

# CLUB of BOLOGNA

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## **AGRICULTURAL DEVELOPMENT AND MECHANIZATION IN 2013: A COMPARATIVE SURVEY AT A GLOBAL LEVEL**



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# Outline

## Part 1

### 1. Socio-economic impact of agricultural machinery

- Agriculture development - Impact on poverty
- Productivity and economic gains
- Future challenges

## Part 2

### 2. Overview of agricultural mechanization in different regions of the world

- Data sources and their limitations
- General status

### 3. Future trends and evolution of agricultural mechanization

- Impact factors/drivers
- Status and projection of agricultural mech. in surveyed regions
- Cross regional comparison

### 4. Conclusions



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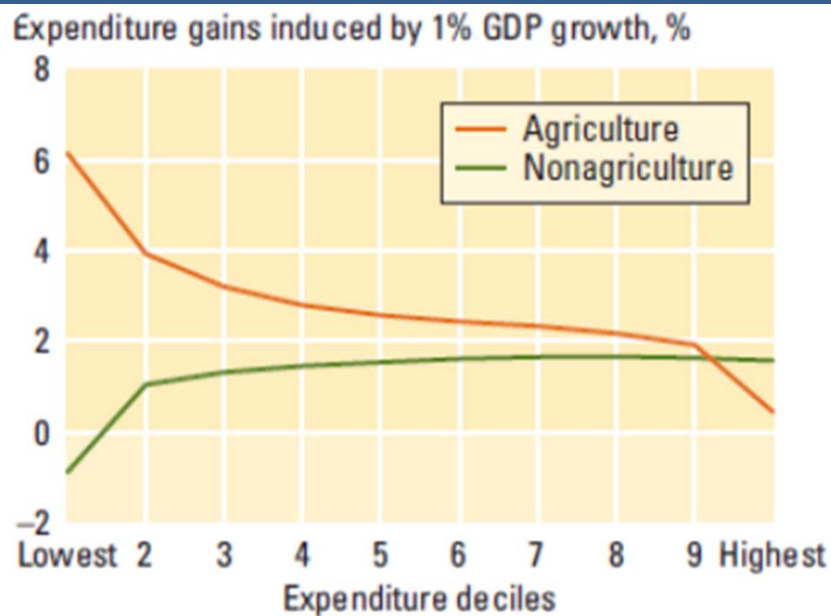
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# Agriculture and development – Impact on poverty

Developing the agricultural sector benefits the poorest more than any other sector of society



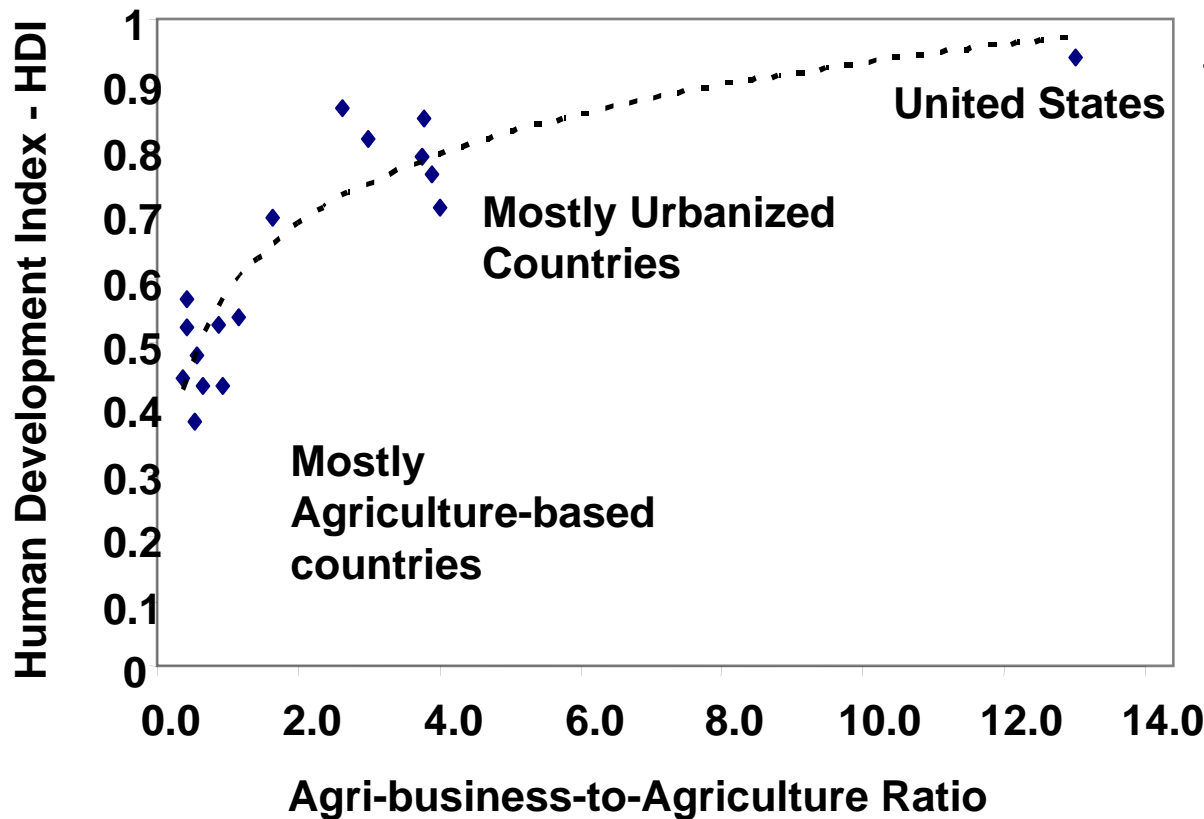
Source: Ligon and Sadoulet 2007.

**Cross country analysis:**  
Growth originating in agriculture is 2-3 times more effective for the poor than growth originating in non-agriculture



## Agriculture and development – **Impact on poverty**

Correlation between human development and the agribusiness/agriculture ratio



The HDI measures development by combining indicators of:

- Life expectancy
- Educational attainment
- Income

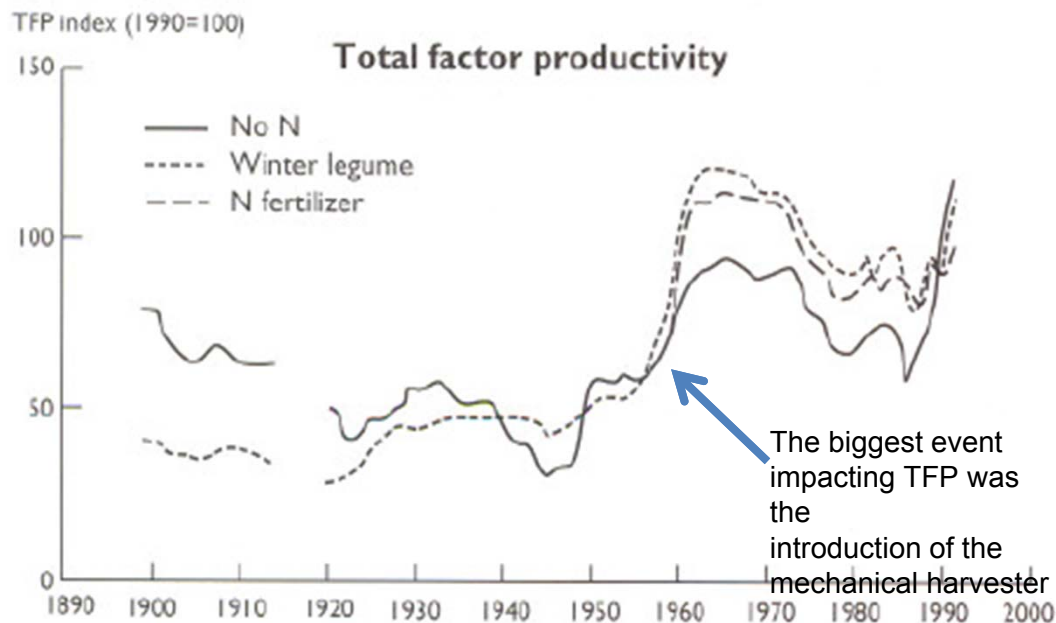


## Productivity and economic gains

Agricultural mechanization has played a major role in:

- Increasing productivity and convenience for the farmers.
- Achieving economical gains

And will continue to be a key factor to achieving the global objective of feeding a growing population.



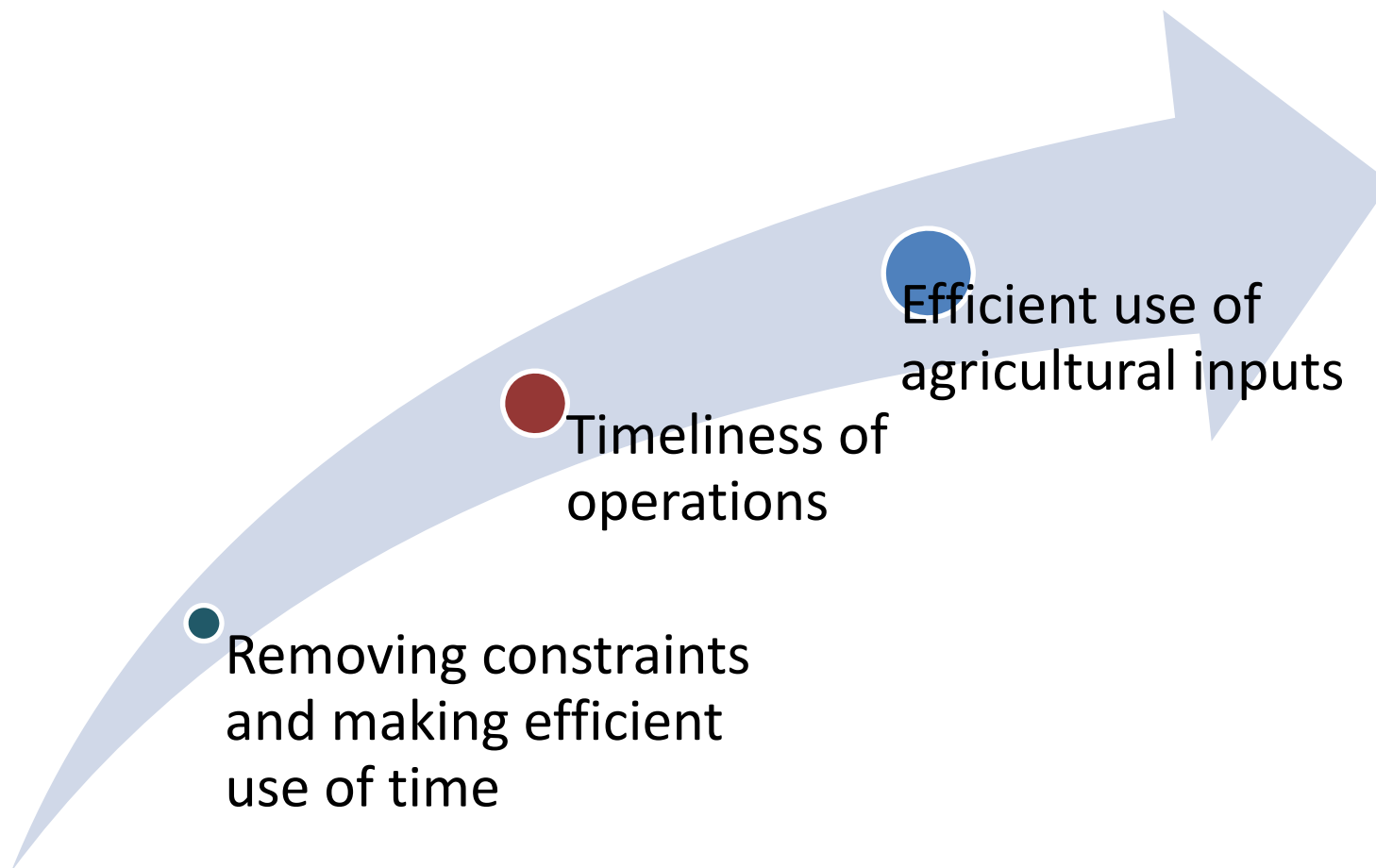
Example of cotton production and the impact of mechanization on TFP

Source: *Michell, C.C. et al. (1996)*

[http://www.aaes.auburn.edu/comm/pubs/specialreports/old\\_rotation.pdf](http://www.aaes.auburn.edu/comm/pubs/specialreports/old_rotation.pdf)

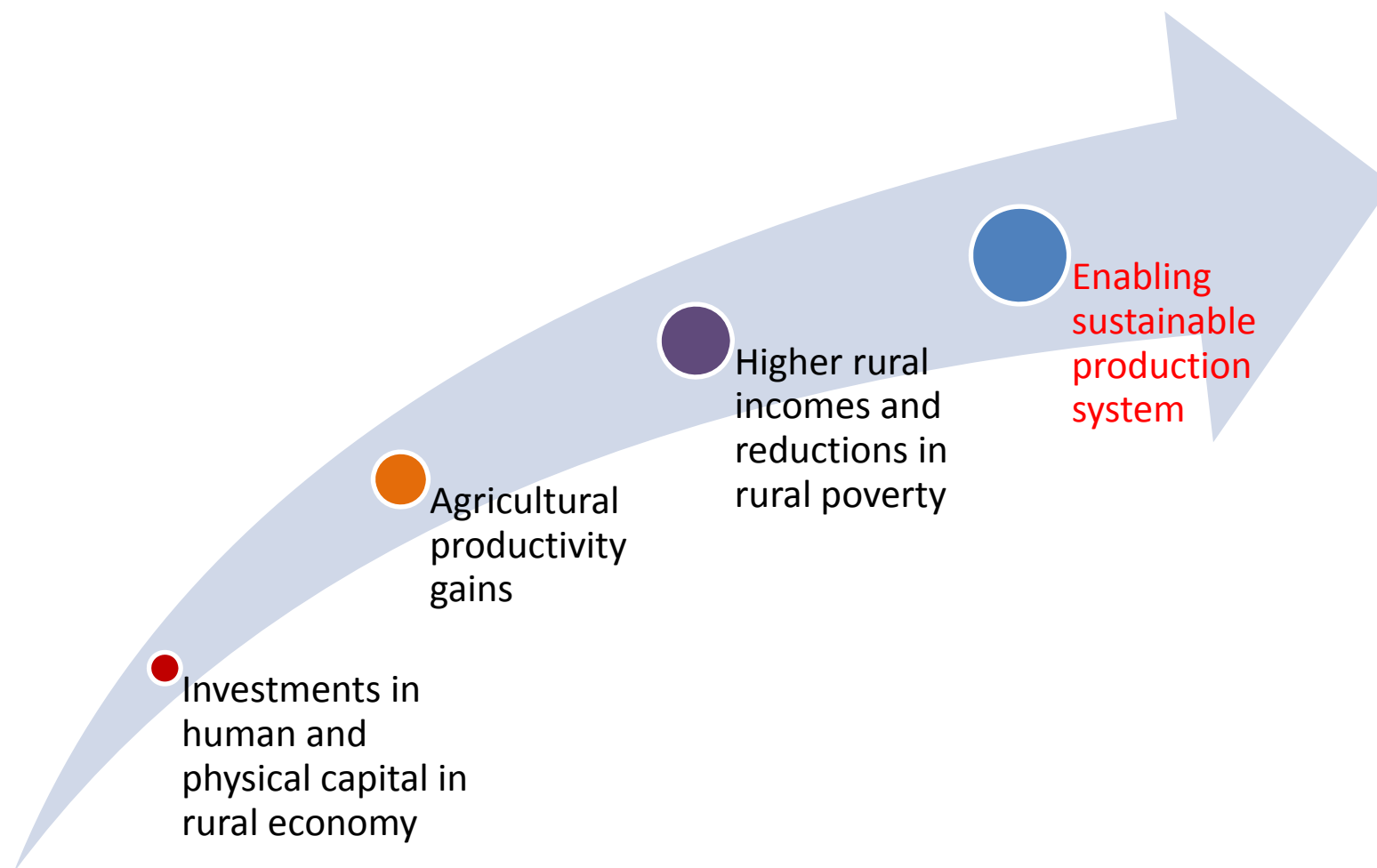


## Productivity Enhancement





## Economic Gains







## ● Challenges - World population



In the next 40 years, the world population is expected to increase by 1/3 to more than 9 billion people.

Feeding such population, which may require doubling agricultural productivity,

✘ **will only be possible with significant, even ground-breaking, improvements in agricultural machines and processes.**



- Challenges– depleting natural resources –  
**improved management is a must**



## Case of water resources:

By 2025, 1.8 billion people are expected to be living in areas with absolute water scarcity, and 2/3 of the world population will live in water-stressed areas.

Improving water management solutions will have to be developed:

- **More efficient irrigation systems and higher efficiencies in whatever technologies farmers are presently using.**



## Challenges - Enabling a sustainable agricultural production system – **the future role/impact of mechanization**



Through further development of precision agriculture, sensor capabilities, etc.,

and **application of ICT into production systems**

the impact of agricultural production on the environment can be substantially reduced and eventually environmental sustainability can be achieved.



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## 2. Overview of agricultural mechanization in different regions of the world – topics investigated

1. General development tendencies likely to affect the future demand of agri. Mech.

2. Most important staple crops and major drivers for mech. of such cropping systems

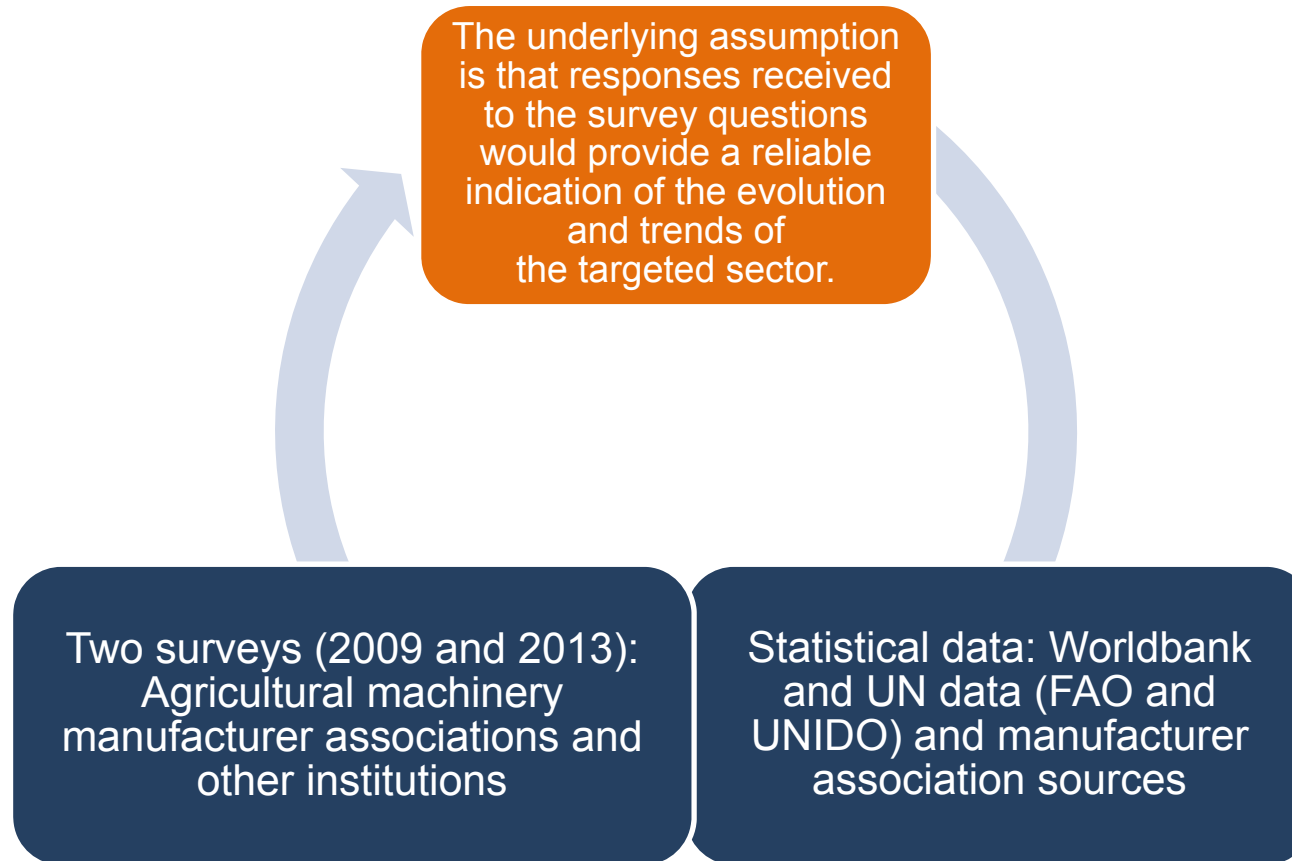
3. Trade related to agricultural machinery – including implements, tractors and combines

4. The impact that selected issues will have on the demand for agricultural mechanization

6. The technological trends for the sector over the next 10-20 years.



## 2. Overview of agricultural mechanization in different regions of the world – **Data sources**





## 2. Overview of agri. mechanization in diff. regions of the world – **Data sources for 2013**

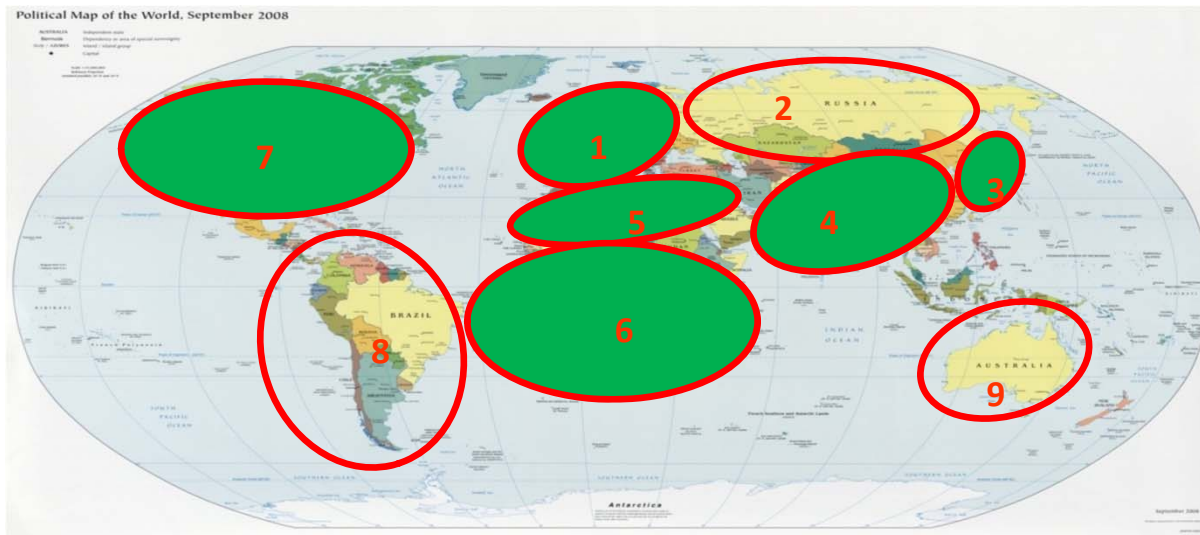
Country	Association and/or Institution	Region
Germany	VDMA – Verband Deutscher Maschinen- und Anlagenbaue	European Union
Italy	UNACOMA – Unione Nazionale Costruttori Macchine per l’Agricoltura	
France	AXEMA – Union des Industriels de l’Agro-Equipment	
Finland	Federation of Finnish Technology Industries	
USA	AEM – Association of Equipment Manufacturers	North America
Japan	JFMMA – Japan Farm Machinery Manufacturer’s Association	Japan
China	CAAMM – China Association of Agricultural Machinery Manufacturers	Asia
India	FICCI – Federation of Indian Chambers of Commerce and Industry IARI – Indian Agricultural Research Institute CIAE - Central Institute of Agricultural Engineering	
Morocco	Institut Agronomique et Vétérinaire Hassan II	
Cameroon	The University of Dschang	Sub-Saharan Africa
Botswana	Botswana College of Agriculture	
South Africa	SAAMA – South African Agricultural Machinery Association	






## 2. Overview of agri. mechanization in different regions of the world – **Data limitations**

- Data availability
- Global perspective <> Regional / local accuracy
- Relatively limited response rate (questionnaire survey)



 Respondents of the 2013 questionnaire survey





## 2. Overview of agricultural mechanization in different regions of the world – **Status**

- **Europe/EU**
  - High numbers of machines per ha reflecting over mechanization and a great variety of farm structures
  - Tendency to fewer and higher powered machines
  - Strong industry with high rate of export
  
- **USA**
  - Completely mechanized farms
  - Trend towards larger and higher horsepower equipment
  - Further technical progress tends towards automation



## 2. Overview of agricultural mechanization in different regions of the world – **Status**

- **Japan**

- The agri. sector has been diminishing in recent decades (agricultural land, population working in agriculture, etc.).
- However, the sector is highly mechanized with about 461 tractors and 237 harvesters per 1,000 ha.
- Mostly small, sophisticated and specialized machines.
- Further technical progress tends towards more automation.
- Strong industry with export to whole Asia and other regions of the world.

- **India/China**

- Agriculture contributes large shares to the GDP and more than one third of the population gains income from agriculture.
- Small scale farm operations (~ 0,5 to 1.5 ha) are predominant.
- Structural change with tendencies to larger farms is increasing.
- Rapid increase in number of machines and of mech. custom-hire services.
- Fast growing tractor production: from 2002/03 to 2007/08 the production capacity doubled to reach 364,205 units in India.



## 2. Overview of agricultural mechanization in different regions of the world – **Status**

- **Russia**

- Developing market but still insufficient compensation of aging machines/tractors
- Local machinery manufacturing capacity being upgraded
- Additional taxes limiting import of machines

- **Latin America/Brazil**

- The numbers of tractors per 1,000 ha are fairly constant over the last three decades, but a significant trend towards tractors of larger scale
- Developing machinery manufacturing sector, mainly by international companies
- The production of bio-ethanol from sugarcane plays a very important role in Brazil which in turn may be a driver for accelerating demand for agricultural machinery



## 2. Overview of agricultural mechanization in different regions of the world – **Status**

- **North Africa / Middle East**

- The levels of mechanization are significantly higher than SSA. The average number of tractors per 1000 ha is 11.
- Large disparities can be observed in the region, for example:
  - in Morocco the Nbr of tractors per 1,000 ha averages 6.
  - in Egypt the data observed are on avg 31 tractors.

- **Sub-Saharan Africa**

- Land productivity is the lowest in the world. Average grain and maize yields range at about 1 ton/ha.
- 80% of agricultural area cultivated with only human power.
- 5% of agricultural area with tractor.
- 70% of all tractors are in South Africa and Nigeria.
- Increasing imports from India and China.



## 2. Overview of agricultural mechanization in different regions of the world –

### Status

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**Impact Factors/Divers on the demand of agri. mechanization \***

<b>Natural conditions</b>	<b>Low (+/-)</b>
Climate change	Low (+/-)
Land (availability, condition)	Low (+/-)
Water availability	Med. (+/-)

<b>Economic conditions</b>	<b>Strong (+/-)</b>
Technical progress	Med./Strong (+)
Economic growth and welfare	Med. (+)
Oil price	Med. (+/-)
Economic crises,	Med. (-)
Energy supply	Med. (+/-)

<b>Political conditions</b>	<b>Medium (+)</b>
Food safety goals	Low (+)
Education of farm operators	Med. (+)
Research	Low (+)
Subsidies	Med. (-)
Farm structure development	Med. (+)
Biofuel production	Low/Med. (+)

<b>Demographic conditions</b>	<b>Med. (+/-)</b>
Population growth	Med. (+)
Population age in rural areas	Med. (+/-)
Change in diets, consumer concerns	Low (+)
Urbanization and industrialization	Med. (+)

Values for all 8 surveyed countries



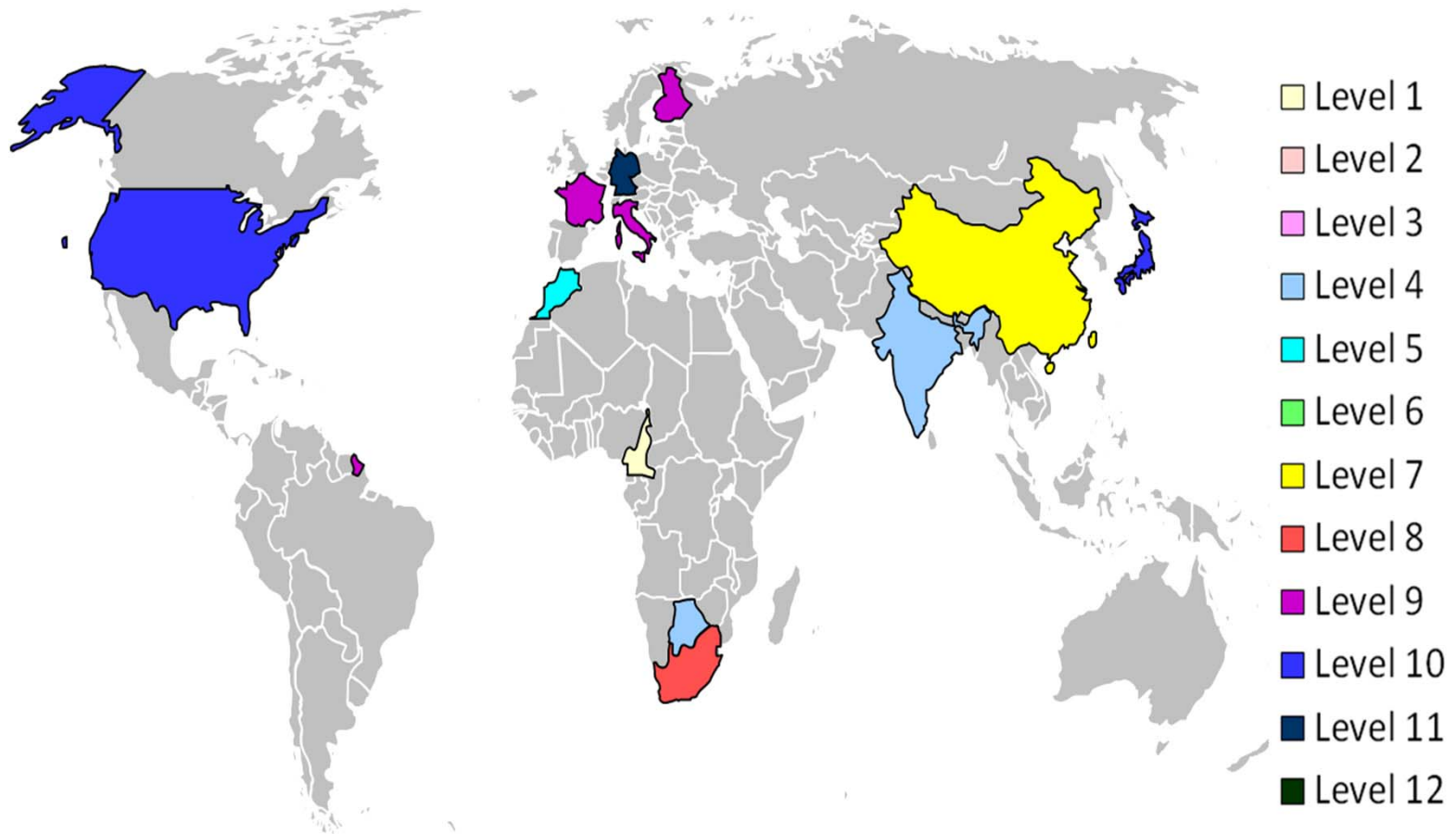
Status and projection of agr. mechanization in surveyed regions: *Twelve levels of agricultural mechanization*

Level	Farm power characteristics	hand	Draught animal	tractors	Nomin. speeds (km/h)		No. of speeds forw./rew.	Shift	PTO speeds rpm
					forw.	rev.			
1	Predominantly hand power	> 80	<= 20	<= 5					
2	Significant use of draught animal power	46 – 80	21 – 39	<= 10					
3	Significant use of tractors	15 – 45	>= 40	<= 19					
4	Tractors predominant	20 – 50	15 – 30	20 - 49					
5	Fully motorized technology level I	<= 25	<= 25	50 - 75					
6	Fully motorized technology level II	<= 10	<= 10	> 75	2 – 20 (25)	3 - 8	6/2 – 8/2	SG, CS	540
7	Fully motorized technology level III	“	“	“	2 - 30	3 - 10	8/4 – 12/4	CS, SS	540/(1000)
8	Fully motorized technology level IV	“	“	“	(0,5) 2 – 30 (40)	3 - 15	12/4 – 16/8	SS, HL	540/1000
9	Fully motorized technology level V	“	“	“	(0,3) 2 – 40 (50)	2 - 20	16/12 – 36/36	SS, PPS, FPS	540/1000 (750/1250)
10	Fully motorized technology level VI	“	“	“	0 – 50 (60)	0 - 25	∞	autom.	
11	Moderate share of autonomous vehicles								
12	Significant share of autonomous vehicles								



# Status and projection of agr. mechanization in surveyed regions: Current status (2013)

Agricultural mechanization: Status

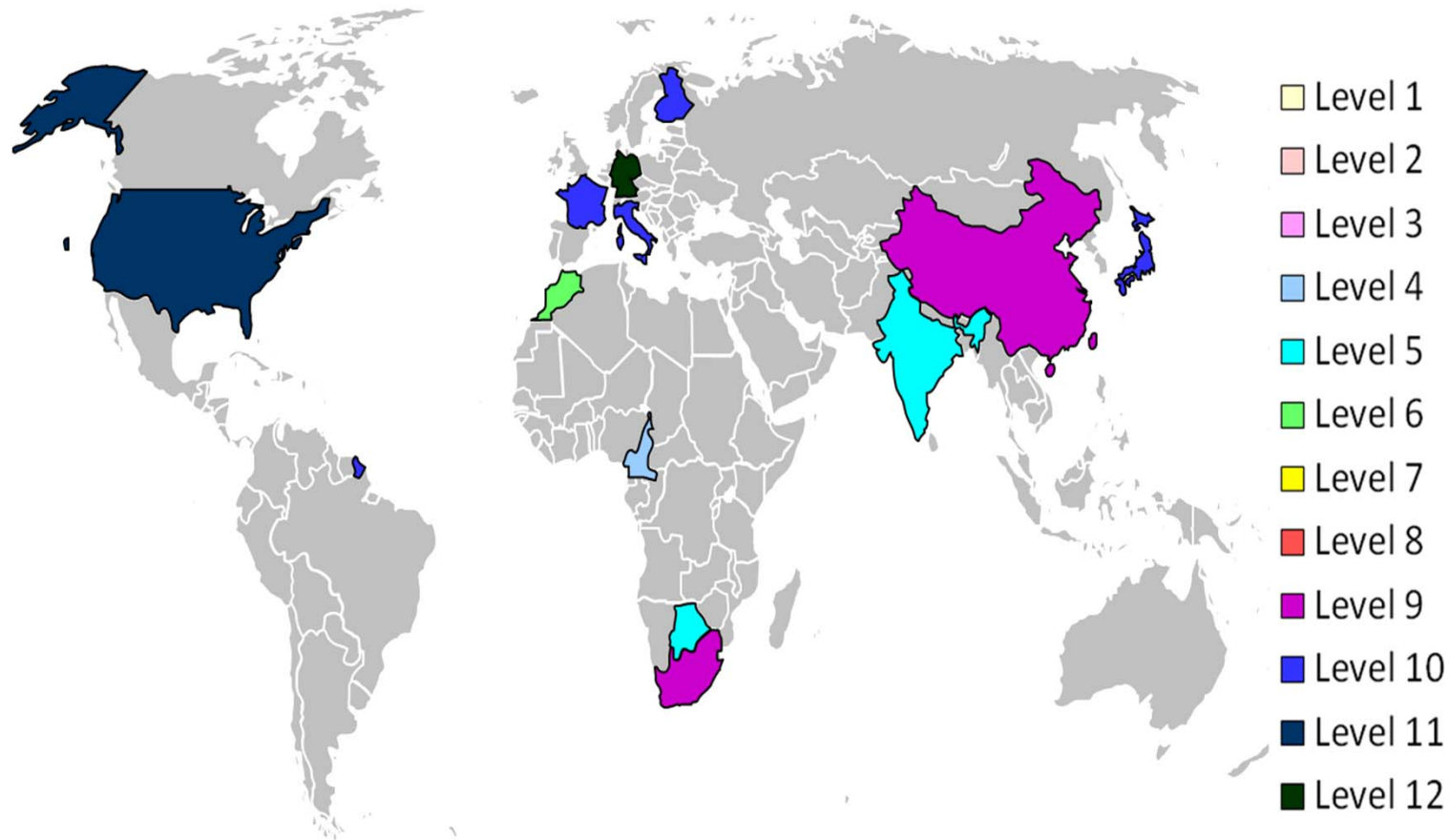






# Status and projection of agr. mechanization in surveyed regions

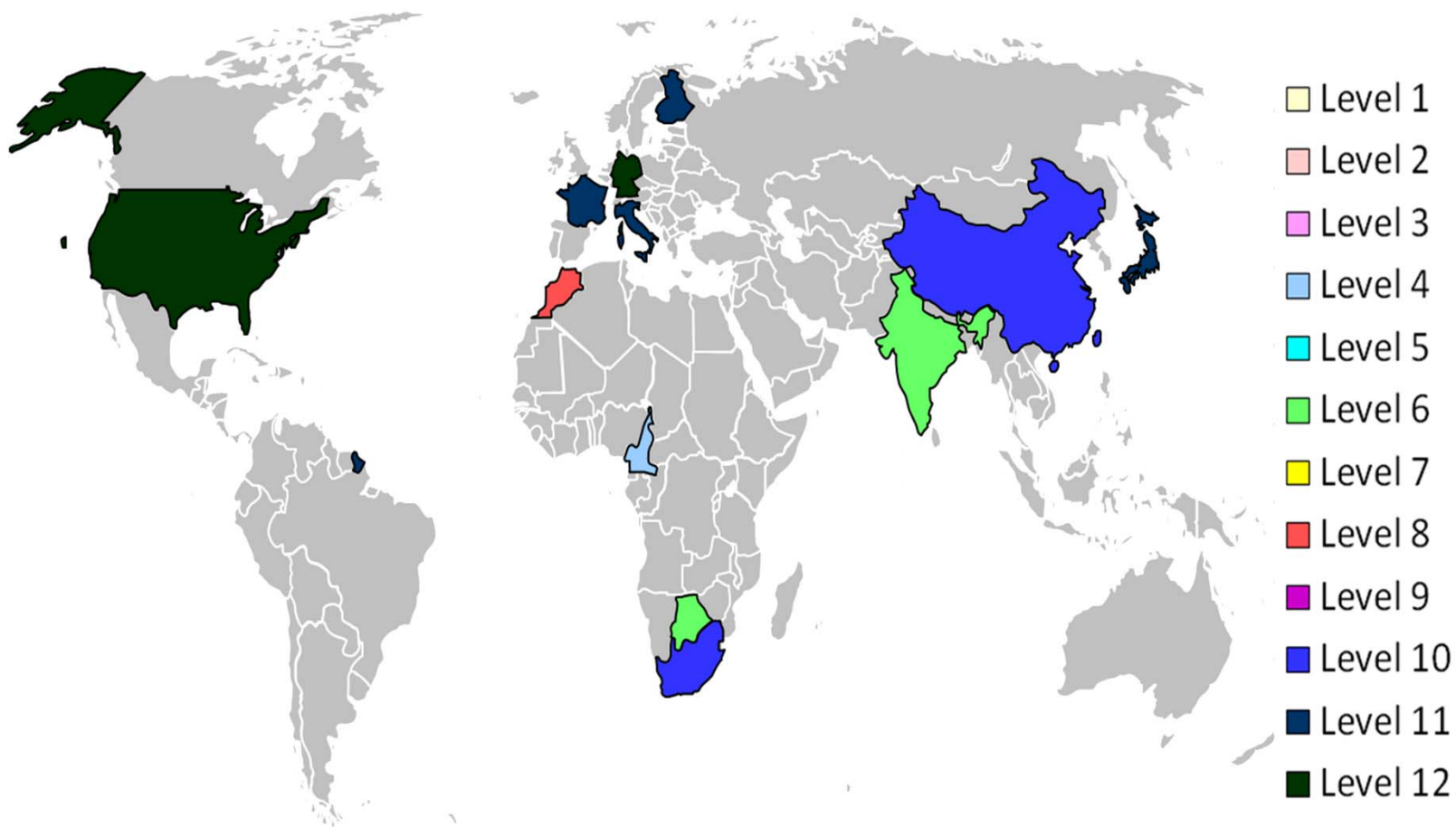
Agricultural mechanization: 10 years prediction





# Status and projection of agr. mechanization in surveyed regions

Agricultural mechanization: 20 years prediction





## Cross regional comparison: Domestic demand over the next 10 years

	Germany	Italy	France	Finland	USA	Japan	China	India	Morocco	Cameroon	Botswana	South Africa
Small size tractors (= < 40 hp)	→	↗	↗	↗	↗	↘	↗	↗	→	↗	↗	→
Medium size tractors (= < 100 hp)	→	↗	↗	↘	↗	↗	→	↗	↑	↗	↗	↗
Big size tractors (> 100 hp)	↗	↗	↗	↗	↗	↗	↑	/	↗	↗	↗	↗
Spare parts for tractors	→	↗	↗	→	↗	↗	↗	↗	↑	↑	↑	↗
Self propelling combines	→	↗	→	↘	↗	↗	→	↗	↗	↗	↗	↗
Forage harvesters	→	↗	→	→	↗	→	↑	↗	↗	→	↗	↗
Reapers	→	↗	→	→	/	/	→	↗	↗	↗	↗	↗
Threshers	/	↗	→	/	/	↘	↘	↗	↗	↑	↗	↗
Irrigation systems	→	↗	↗	↘	↑	↘	↗	↗	↑	↗	↑	↗
Diesel engines	→	↗	↗	↘	↗	↘	↗	↗	↑	↗	↑	↗
Power tillers	→	↗	→	→	→	↘	→	↗	↑	↗	↑	↗
Food processing technique	→	↗	→	→	↗	/	↗	↑	↑	↗	↗	↗
Spare parts in general	→	↗	↗	↗	↗	↘	→	↗	↑	↑	↑	↗
Hand implements	/	/	→	↘	↘	/	→	↗	→	↑	↑	↗
Draught animal implements	/	/	→	/	/	/	/	→	/	↗	↑	↗
Soil preparation	→	-	↗	↗	↗	→	→	↗	↗	↗	↑	↗
Seeding	→	-	↗	↗	↗	→	→	↗	↗	↗	↑	↗
Plant protection	→	-	↗	↗	↗	→	↗	↗	↗	↗	↑	↗

### Legend

[↑] ≥ 10% annual growth rate	[↘] -10% to 0 % annual growth rate	[-] not specified
[↗] 0% to 10% annual growth rate	[↘] ≤ -10% annual growth rate	
[→] -/+ 0% annual growth rate	[/] not relevant	



## Cross regional comparison: **Import dev. over the next 10 years**

	Germany	Italy	France	Finland	USA	Japan	China	India	Morocco	Cameroon	Botswana	South-Africa
Small size tractors (= < 40 hp)	↗	↗	↗	↗	↗	↗	↘	→	→	↗	↑	→
Medium size tractors (= < 100 hp)	↗	↘	↗	↘	↗	↗	↘	→	↑	↗	↑	↗
Big size tractors (> 100 hp)	↗	↘	↗	→	→	↗	→	/	↗	↗	↑	↗
Spare parts for tractors	→	↗	↗	→	↗	↗	→	→	↑	↑	↑	↗
Self propelling combines	→	↘	→	↘	→	→	→	→	↗	↗	↑	↗
Forage harvesters	→	↘	→	↗	→	→	↗	-	↗	→	↑	↗
Reapers	→	↘	→	↘	/	/	→	-	↗	↗	↑	↗
Threshers	/	↘	→	/	/	/	→	-	↗	↑	↑	↗
Irrigation systems	→	↘	→	↘	→	→	↗	-	↑	↗	↑	↗
Diesel engines	→	↗	↗	↘	→	→	→	-	↑	↗	↑	↗
Power tillers	→	↘	→	↘	→	↘	→	↑	↑	↗	↑	↗
Food processing technique	→	↘	→	→	↗	/	→	↗	↑	↑	↑	↗
Spare parts in general	→	↘	↗	↗	→	↗	→	-	↑	↑	↑	↗
Hand implements	/	/	→	↘	↗	/	/	→	→	↗	↑	→
Draught animal implements	/	/	→	/	-	/	/	→	/	↗	↑	→
Soil preparation	→	-	↗	→	↗	/	→	→	↗	↗	↑	↗
Seeding	→	-	↗	↗	↗	→	→	→	↗	↗	↑	↗
Plant protection	→	-	-	↗	↗	→	↗	→	↗	↗	↑	↗

### Legend

[↑] >= 10% annual growth rate

[↘] -10% to 0 % annual growth rate

[-] not specified

[↗] 0% to 10% annual growth rate

[↘] <= -10% annual growth rate

[→] -/+ 0% annual growth rate

[/] not relevant



## Cross regional comparison: Export dev. over the next 10 years

	Germany	Italy	France	Finland	USA	Japan	China	India	Morocco	Cameroon	Botswana	South Africa
Small size tractors (= < 40 hp)	→	↘	↗	/	↑	↗	↑	↗	/	/	→	/
Medium size tractors (= < 100 hp)	→	↗	↗	→	↑	→	↑	↗	/	/	→	/
Big size tractors (> 100 hp)	↗	↗	↗	↗	↑	→	↗	/	/	/	→	/
Spare parts for tractors	→	↗	↗	→	↑	→	↗	↗	/	/	→	/
Self propelling combines	↑	↗	→	↗	↑	↘	↗	↗	/	/	→	/
Forage harvesters	↑	↗	→	→	↗	→	→	↗	/	/	→	/
Reapers	→	↗	→	→	/	/	→	-	/	/	→	/
Threshers	/	↗	→	/	/	→	→	-	/	↗	→	↗
Irrigation systems	→	↗	↑	→	↗	→	→	↗	/	→	→	↗
Diesel engines	→	↗	↗	↗	↗	↗	→	↗	/	-	→	/
Power tillers	→	↗	↗	/	↗	↗	→	-	/	-	→	/
Food processing technique	↗	↗	↑	→	↗	/	→	↗	/	↗	→	↗
Spare parts in general	↗	↗	↗	→	↗	↗	→	↗	/		→	/
Hand implements	/	/	↗	→	↘	/	→	↗	/	↗	→	↗
Draught animal implements	/	/	↗	/	/	/	/	↗	/	↗	→	↗
Soil preparation	↗	-	↗	↗	↗	/	→	↗	/	→	→	↗
Seeding	↗	-	↗	→	↗	→	→	↗	/	→	→	↗
Plant protection	↗	-	↗	→	↗	→	↗	↗	/	→	→	/

### Legend

[↑] >= 10% annual growth rate

[↘] -10% to 0 % annual growth rate

[-] not specified

[↗] 0% to 10% annual growth rate

[↓] <= -10% annual growth rate

[→] -/+ 0% annual growth rate

[/] not relevant



## Cross regional comparison: Market penetration of selected technologies

		Precision farming													
		Overall	Tillage	N-fertilizer application	Other fertilizer application	Plant protection	Guidance systems	Yield mapping	Driverless tractors	Fleet management (telematics)	Smart implements	ISOBUS	Remote diagnostics	Use of sensor technology	Robotics
Germany	status	4	5	5	5	5	4	4	1	2	1	3	3	4	3
	10 years	5	5	5	5	5	5	5	1	5	2	4	4	5	4
Italy	status	2	2	-	-	4	2	2	1	2	1	1	1	1	1
	10 years	3	3	-	-	5	3	3	2	2	2	3	3	2	2
France	status	2	1	2	1	2	1	2	1	2	2	2	1	2	1
	10 years	3	2	4	3	4	3	4	2	3	4	4	3	4	2
Finland	status	2	1	2	2	1	2	2	1	1	2	2	1	2	1
	10 years	3	2	3	3	4	5	3	1	2	4	4	4	4	2
USA	status	5	5	5	5	5	5	4	1	3	2	2	3	3	2
	10 years	5	5	5	5	5	5	5	3	4	4	4	5	5	4
Japan	status	1	5	1	5	5	2	1	1	-	-	1	1	1	2
	10 years	3	5	1	5	5	3	1	1	-	-	4	2	3	3
China	status	1	1	4	4	3	1	1	1	1	1	1	1	1	1
	10 years	3	2	5	5	5	2	2	2	3	3	3	2	3	2
India	status	1	3	4	2	3	1	1	1	1	1	1	1	1	1
	10 years	2	4	5	3	4	1	1	1	1	2	1	1	1	1
Morocco	status	1	4	3	3	3	1	1	1	1	1	1	1	1	1
	10 years	2	5	4	4	4	2	2	1	2	2	2	2	2	2
Cameroon	status	1	2	1	1	1	1	1	1	1	1	1	1	1	1
	10 years	1	2	2	2	1	1	1	1	1	1	1	2	2	1
Botswana	status	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	10 years	2	3	3	2	3	1	2	1	1	1	1	1	1	1
South Africa	status	3	5	5	5	5	2	2	1	1	1	1	1	1	1
	10 years	4	5	5	5	5	3	3	2	2	2	3	3	3	2

Legend:





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### 4. Conclusions



## 4. Conclusions

- Agricultural mechanization has increased productivity and convenience for the farmers. Moreover, it has contributed to significant economic gains.
- The need for further mechanization to improve productivity in agriculture and to feed the world cannot be overemphasized in particular in the light of expected demographic developments.
- The political conditions and also expected socio-development factors seem to be very favorable for investments in agricultural mechanization.
- The use of precision farming will become standard in the short to the mid-term range, but also the use of control and automation systems will become common and offer new growth opportunities for the corresponding industries.





## 4. Conclusions

- The emerging countries such as India, China and South-Africa are seeing significant economic growth with associated technology transfer and progress in agricultural production.
- They are becoming important players on the world markets for agricultural machinery and also represent promising markets with high demands for further mechanization.
- Strong advances towards high levels of mechanization can be expected in these regions, however, this support that:
  - ✓ the current trends of technology transfer is pursued as part, for example of joint-ventures.
  - ✓ issues like e.g. property rights, taxation practices across countries, market access, etc. are further dealt with.



## 4. Conclusions

- The most challenging region for agricultural mechanization development remains Africa.
- While only limited progress has been achieved in terms of increased number of machines and market expansion, the predictions over the next ten years are positive.
- This supposes that increased investments are needed both from the national governments and the private sector to develop the sector.



*Thank you for your attention*