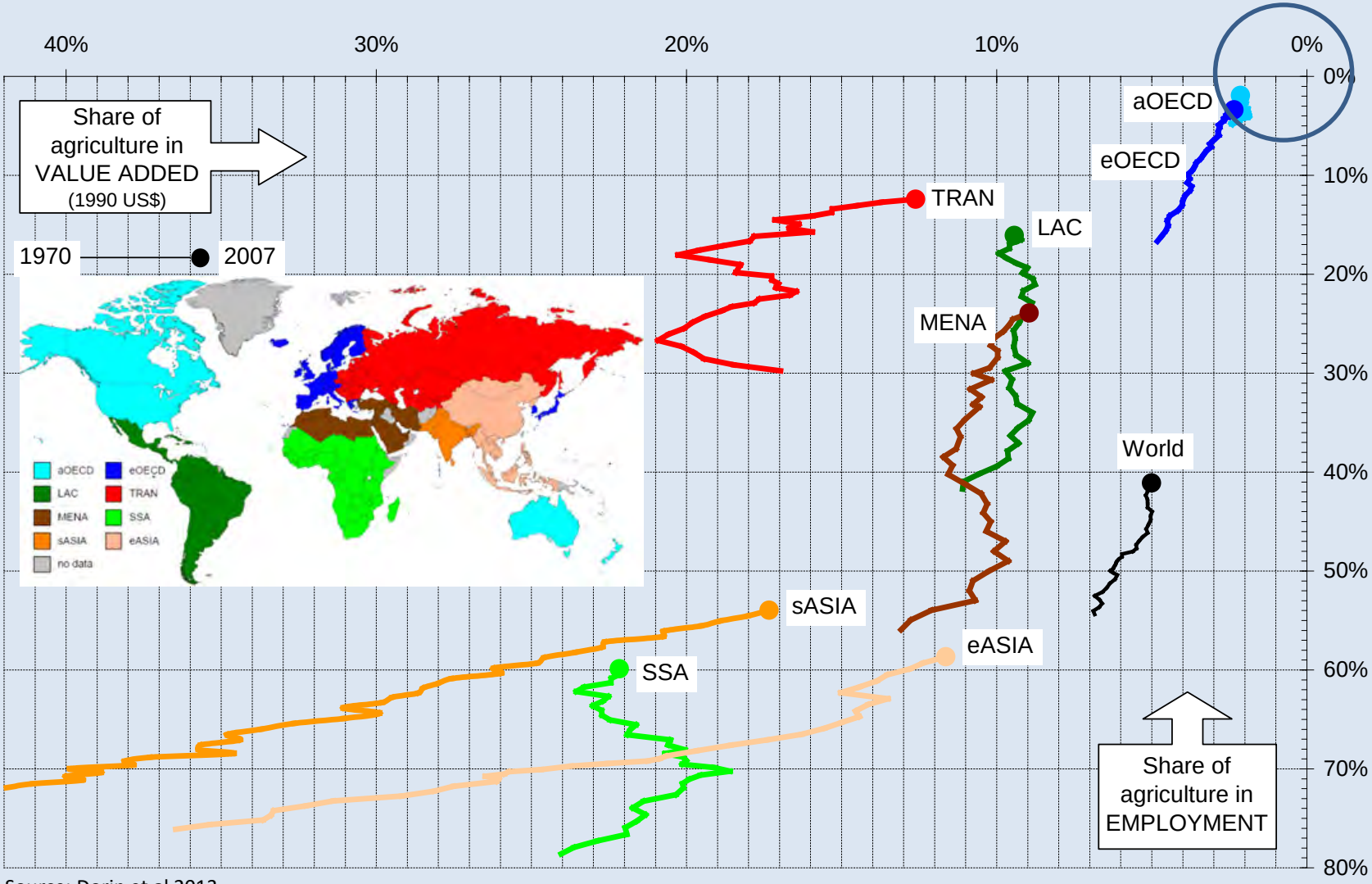
(Social safety net)
(Environmental externalities)

Agricultural economics	*Population pressure on land resources could be circumvented and **labour productivity** increased by several multiples (**up to the levels of Western Europe in the early 1960s**) by investing in agricultural research, human capital and modern agricultural inputs* [Hayami & Ruttan, 1971, 1985, 2002]
Development economics	***Barriers to modern agricultural technology** subject to exogenous technical change **jam the whole development process*** [Gollin & al., 2002]
New structural economics	*Firms in developing countries can exploit the industrial and technological gap with developed countries [on the global technology frontier] by acquiring industrial and technological innovations that are consistent with their new comparative advantage* [Lin, 2011]
Neo-classical Growth theory	***Countries with access to identical technologies should converge to a common income level** .../... Countries that are poorer and have higher marginal productivity of capital should grow more rapidly in the transition to the long-run steady state .../... **Open global economy, access to foreign capital and foreign markets further strengthen the convergence*** [in Rodrik, 2013]

OECD countries now in a “World Without Agriculture" (WWA)

- Is a WWA so desirable ???
- Can all countries migrate into a WWA ???

World Without Agriculture [Timmer 2009]
(3% of employment
3% of GDP)



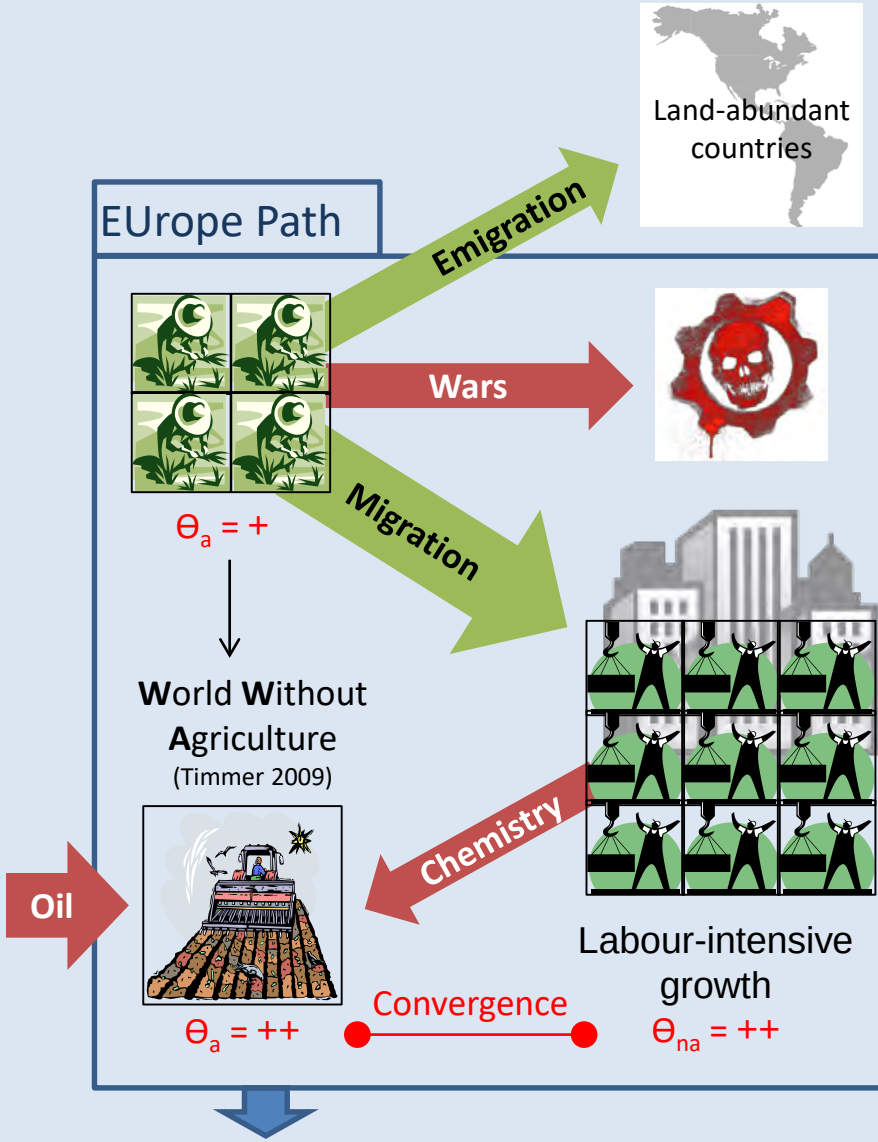
Source: Dorin et al 2013

Historical processes of a WWA

State of agriculture in a WWA

- Farmer income ≈ non-farmer income (on average…)
- Big farms with big machineries and robots
- Within global trade to “feed the world”
- …/…

- High farm specialisation:
  low resilience to economic, climatic & biotic shocks
- Dependence on fossil-energy
- Dependence on big machineries, chemistry and IPR
- Over-indebtedness and suicides of smaller farmers
- Corporatization of farms, oligopsony of input suppliers
- High level of public subsidies
- Erosion of biodiversity, soil, water and air resources
- Unbalance diet, junk food, obesity,
  cardio-vascular diseases, cancers…
- Sad landscape and rural life for tourism…
- …/…



The dynamics of farm labour productivity (without PES…)

Farm labour productivity can be increased through:

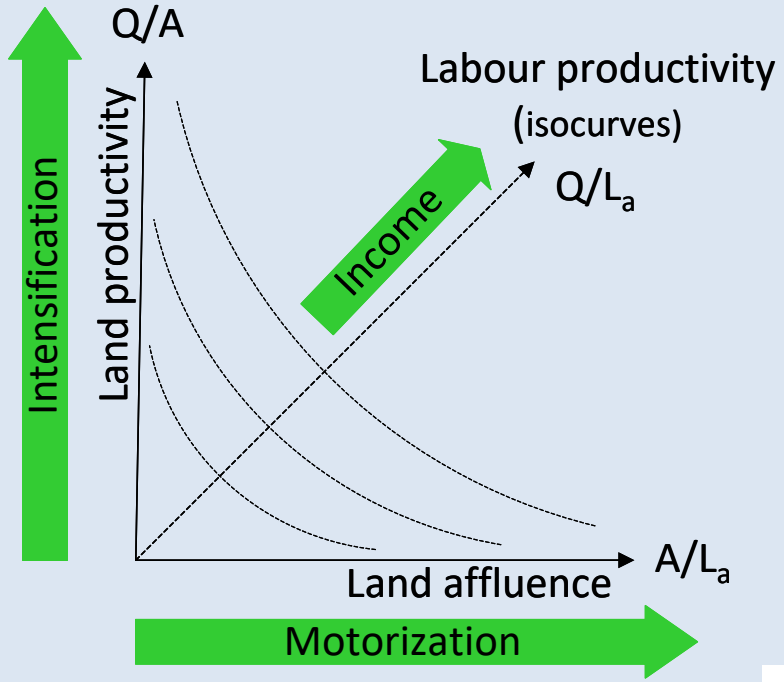
- "Intensification" (with irrigation, fertilizers, HYV, pesticides, etc.) to get higher yields per hectare
- "Motorization" (with tractors, combine harvesters, aeroplanes, etc.) to crop more land per farmer.

① The "TALA" equation

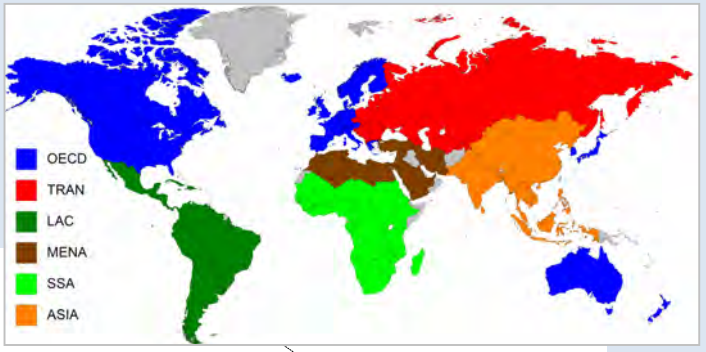
$$Q/A \bullet A/L_a = Q/L_a$$

Technology (Land productivity) **A**vailability in land (Land/Worker) **LA**bour productivity

② The corresponding graph



TALA 1961-2007: growing regional divergences in farm labour productivities!



Yield (kcal.ha^{-1}.day^{-1} of plant food)

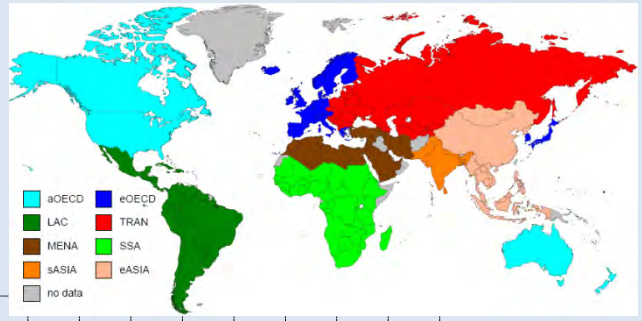
ASIA
LAM
World
MENA
SSA
OECD
TRAN
1961
1975
1982
1983
1988
1990
1996
2000
2006
800,000 daily kcal per worker
400,000 daily kcal per worker
200,000 daily kcal per worker
100,000 daily kcal per worker
50,000 daily kcal per worker
25,000
12,500
6,250
0
5000
10000
15000
20000
25000
30000
0
5
10
15
20
25
30

Land availability (ha.worker^{-1})

Source: Dorin et al, 2013

Not one but several structural transformations!!!

1970 (centre) ➔ 2007 (●)
(cumulated annual growth rates)



FARMER-DEVELOPING :
- 16% population (2007)
- 49 mations (of 1970)

Narrowing income gap

Farmer-Developing Path

LAM

MENA

SSA

aOECD

TRAN

eOECD

Lewis Path

LEWIS PATH :
- 29% population (2007)
- 46 mations (of 1970)

Increasing active population in agriculture

Decreasing active population in agriculture

100%
50%
World
0%
-50%
-100%

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0

Lewis Trap

sASIA

eASIA

Farmer-Excluding Path

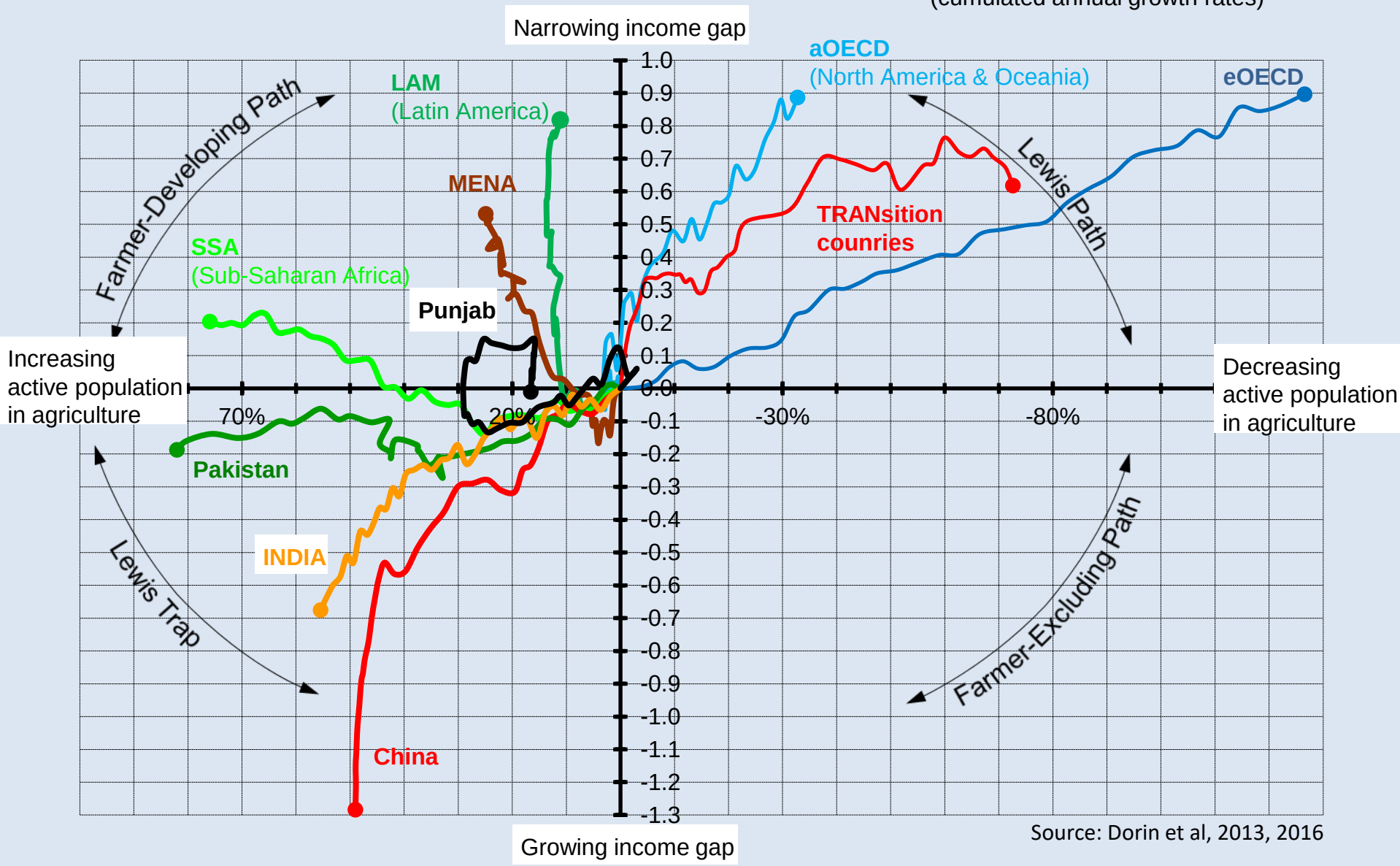
LEWIS TRAP :
- 55% population (2007)
- 29 mations (of 1970)

Growing income gap

Source: Dorin et al, 2013

Structural Transformations

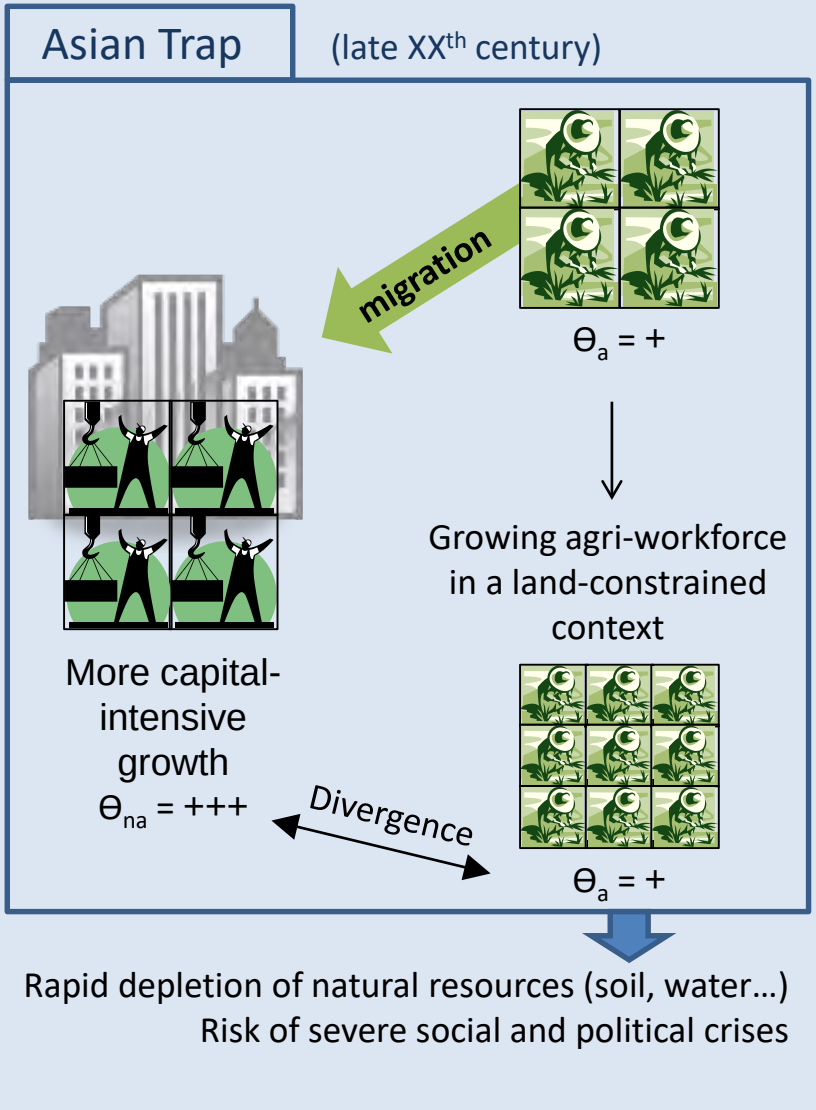
1970 ➔ 2007 (2011 for Punjab)
(cumulated annual growth rates)



Source: Dorin et al, 2013, 2016

Except for Punjab, the figure (Dorin 2013, 2016) represents the cumulative annual growth rates from 1970 (=0) to 2007, of: (1) the active population in agriculture (x-axis) (FAO, 2010), (2) the income differential between agricultural and non-agricultural workers (y-axis) measured with the Labour Income Ratio calculated in 1990-US$ from UNSTAT (2010). The longer the curve, the faster the process. For Punjab, the period starts in 1970 too, but ends in 2011, and national data were used (Censuses and NSDP)

The Asian trap…



Objectives of the research

(1) To get a more accurate (local data) and detailed (state or even district-wise) picture of the structural transformations in India since the 1960s

(2) To incorporate the livestock economy into the picture and assess its impact on farm labour productivity

(3) To imagine and quantify future consistent scenarios (2050)

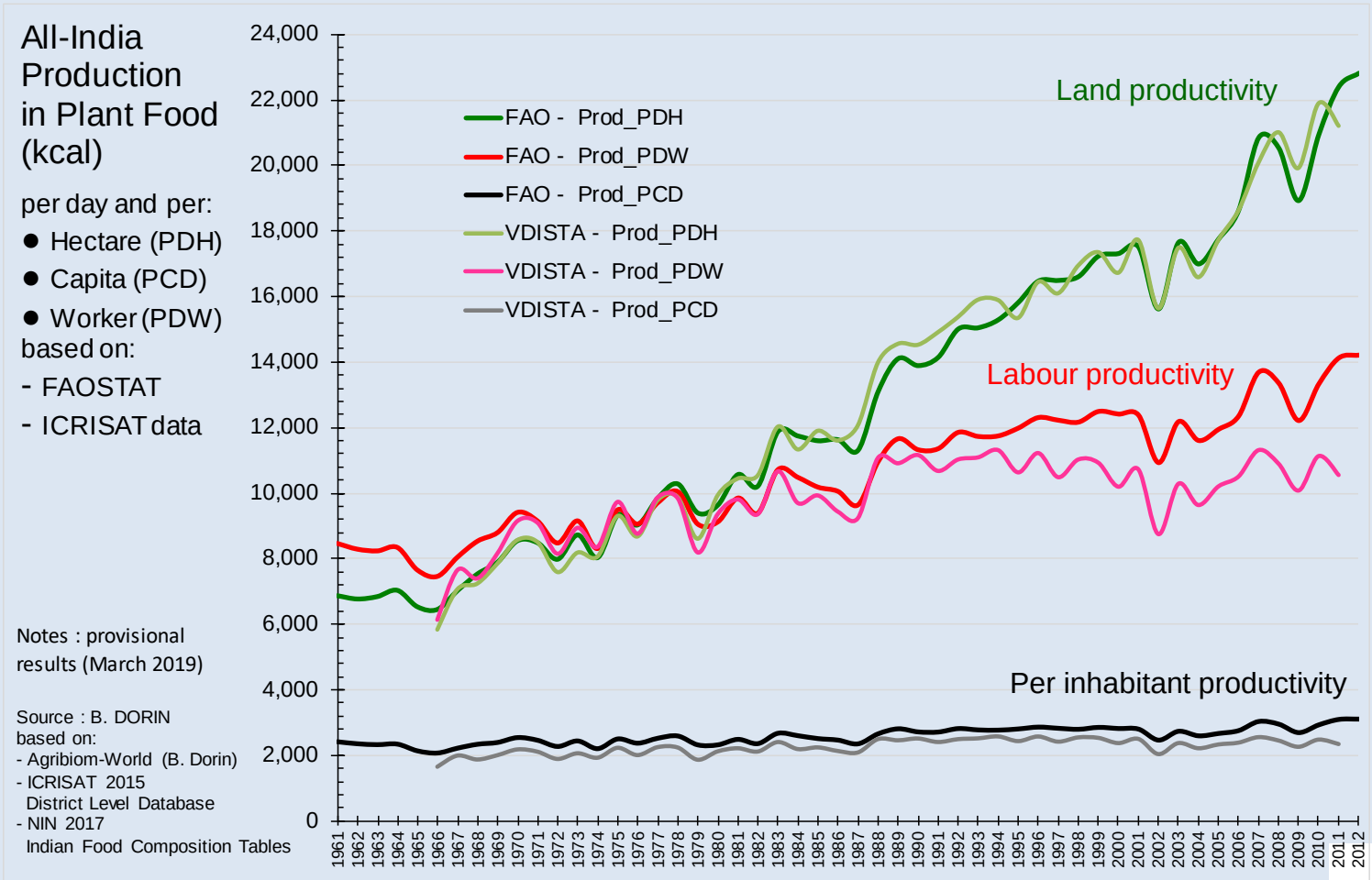
Agro-industrial scenario?

Agro-ecological scenario?

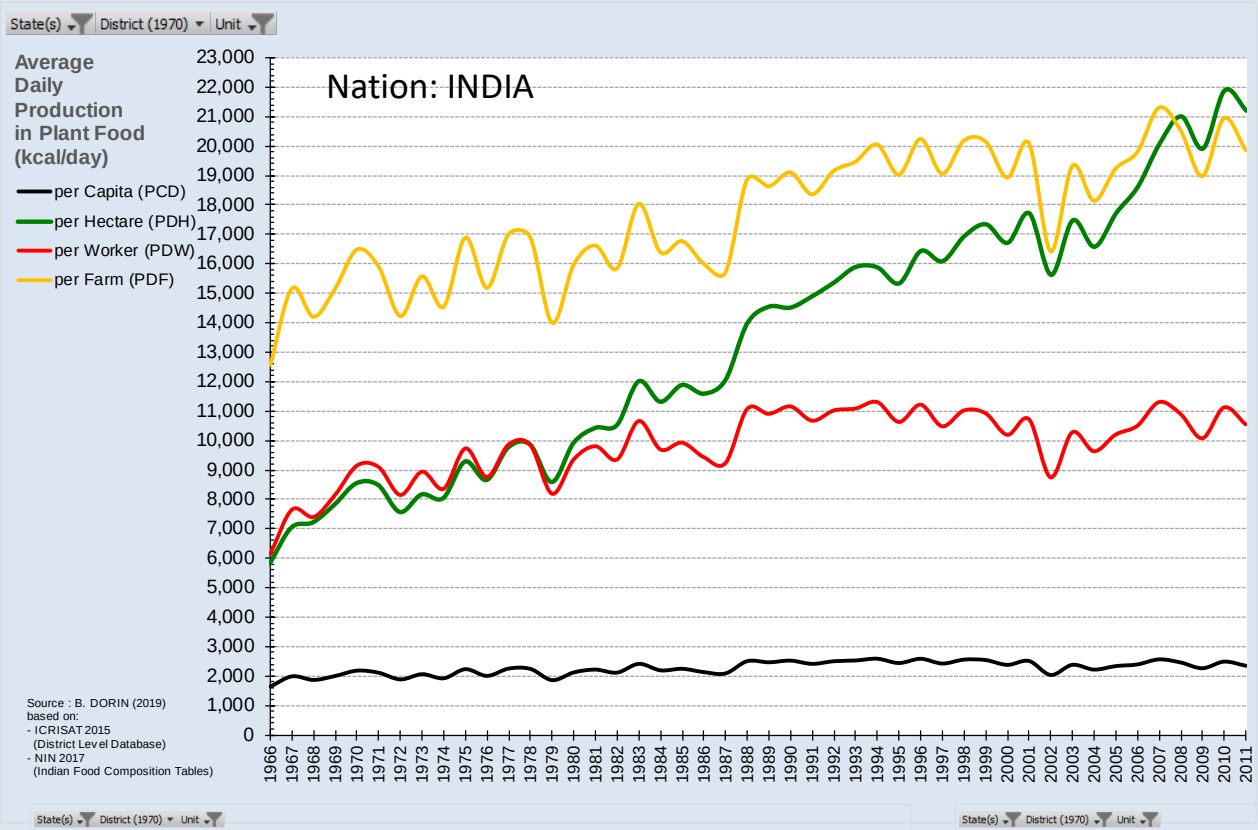
❷ Land and labour productivities in calories

ICRISAT (apportioned) district-level database 1966-2012

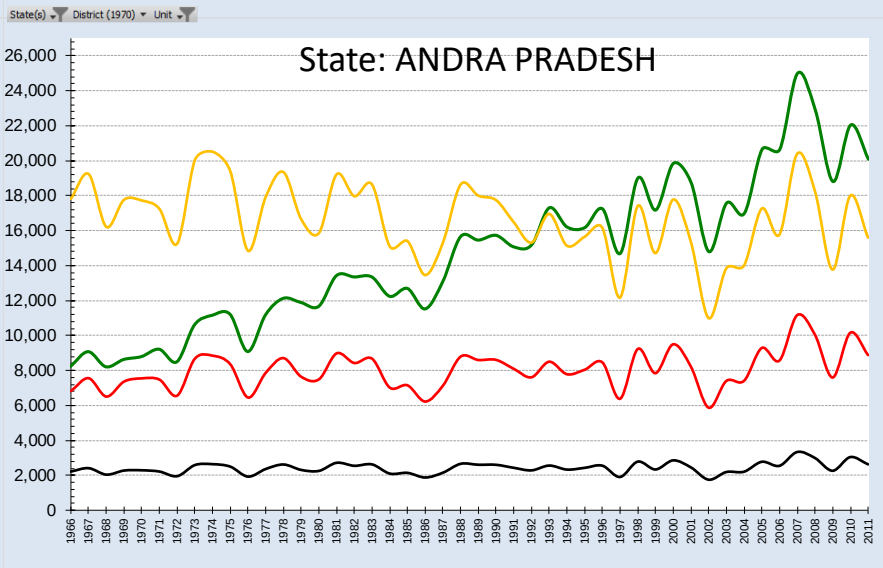
- A unique database accessible at http://vdsa.icrisat.ac.in/vdsa-database.aspx
- 312 apportioned districts (border circa 1970) with, potentially, 224 variables over 46 years
- But no shape file of map, some data inconstancies hard/long to verify and correct, some missing States (e.g North-East), major crops only, and no livestock productions
- However: a good statistical surprise… (1961-2012)

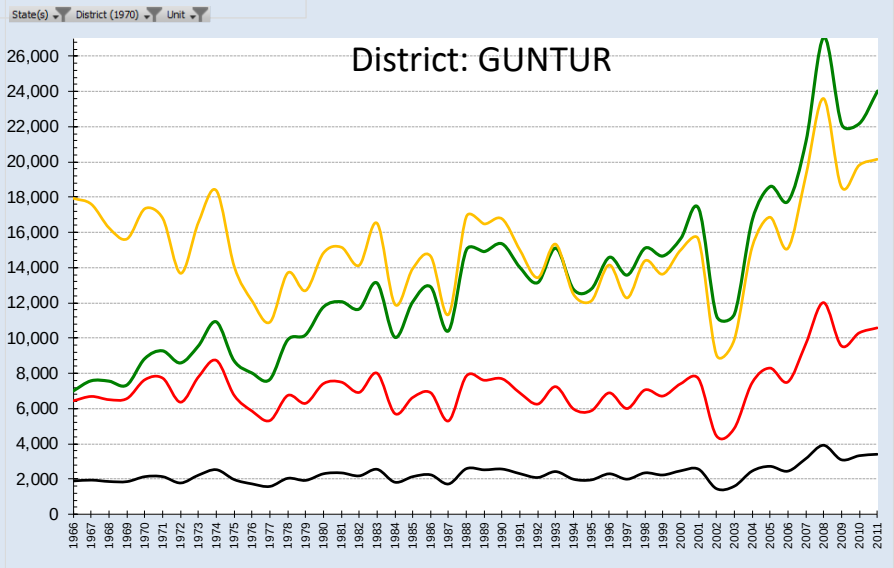


- From All-India to its States or Districts…

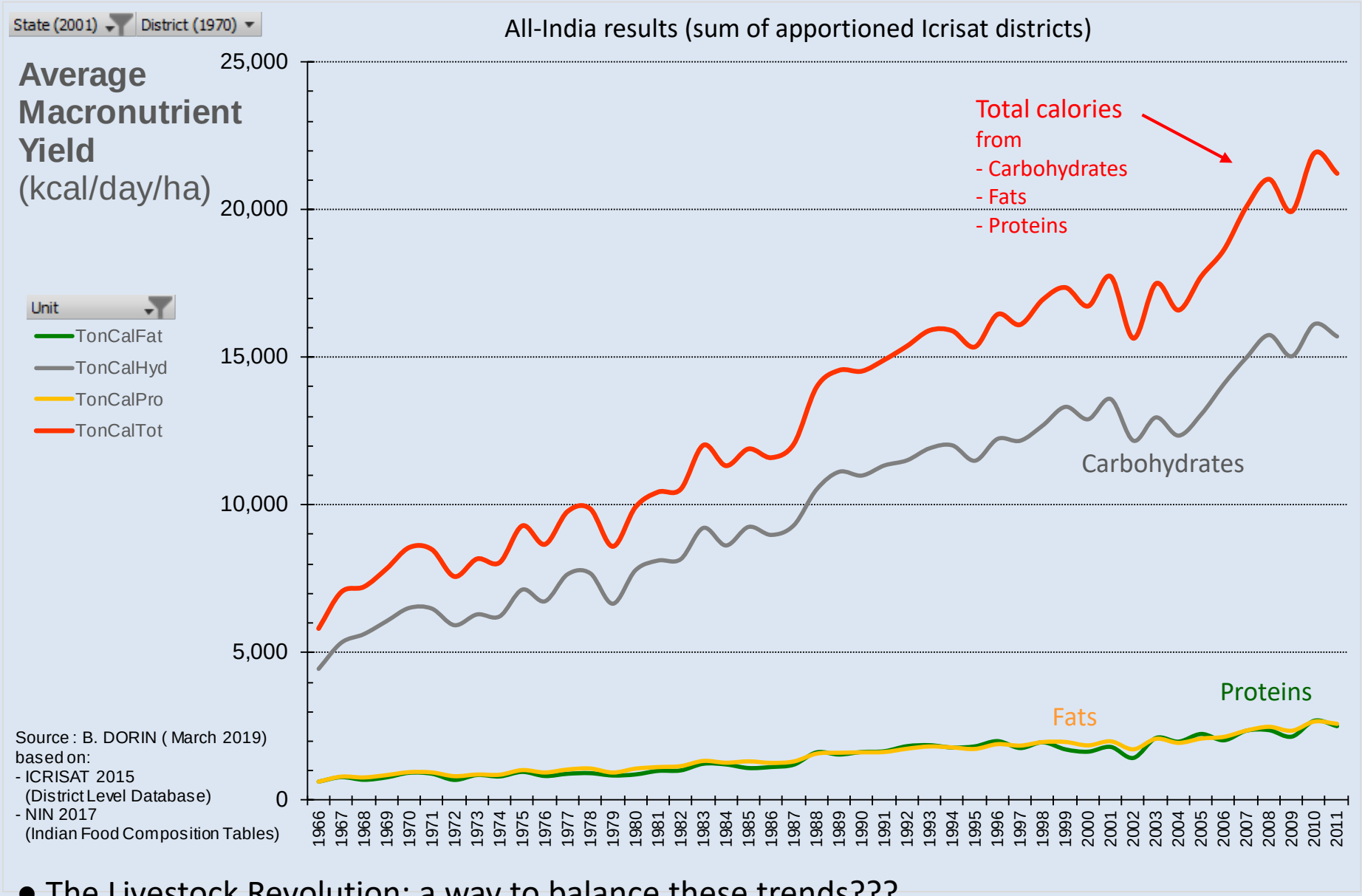


All-INDIA results
(sum of apportioned Icrisat districts)





- The great favourite of the Green Revolution:
  carbohydrates (sugar) at the expense of proteins and fats (+ micro-nutrients…) !!!



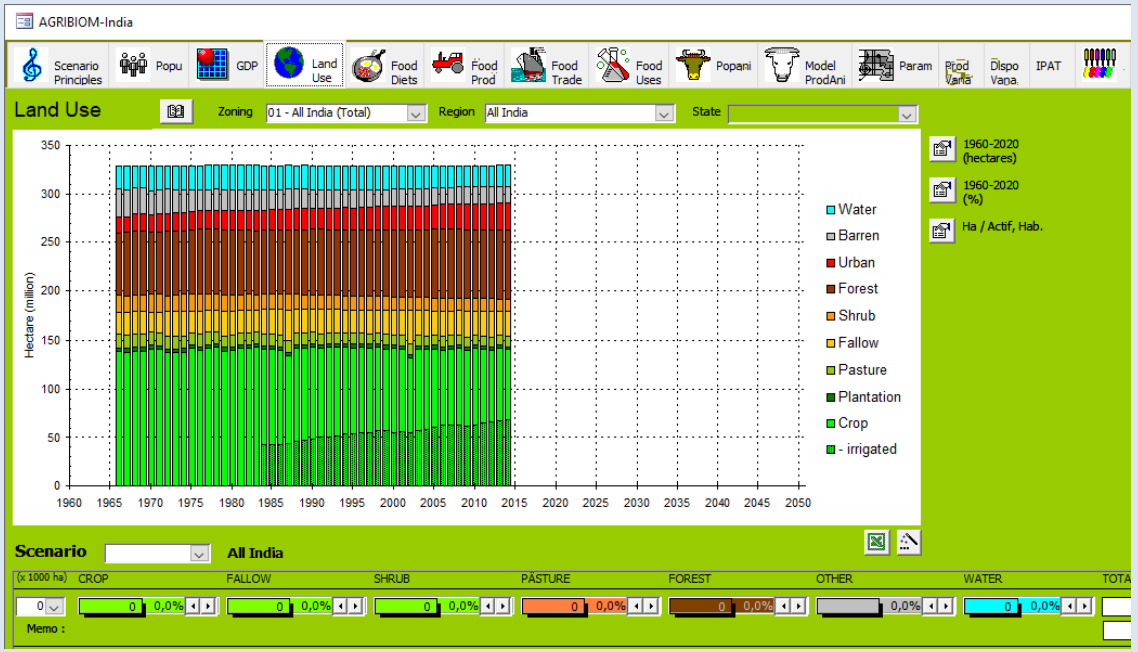
- The Livestock Revolution: a way to balance these trends???

CMIE database “States of India”

- A very costly database (Rps 3.9 lakh for 1 year subscription) available at https://statesofindia.cmie.com
- A large set of data downloadable in a semi-pro format (unlike EPWRF or IndiaStat data, the worst…) on demography, land use, farms and inputs, agricultural productions, domestic products…
- But some inconsistencies remains, and many missing years notably in livestock productions (only recent years available: need to collect elsewhere these missing estimates)
- A large set of data downloadable in a semi-pro format (unlike EPWRF or IndiaStat data…) on demography, land use, farms and inputs, agricultural productions, domestic products…

The Agribiom-India visual interface

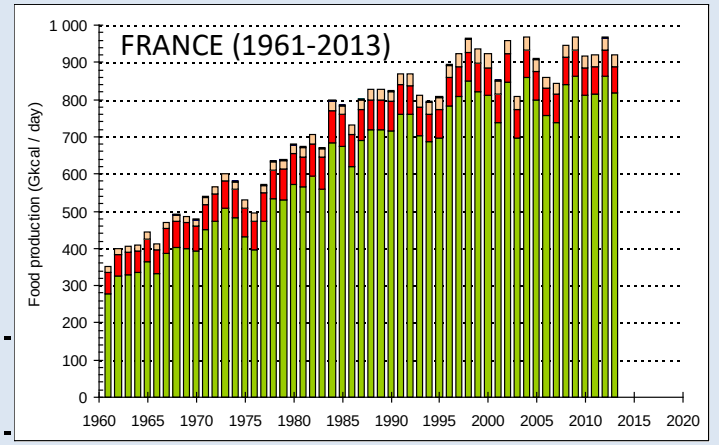
- (within the 2018-2020 project “Foresight ZBNF-Andhra 2050” with Gvt. of A.P. and FAO)
- To check the data consistency over the years (∑States=All-India, missing values, etc.)
- To test quickly various definitions (e.g. “Farmer”) and models for the past and future (scenarios)
- To help collective foresight (“learning machine”: Dorin & Joly 2019)

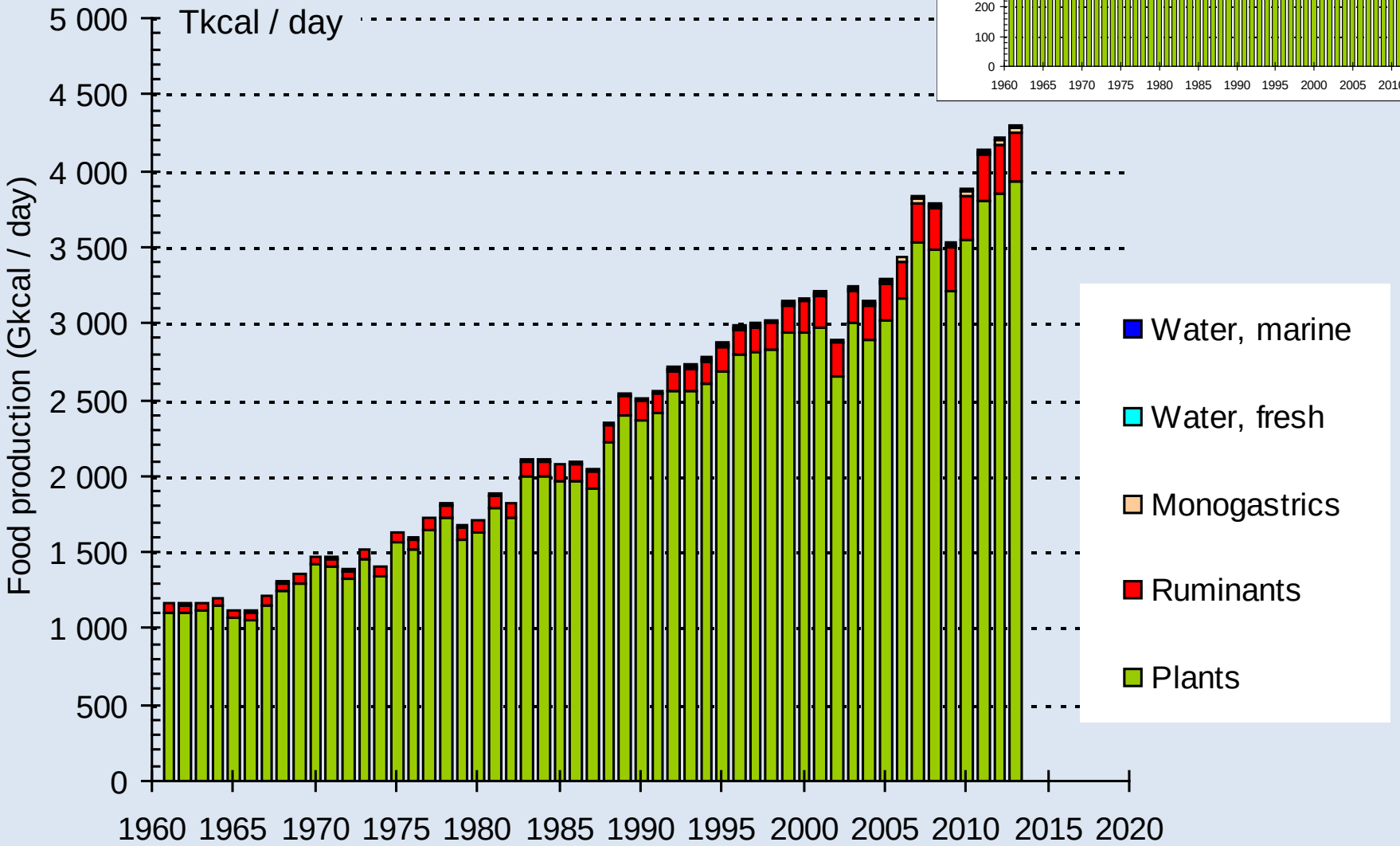


Crops and milk productions in calories

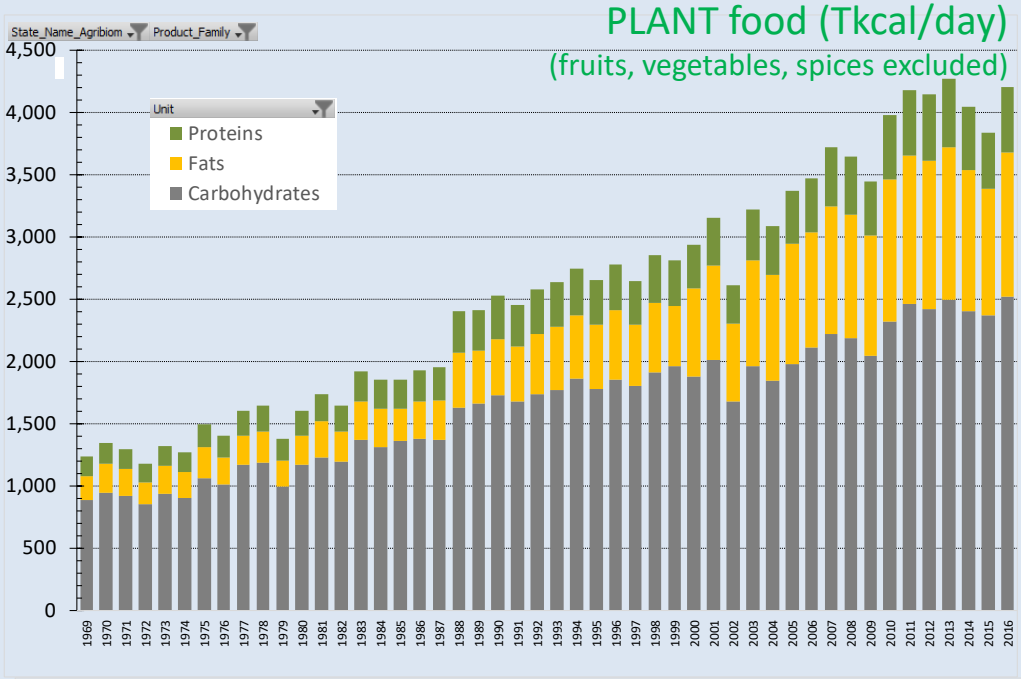
- India with FAO data (1961-2013)

  Source: Agribiom-World (B. Dorin)

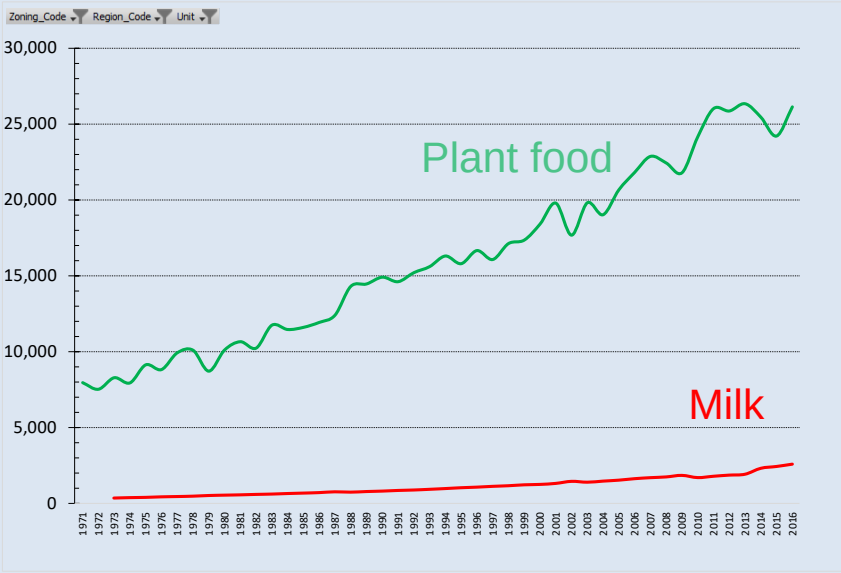


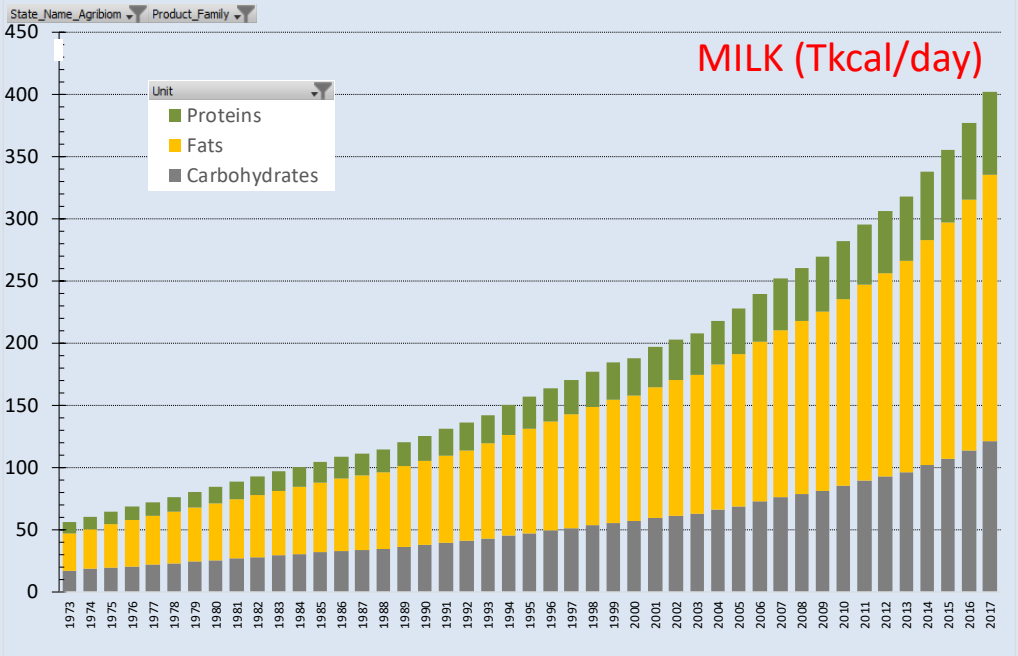


- All-India (sum of States/UTs) with Indian data (1969-2016)

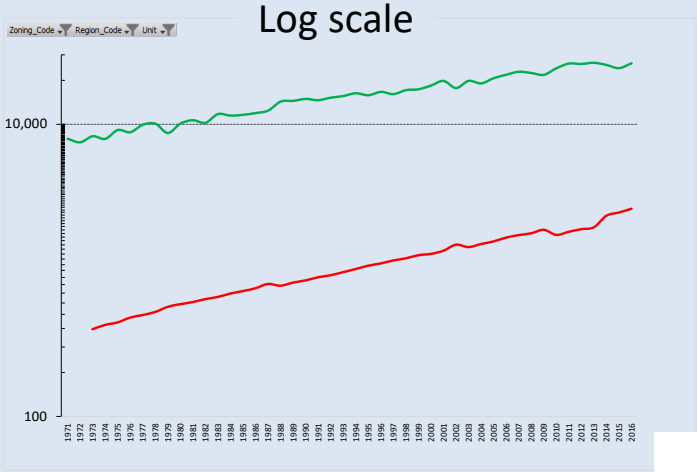


YIELD (kcal/day per hectare of net cropped area)





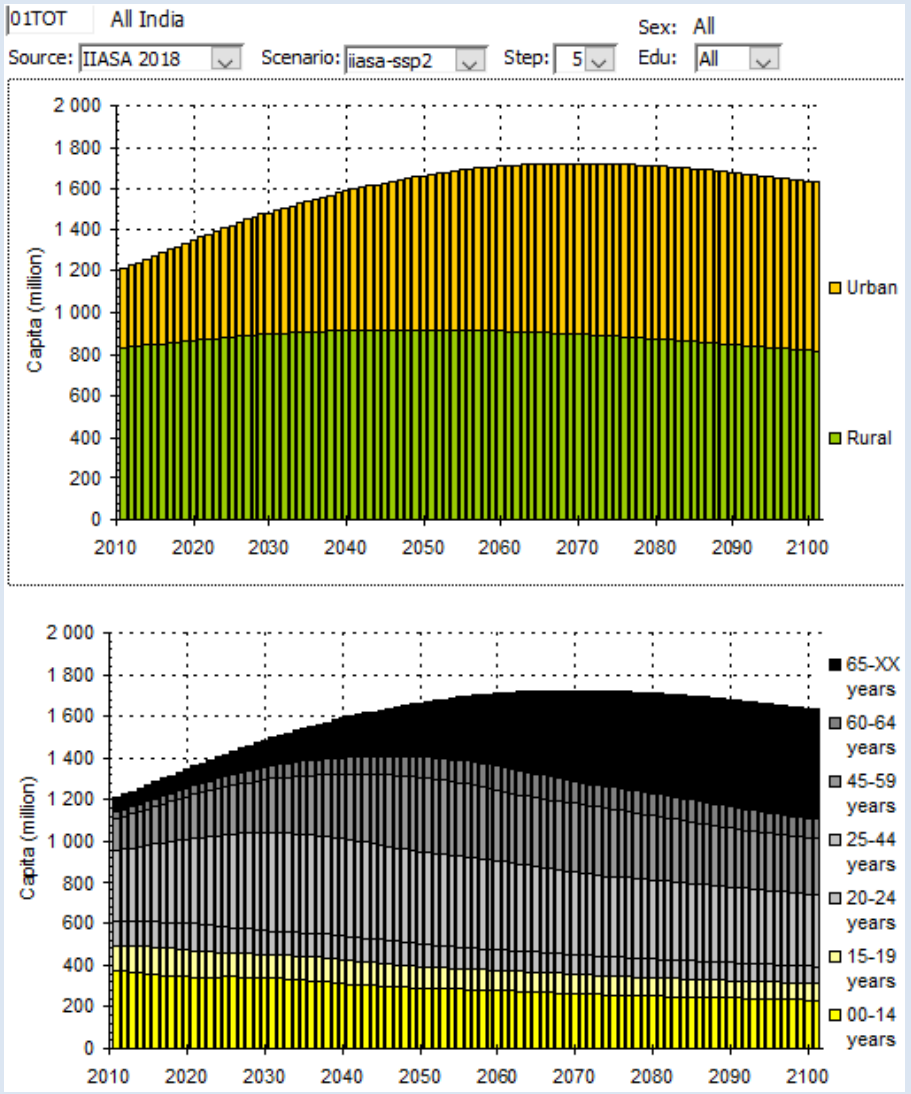
Log scale



❸ Structural transformations of land-squeezed Indian States: knowing the past to question the future(s)

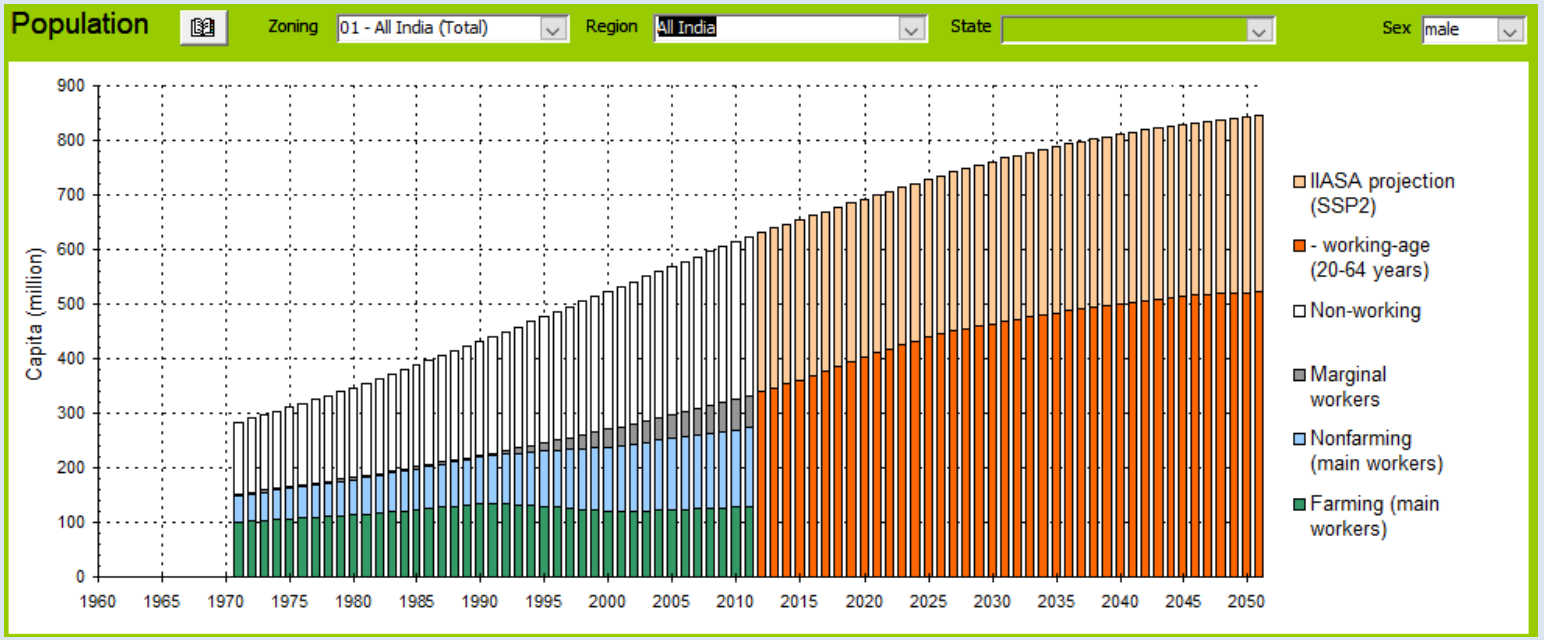
- A growing population, a growing workforce…

The IIASA State-wise projections from 2011 to 2100

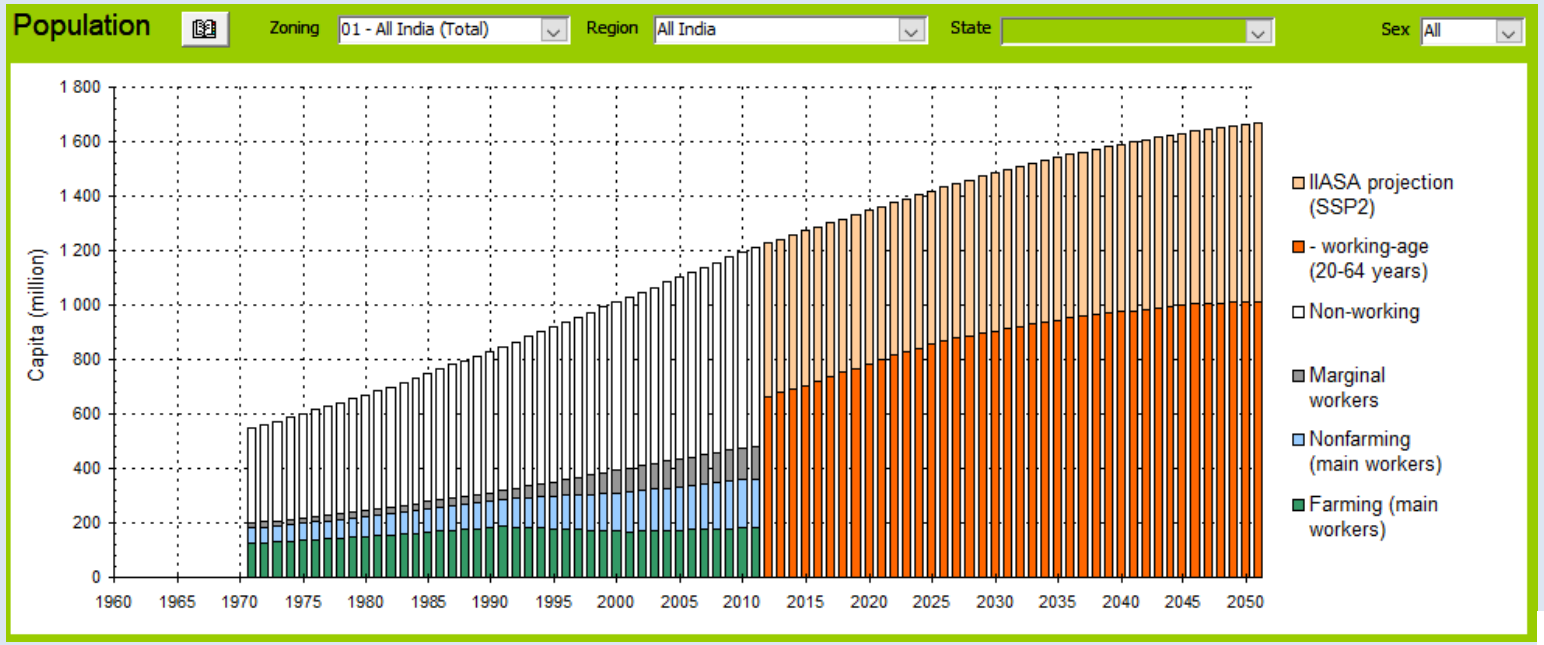


How many male and female farmers and milk producers in 2050?

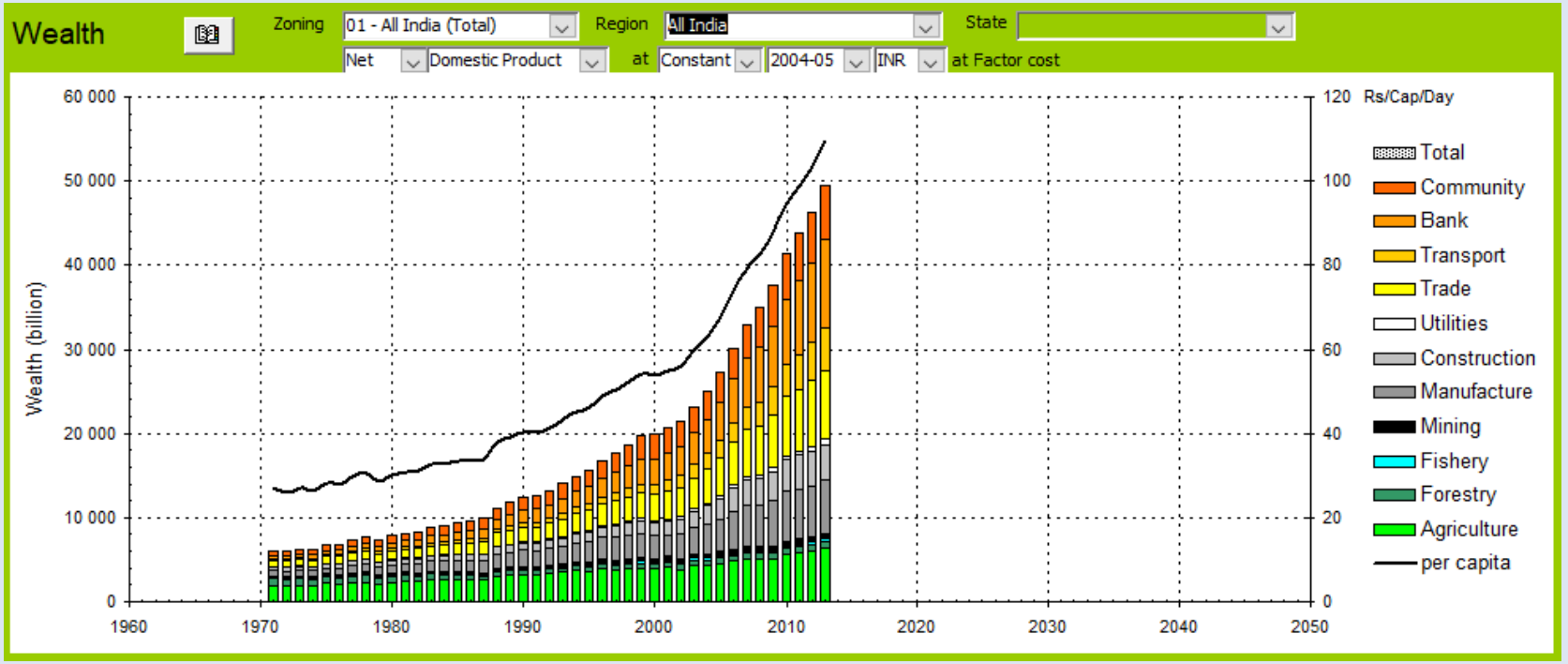
Males only

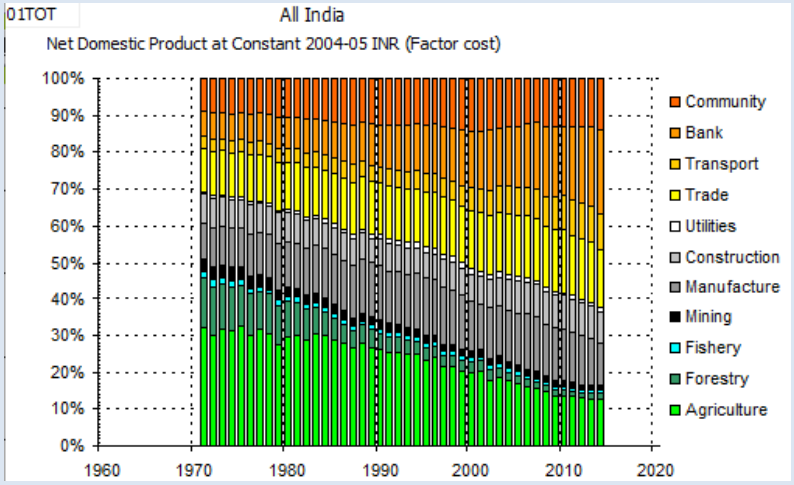


All sex

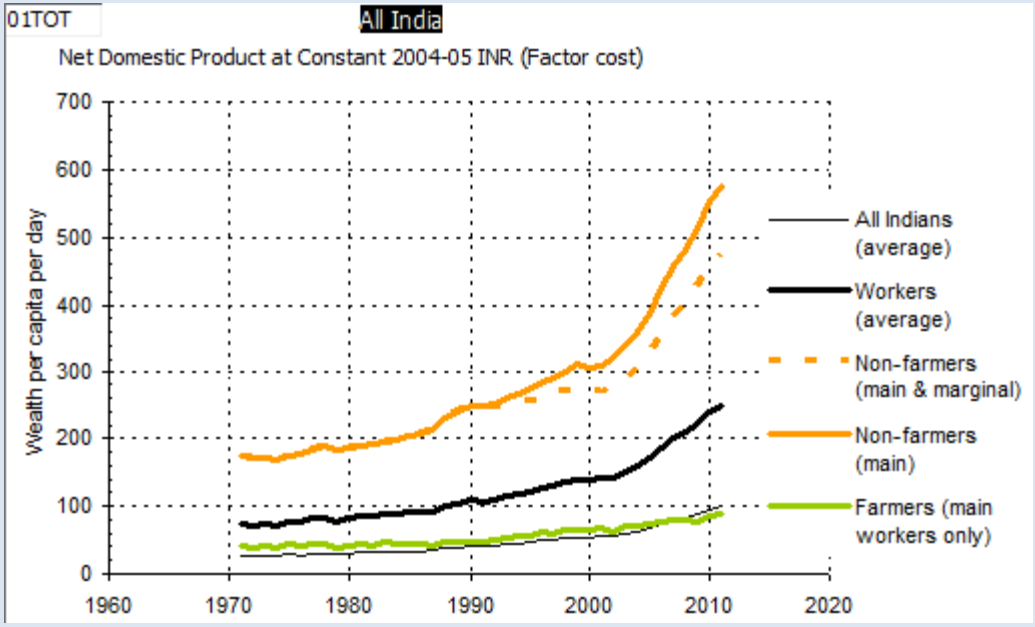


What scenario(s) of economic growth (total, agriculture, livestock) up to 2050?





A growing or narrowing Farm-NonFarm income gap?



Agribiom: a learning machine for thinking futures (Dorin et Joly 2019)

Agribiom Lewisian Model (ALM)
Region : India

				Historical Path (1970-2007) Source : Dorin & al 2013					FAO projections (2006-2050) Sources : FAO 2012, Dorin 2014			My Scenario (2007-2050) Source : based on Shukla				
				1970		2007		1970-2007	2006	2050	2006-2050	2007		2050		2007-2050
			Monetary unit =>	1990-USD		1990-USD		1990-USD	ICP$	ICP$	ICP$	1990-USD		1990-USD		1990-USD
Population	Total	P	kcap	552,964		1,164,670		2.03%	1,147,678	1,613,800	0.78%	1,164,670		1,614,892		0.76%
	- Agriculture	P_a	kcap	368,099	67%	579,802	50%	1.24%				579,802	50%	423,422	26%	-0.73%
	- Non-Agri	P_{na}	kcap	184,865	33%	584,868	50%	3.16%				584,868	50%	1,191,470	74%	1.67%
	Urban	P_u	kcap	109,266	20%	339,979	29%	3.12%				339,979	29%		0%	
Workforce	Total	L	kcap	209,457	38%	463,140	40%	2.17%				463,140	40%	734,774	45%	1.08%
	- Agriculture	L_a	kcap	149,133	71%	258,642	56%	1.50%	289,546	291,413	0.01%	258,642	56%	217,384	30%	-0.40%
	- Non-Agri	L_{na}	kcap	60,324	29%	204,498	44%	3.35%				204,498	44%	517,390	70%	2.18%
	Popu per farmer	P/L_a	cap	3.71		4.50		0.53%	3.96	5.54	0.76%	4.50		7.43		1.17%
	Farm household	P_a/L_a	cap	2.47		2.24						2.24		1.95		
GDP	Total	Y	M$	128,942		865,094		5.28%	863,255	9,605,050	5.63%	865,094		17,984,832		7.31%
(Value	- Agriculture	Y_a	M$	54,810	43%	142,054	16%	2.61%				142,054	16%	428,341	2%	2.60%
Added)	- Non-Agri	Y_{na}	M$	74,132	57%	723,040	84%	6.35%				723,040	84%	17,556,491	98%	7.70%
	GDP per capita	Y/P	$/cap/day	0.64		2.04		3.18%	2.06	16.31	4.81%	2.04		30.51		6.50%
Land	Cultivated	A	Kha	165,060		169,284		0.07%	169,481	175,660	0.08%	170,000		170,000		0.00%
	VA per ha	Y_a/A	$/ha/day	0.91		2.30		2.54%				2.29		6.90		2.60%
	Land per farmer	A/L_a	ha/worker	1.11		0.65		-1.41%	0.59	0.60	0.07%	0.66		0.78		0.40%
	Plant food per ha	Q/A	kcal/ha/day	8,564		20,446		2.38%	17,485	26,611	0.96%	20,446				
Labour productivity	Plant food per farmer	Q/L_a	kcal/worker/day	9,479		13,382		0.94%	10,234	16,041	1.03%	13,382				
	VA per worker	Y/L	$/worker/day	1.69		5.12		3.05%				5.12		67.06		6.17%
	- Agriculture	Y_a/L_a	$/worker/day	1.01		1.50		1.09%				1.50		5.40		3.02%
	- Non-Agri	Y_{na}/L_{na}	$/worker/day	3.37		9.69		2.90%				9.69		92.97		5.40%
	Labour Income Gap	LIG		-0.29		-0.39		0.86%				-0.39		-0.27		-0.86%
	Labour Income Ratio	LIR		0.60		0.29		-1.90%				0.29		0.08		-2.97%
Structural Path (Dorin, 2013)								Lewis Trap								Farmer Exc.

This could lead to rethinking crops and livestock…

- The equation at stake

Increasing farmers' income & production

…without sending most of them to shantytowns

$$\theta_a = (pQ - Y_{na}^a) / L_a$$

Prices

Costs of non-agricultural inputs

- A 2050 vision

Science & farmers managing
a mosaic of agro-ecosystems
boosting local synergies
amongst many plant and animal species
above & below the ground surface.

AGROECOLOGY

"A science, a movement and a practice"
(Wezel & al,2009)

❶ Higher biodiversity & biological synergies
↗ production ***Q*** (total useful biomass)
↗ resilience to economic & climatic shocks

❷ Saving of inputs ***Y***
↘ production costs (higher incomes)
↘ environmental costs

❸ Higher prices ***p***
↗ quality (tasty/nutritious food)
↗ co-products (wood, fuel, fibre, drugs…tourism)
↗ ecosystem services (local & global)

❹ Higher labour intensity L_a:
- for knowledge-intensive & context-specific work
- small family farms usually more productive & profitable per hectare (Sen 1964; Wiggins et al. 2010)

Bullet points

1. World extreme poverty
   is still disproportionally rural and in agriculture
2. Only OECD and transition countries
   follow a canonical “modern growth” path (“Lewis Path”)
3. Agricultural labour force increased elsewhere (1961-2007)
   and shrank available land per farmer for a long time (2050)
4. Labour income gap of Asian farmers widen
   despite best growth and ranking in yield
5. Small-scale agro-ecological farms
   might be an alternative to mega-slum-urbanization