The rise of the 2nd Optimum

The future of farming will be bee-friendly!

Walter Haefeker
President European Professional Beekeepers Association
Member of the Board of Directors German Professional Beekeepers Association
Deutscher Berufs und Erwerbsimkerbund e.V
Coordinator Apimondia Working Group on GMOs

Bee-friendly agriculture needs innovation

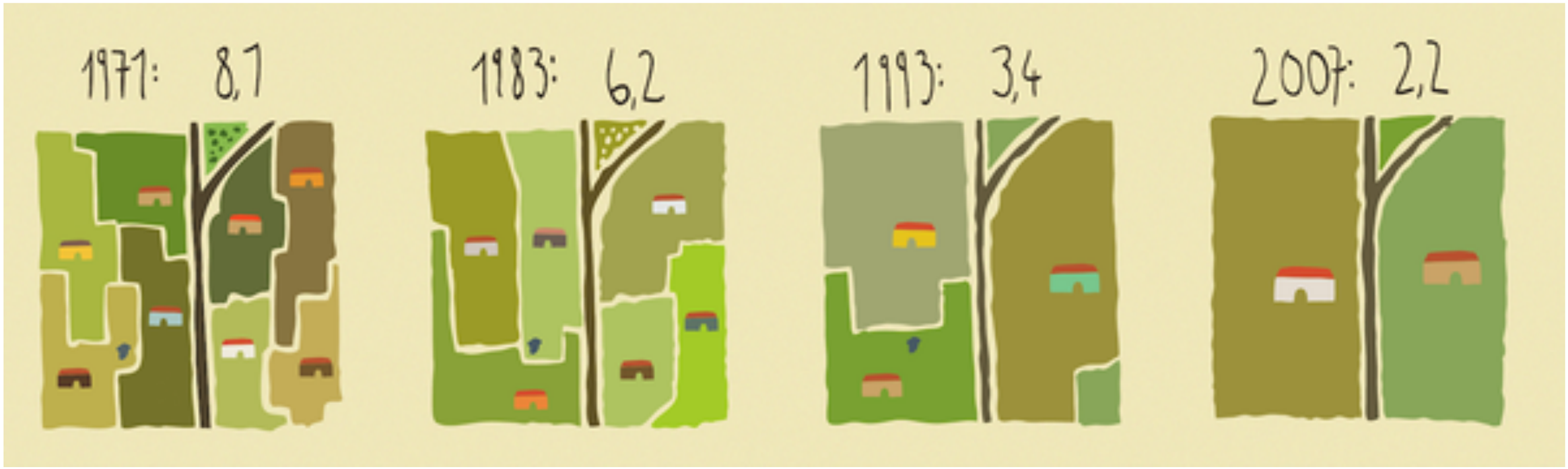
PRESS RELEASE

CEMA and EPBA launch joint effort to aid bee-friendly farming practices through training and innovation

Brussels, 7 April 2014 – CEMA and EPBA have decided to explore opportunities for co-operation in training and innovation, with the aim of promoting the deployment and development of technical innovations that support bee-friendly farming practices.

The European Professional Beekeepers Association (EPBA) welcomes the chance to explore with the European Agricultural Machinery Association (CEMA) ways to share best practices and leverage new technologies that enable farmers to minimize the impact of farming operations on honeybees and other pollinators.

Structural change in agriculture



Anzahl der landwirtschaftlichen Betriebe pro 100 Hektar. (Grafik: Leo Koppelkamm) Quelle: Statistisches Bundesamt

Perception in civil society:

- Bad for family farmers.
- Bad for socio-economic structure of rural areas and towns.
- Bad for biodiversity.
- Bad for solitary bees, bumble bees and honey bees

What is driving this change? Laws of physics?

Main driver:

Big “dumb” machine needs to be fast to earn it‘s money back

Agricultural industry has found one optimum:

Big “dumb” machines need optimal conditions to recuperate the investment:

- Monocultures – only able to deal with one crop at a time
- Large fields – as homogeneous as possible
- Application of chemicals to achieve homogeneous conditions for large machinery.
- Large farms able to make big investments
- Production site: No other users have to be considered in the agricultural landscape (humans, wildlife, bees)
- No regulations should stand in the way of maximum utilization of the machines. (Foraging times of honey bees, wind speeds etc.)

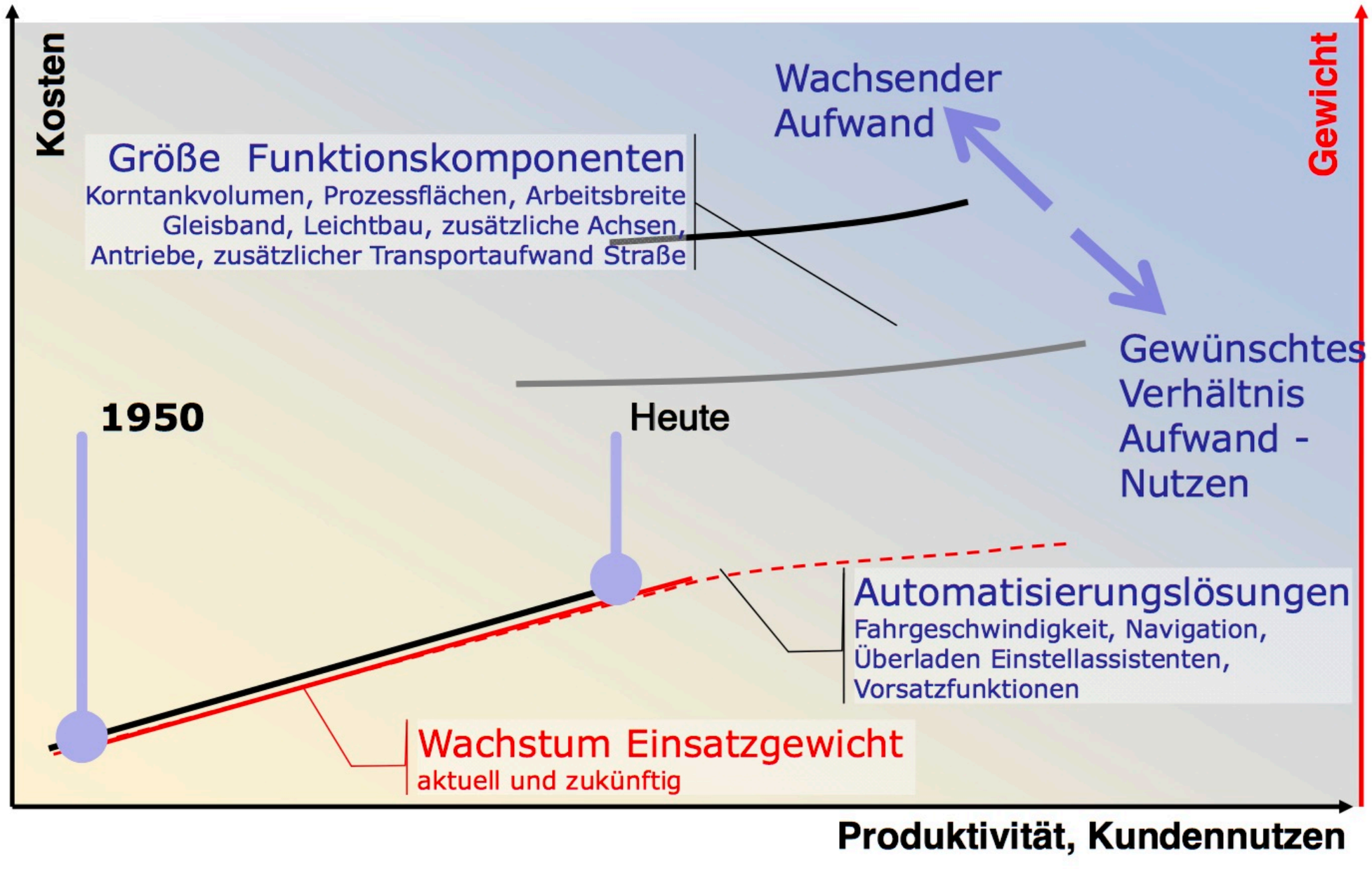
This model has reached it‘s limits.

TECHNISCHE UNIVERSITÄT DRESDEN

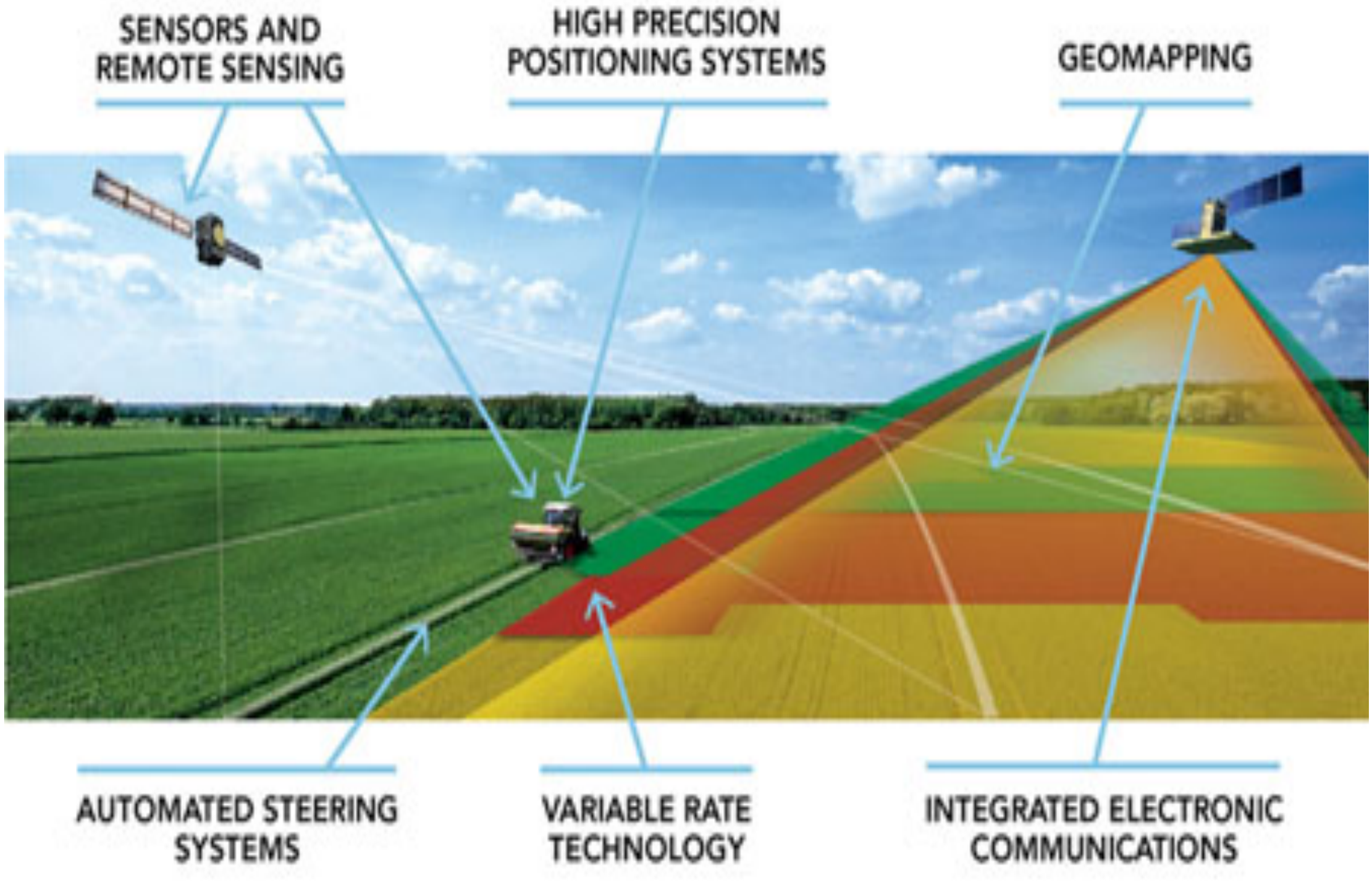
Progressive Aufwandssteigerung erzeugt Lücke zwischen Wunsch und Wirklichkeit

ast

Fakultät Maschinenwesen Institut für Verarbeitungsmaschinen und Mobile Arbeitsmaschinen



Digitalization
of the old model:



But, there is at least one more optimum!

- What if agricultural technology is cheap and intelligent
- Devices that are not expensive, do not have to be fast.
- Devices that are so cheap that they can constantly remain on the field, do not have to be powerful:
  - Problems are detected at an early stage.
  - In early stages weeds and pests can be dealt with applying minimal effort.
- Pesticide use is at least partially no longer necessary.
- Slow machines do not need large homogeneous areas.
- Technical challenges for image processing and actors are dramatically lower for slow machines.
- Low cost machines do not need large farms.
- Low cost and intelligent machines fit the cultural landscape and the needs of people in rural areas.
- Some machines can be built in the community (Digital Blacksmith)

Paradigm shift in lawn mowers

Digitalization actually enables a whole new model:

Farm robot competition in corn crop


Z440

Robot „BoniRob“ by Amazone and Bosch

egulierung

Deepfield

A Bosch Start-Up

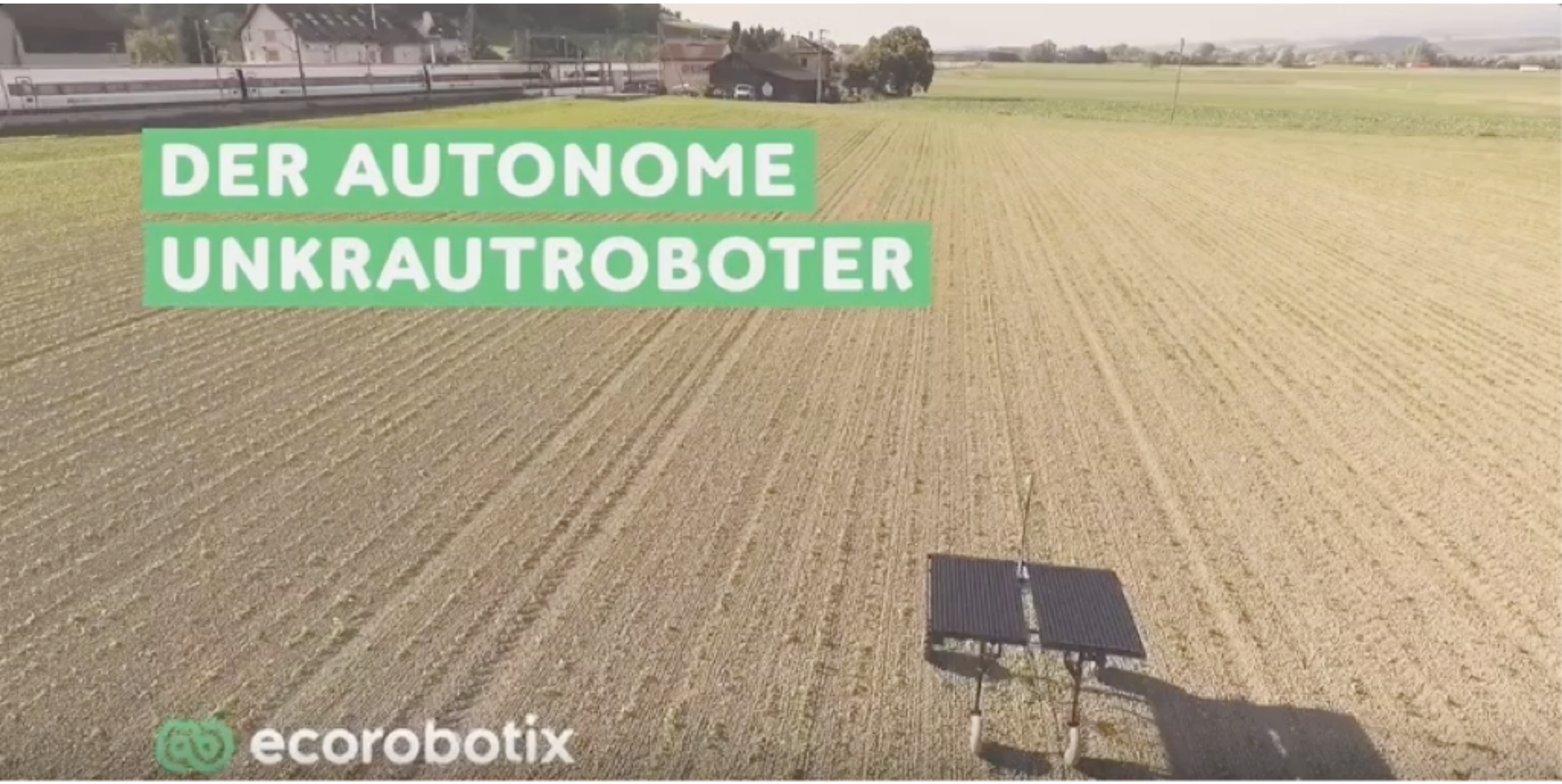
4

Bosch Start-up Deepfield Robotics | 15.03.2017

NEC

Achieving low cost by using mass produced components …

Microapplication of Herbicide with autonomous rover



What about Drones?

- **Drones need a lot of energy just to stay in the air.**
- **If a drone detects a problem, it cannot exert mechanical force to deal with it.**
- **No long term autonomous operation.**
- **Noisy.**
- **Better: Bring the intelligence of a drone to a low cost, light weight, stable platform.**
- **Rovers in many cases better than drones.**

Want to be fast to market?

Inherently dangerous technologies will be beaten to market by inherently safe technologies!

- If the technology you are working with is inherently dangerous, someone will want to regulate it.
- Regulation dramatically increases development cost and delays market entry.
- It takes 12 years and ½ billion dollars to introduce a new pesticide.
- If you can solve the same problem with technology nobody sees a reason to regulate, you can have a tool in the farmers hands in ¼ of the time at ¼ of the cost.
- Autonomous drones: may drop on someone's head, may spy on other properties = regulation.
- Autonomous 400 hp farm tractor: may drive through local kindergarten = regulation.
- Autonomous lawn mowing robot: low weight, low speed = no regulation.

Want to avoid resistance from civil society?

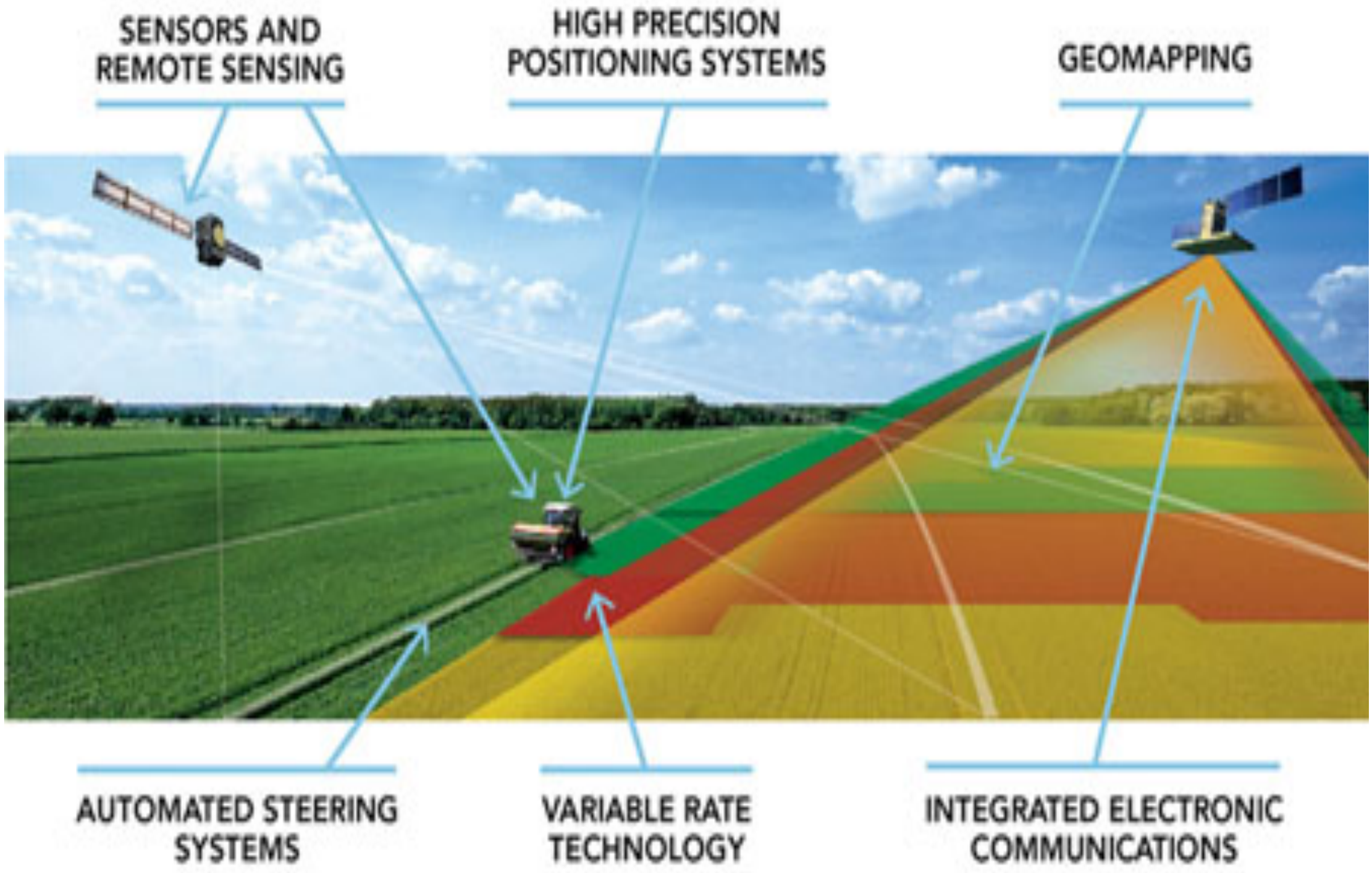
- Avoid temptation to show of digitalization on big equipment.
- Demonstrate non-threatening small scale implementations.
- Avoid big data, big cloud imagery.
- Avoid painting pictures of a future, which looks like small players are going to be left behind.
- There are already helpful initiatives in Europe.

No farm left behind:

Ownership of data:

fertilizers europe
Ceettar
EFFAB
copa cogeca
european farmers
european agri-cooperatives
ESA
CEMA
European
Agricultural
Machinery
FEFAC
CEJA
European
Crop Protection

Why data acquisition by satellite, if you can do it locally?



Farmer‘s data sold to commodity traders. Why should farmers support a business model used to speculate against them?

Think outside the box!

- Digitalization of the old model is just an intermediate stage.
- Digitalization will enable completely new model.
- We will no longer need to tolerate structural change to adapt the landscape and the farming communities to the needs of large but relatively dumb machines.
- Machines will be smart enough to adapt to the needs of the crops, the farmers and the ecosystem.
- Machines will be smart enough to actually discriminate between harmful and beneficial insects.
- Machines will be smart enough to suppress pests, but not completely eliminate them, leaving room for beneficial effects of ecosystem.

Recent break through in neural networks

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Learning multiple layers of representation

Geoffrey E. Hinton

Department of Computer Science, University of Toronto, 10 King's College Road, Toronto, M5S 3G4, Canada

To achieve its impressive performance in tasks such as speech perception or object recognition, the brain extracts multiple levels of representation from the sensory input. Backpropagation was the first computationally efficient model of how neural networks could learn multiple layers of representation, but it required labeled training data and it did not work well in deep networks. The limitations of backpropagation learning can now be overcome by using multilayer neural networks that contain top-down connections and training them to generate sensory data rather than to classify it. Learning multilayer generative models might seem difficult, but a recent discovery makes it easy to learn nonlinear distributed representations one layer at a time.

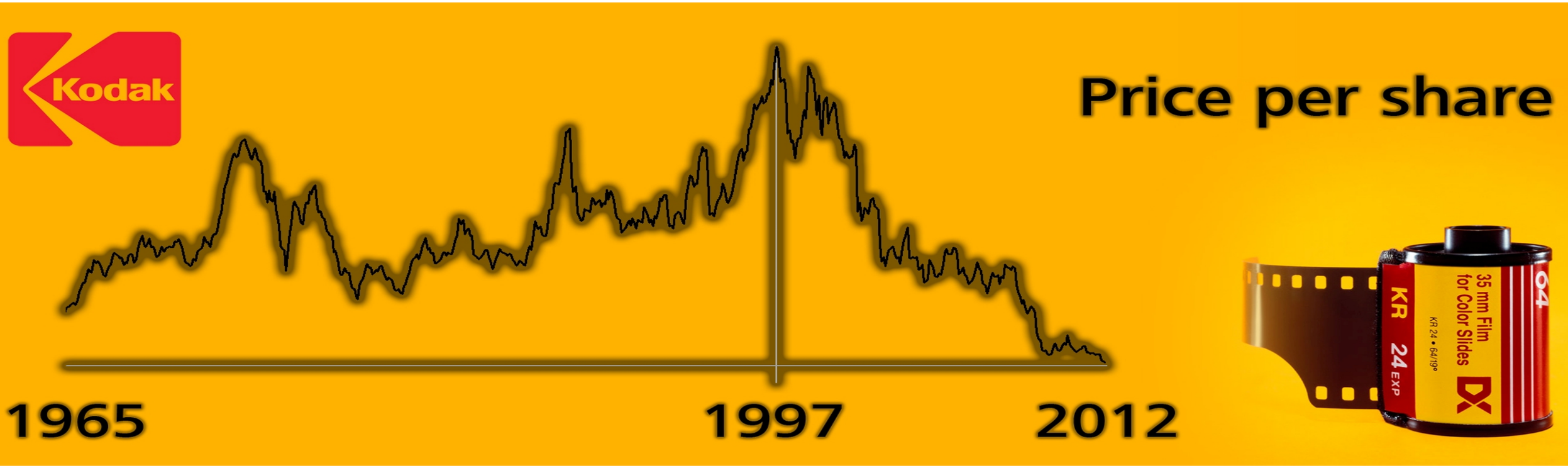
Learning feature detectors

To enable the perceptual system to make the fine distinctions that are required to control behavior, sensory cortex needs an efficient way of adapting the synaptic weights of multiple layers of feature-detecting neurons. The backpropagation learning procedure [1] iteratively adjusts all of the weights to optimize some measure of the classification performance of the network, but this requires labeled training data. To learn multiple layers of feature detectors when labeled data are scarce or non-digits, the complicated nonlinear features in the top layer enable excellent recognition of poorly written digits like those in Figure 1b [2].

There are several reasons for believing that our visual systems contain multilayer generative models in which top-down connections can be used to generate low-level features of images from high-level representations, and bottom-up connections can be used to infer the high-level representations that would have generated an observed set of low-level features. Single cell recordings [3] and the reciprocal connectivity between cortical areas [4] both suggest a hierarchy of progressively more complex features in which each layer can influence the layer below. Vivid visual imagery, dreaming, and the disambiguating effect of context on the interpretation of local image regions [5] also suggest that the visual system can perform top-down generation.

The aim of this review is to complement the neural and psychological evidence for generative models by reviewing recent computational advances that make it easier to learn generative models than their feed-forward counterparts. The advances are illustrated in the domain of handwritten digits where a learned generative model outperforms discriminative learning methods at classification.

Just a few years ago photography was wet chemistry!



Will this also happen to Bayer, Monsanto, BASF, Syngenta etc. ?

Once upon a time plant protection was wet chemistry!

Questions leading to proposal for new model

- Is the business model of the plant protection industry unnecessarily risky for our bees?
- Is the business model of the plant protection industry unnecessarily risky for it's shareholders?
- Are there internal and external drivers for changing the current model?
- How can we facilitate this change?

1st Commandment of marketing:
Know thy customer!

- In the plant protection business, the customer is not the plant!
- The customer is the farmer.
- The customer is paying to protect the financial outcome of the investments in his crop.
- One option to protect his investment is to protect the plant using chemicals.
- But there are more options:
  - Business model options
  - Technology options

Business Model Options

* In integrated pest management the risk of crop damage is assessed before applying pesticides.
* The same data can be used calculate the insurance risk.
* In cases with low pest pressure, the farmer's need to protect his financial outcome can be met with crop insurance.
* Industry has something to sell below the pesticide application threshold.

Technology Options

- Technology is creating more options to protect the plant.
- Main challenge in plant protection:
  - Selectively removing the pest without harming pollinators, beneficial organisms, the environment and the consumer.
  - Chemicals are not very good at being selective, because in biology everything is related to everything else.
  - Digital technology is extremely good at being selective.
  - Digital plant protection will replace chemical plant protection.
  - Application of chemicals will continue to have a role as one of many tools used to control pests within the digital plant protection context.

Disruption of plant protection industry by digital innovation

- Plant protection industry is beginning to reinvent itself.
- Multiple pressures on current volume model.
- New solutions becoming available from other players.
- Crop protection as a service consisting of all options is likely to be the new model.

Blue River Technology acquired by John Deere

Teaming up to change the future of farming

SEE & SPRAY TECHNOLOGY

The next generation of smart machines

See & Spray is the next generation of Blue River's technology. See & Spray machines leverage deep learning to enable our machines to identify a greater variety of plants—both crops & weeds—with better accuracy, and then make crop management decisions on the spot. Custom nozzle designs enable <1-inch spray resolution, and powerful software powers faster and more agile crop protection. See & Spray is currently operating in both lettuce thinning and weeding for cotton.

Digital Plant Protection: Investment by John Deere

BLUE RIVER TECHNOLOGY

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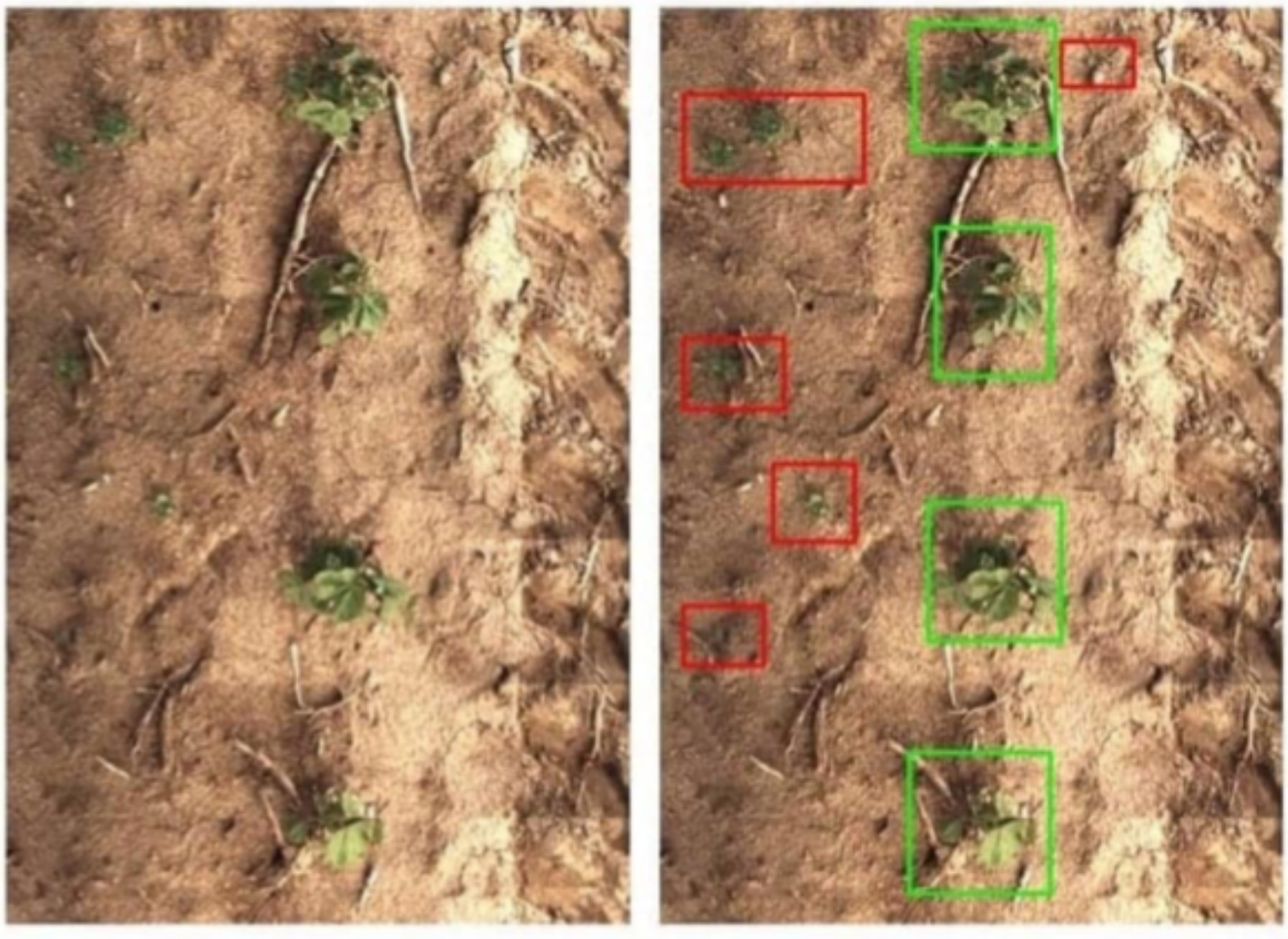
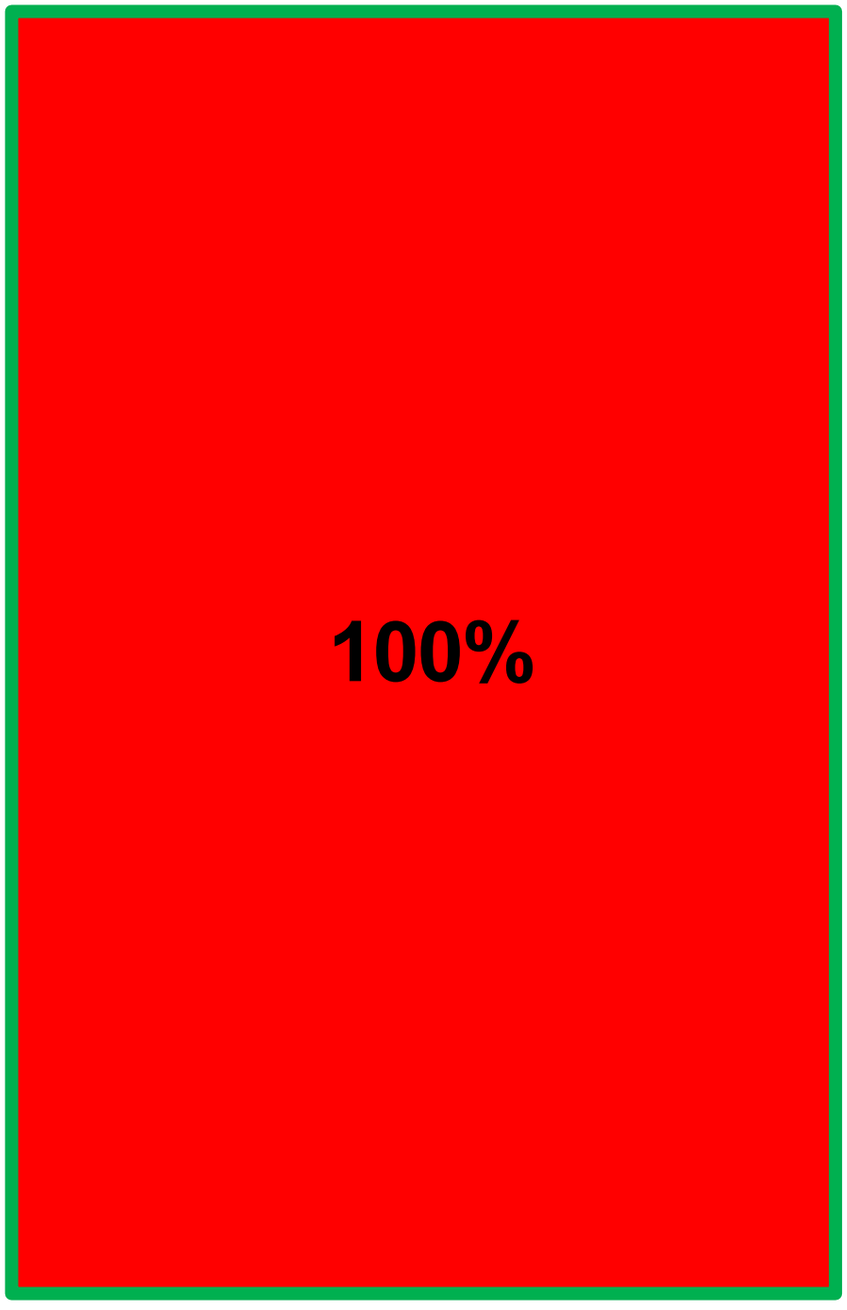
count at scale

Using computer vision and artificial intelligence, our smart machines can detect, identify, and make management decisions about every single plant in the field.

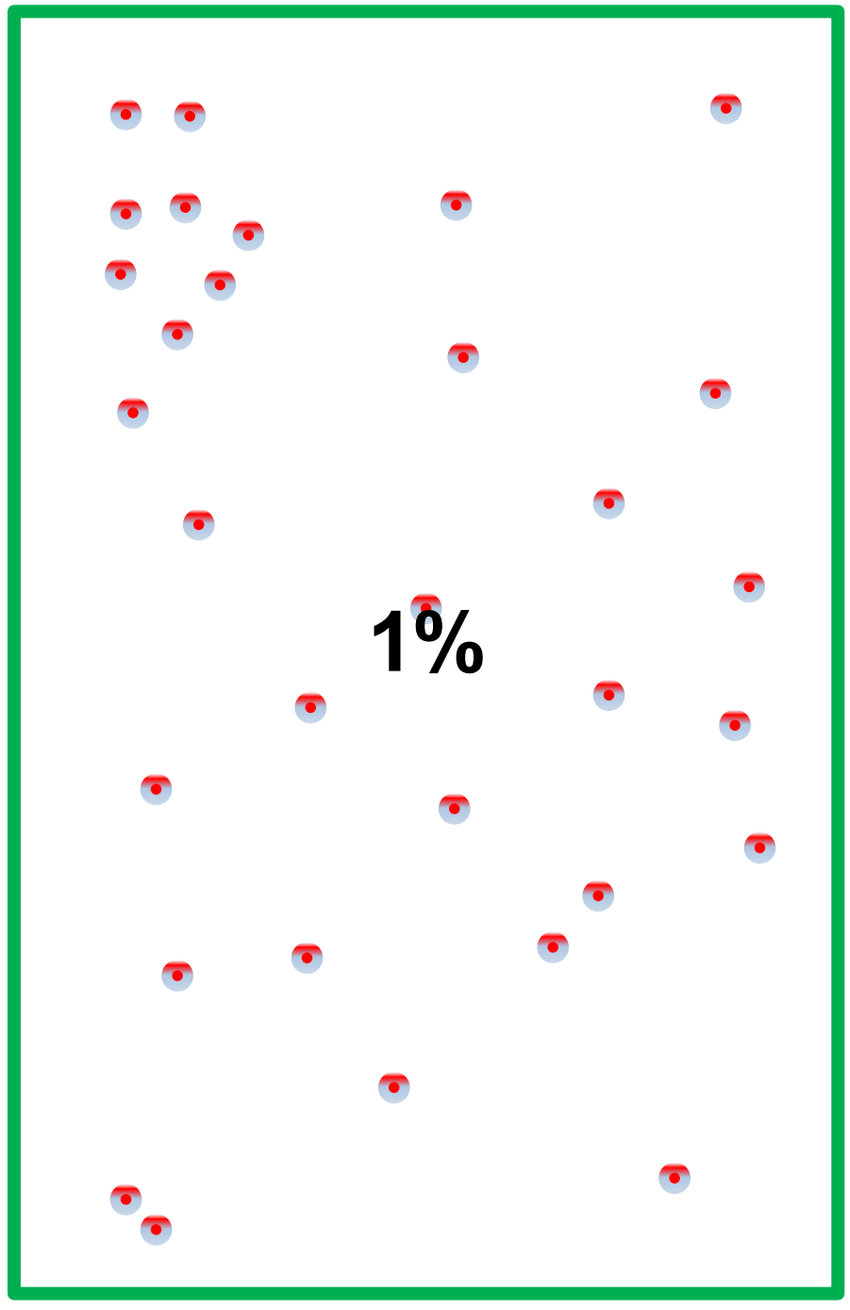


Chemical Plant Protection vs. Digital Plant Protection

Don‘t know where the pest is.
Apply lethal dose for target on entire field.
Chemical needs to be selective to minimize impact on non-target species.



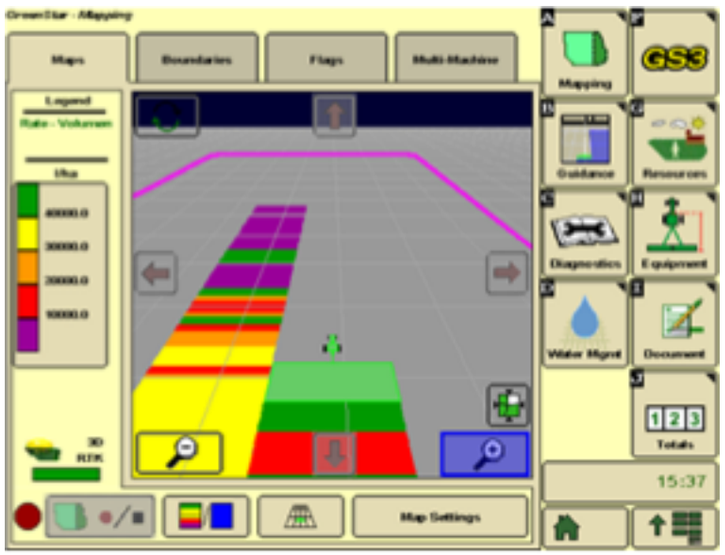
Do know where the pest is.
Apply lethal dose for target only on pest.
Chemical does not need to be selective to minimize impact on non-target species.



Application of chemicals will not only be more precise, it will also be precisely documented.

New tools for regulatory compliance:

Geo-referenced recording of as-applied chemicals.
Site specific pesticide/fungicide application rate control in kg/ha based on actual chemicals used (Regulatory Targets)



Source: John Deere

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Also allows for better impact assessment for risk management.

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