Precision Ag Technology Adoption: Past, Present & Next Steps

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Projected PA Adoption 1998

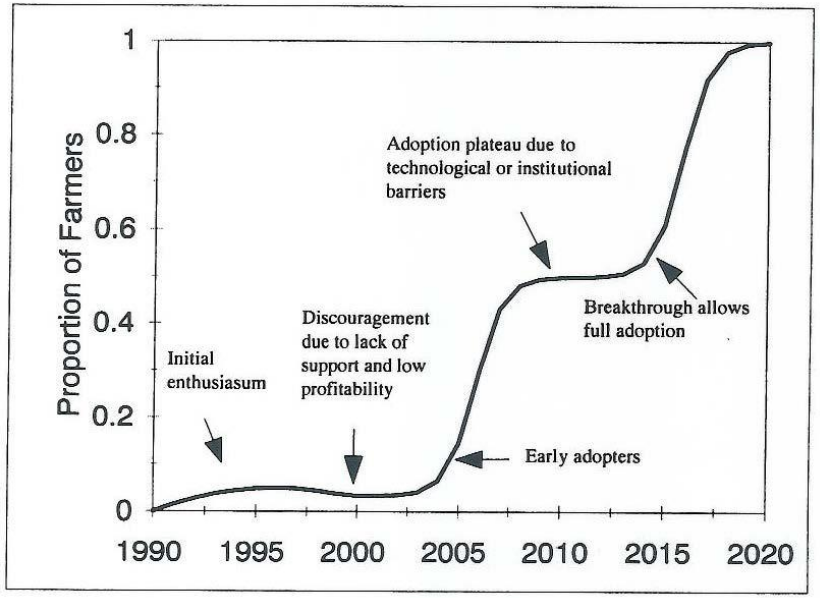

Figure 7. An alternative adoption scenario for integrated precision farming systems using information technology for spatial and temporal management multiple inputs.

Source: Lowenberg-DeBoer, SAE, 1998

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Presented at the 9th European Conference on Precision Agriculture (ECPA), Lleida, Spain, 8 July, 2013

Objectives

- Summarize worldwide precision agriculture (PA) adoption
- Link trends in PA adoption with economics
- Identify PA Lessons Learned in the last 20 years
- Outline next steps for PA worldwide

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"Information-intensive" vs. "Embodied knowledge"

Information-intensive

- Field level data to make decisions
- Requires additional data and skill
- IPM
- Agronomist VRT

Embodied knowledge

- Information purchased in the form of an input
- Requires minimal additional data/skill
- Hybrid seed
- GPS Auto-guidance
- On-the-go sensors

Ideal Embodied Knowledge Technology?

- Users do not need to understand the science for the technology to be effective
- Input decisions made by the computer, without a human being in the decision making loop
- Usable by workers with low educational levels
- Reliable – provide lower input use, higher yields, higher profits almost every use
- Relatively inexpensive compared to benefits – does not require a major investment

Precision Ag Adoption: Sparse Data Warning

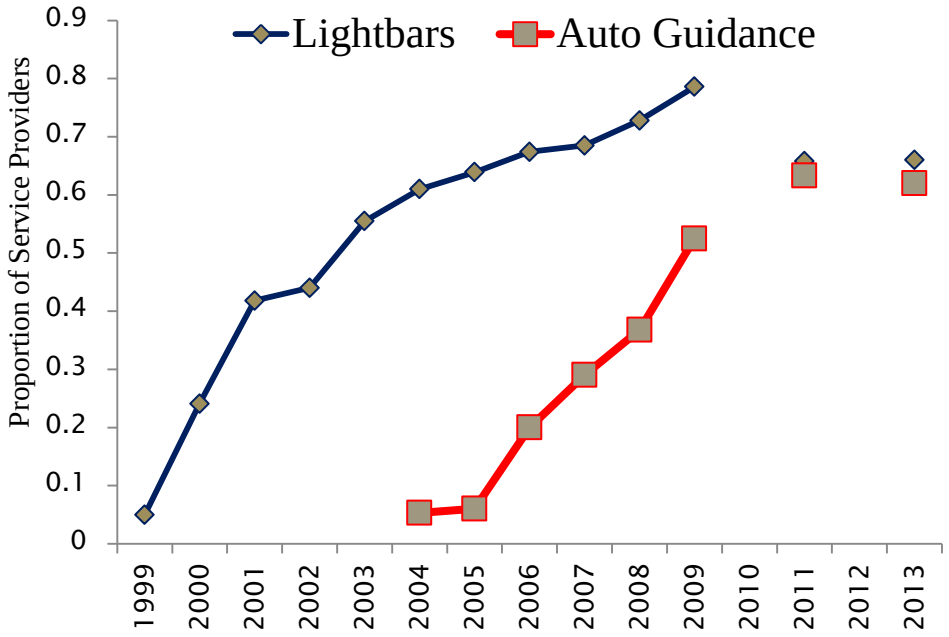
- No country regularly collects data on use of precision ag technology
- Manufacturers and PA dealers usually do not reveal sales data – proprietary information!
- Our knowledge of PA adoption comes from piecing together information from sporadic and geographically dispersed surveys.
- Any tips on new PA adoption data are appreciated.

GPS-enabled Navigation Technologies

adoption by Service Providers

- The 2013 Purdue-CropLife survey shows 82% of US ag input dealers offer custom application with GPS guidance.
- Manual lightbar guidance being replaced by autoguidance
- 86% of all materials custom applied with GPS guidance; 40% with automated guidance

Lightbars and Autoguidance Use by US Ground Based Ag Service Providers



Sources: Whipker and Akridge, 2009: Whipker and Erickson, 2011; Erickson, Widmar & Holland, 2013

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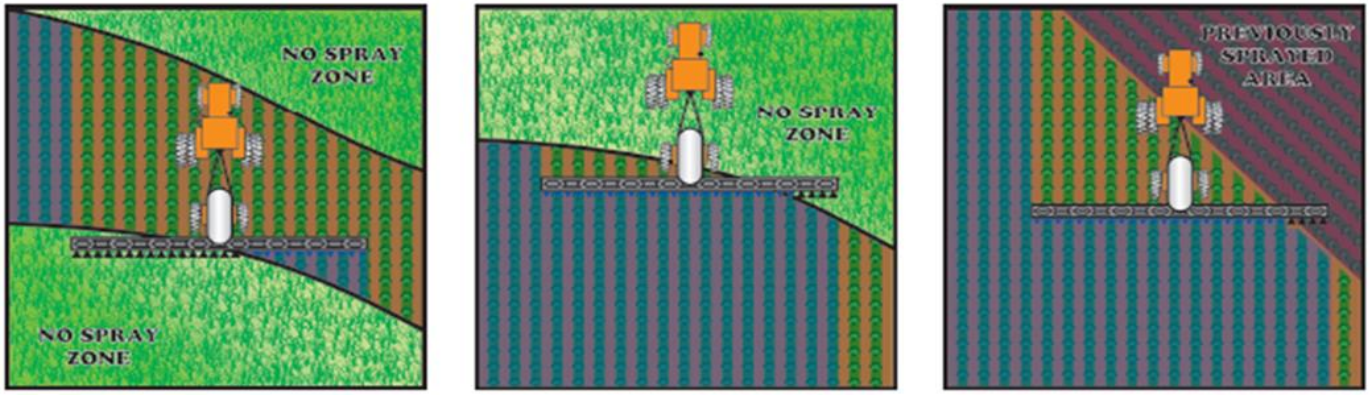
Growth in GPS Guidance Related Tech

- In US both farmers and custom applicators adopting GPS guided sprayer boom control and planter shut offs.
- Purdue-CropLife survey indicates that ag input dealers using sprayer boom controls jumped from 39% in 2011 to 53% in 2013



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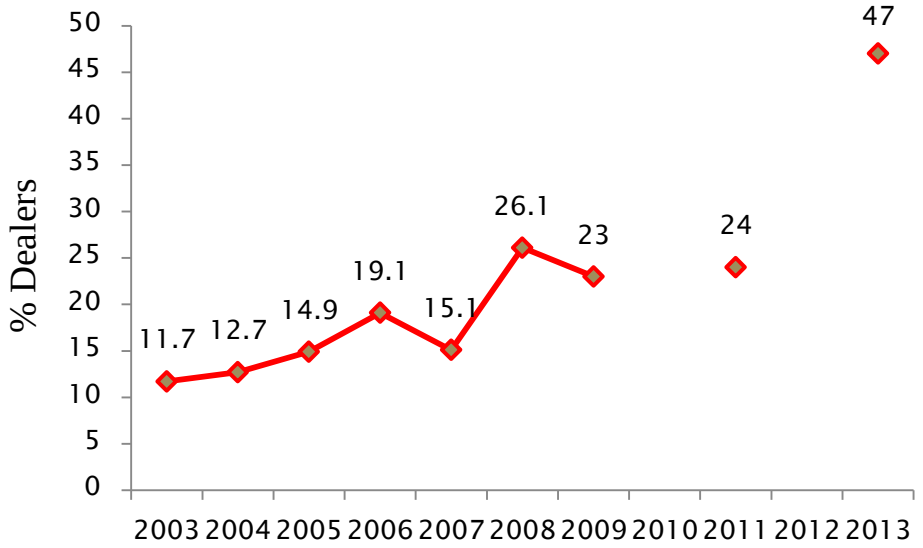
Equipment Mounted N Sensors Generate Industry Interest

- Proof of concept by the Yara N Sensor, N-Tech and Crop Circle have led to a second generation of products including:
  - GreenSeeker by Trimble Navigation
  - OptRx by Ag Leader
  - CropSpec by TopCon
  - Isaria and MiniVeg by Fritzmeier Umwelttechnik
  - Multiplex by Force A
- 7% of US ag input dealers offered crop sensor driven N application in 2013, up from 4% in 2011.
- In the US crop area managed with N sensors still small.

Remote Sensing Excitement

- After years of slow growth US ag input dealers double offering satellite/aerial imagery services
- Crop area managed with imagery still quite modest – 12.9% in 2011
- Tremendous interest in UAVs & drones as military suppliers look for new clients.



Percent of Ag Input Dealers Offering Satellite/Aerial Imagery Services (Source: Purdue-CropLife Survey, 2013)

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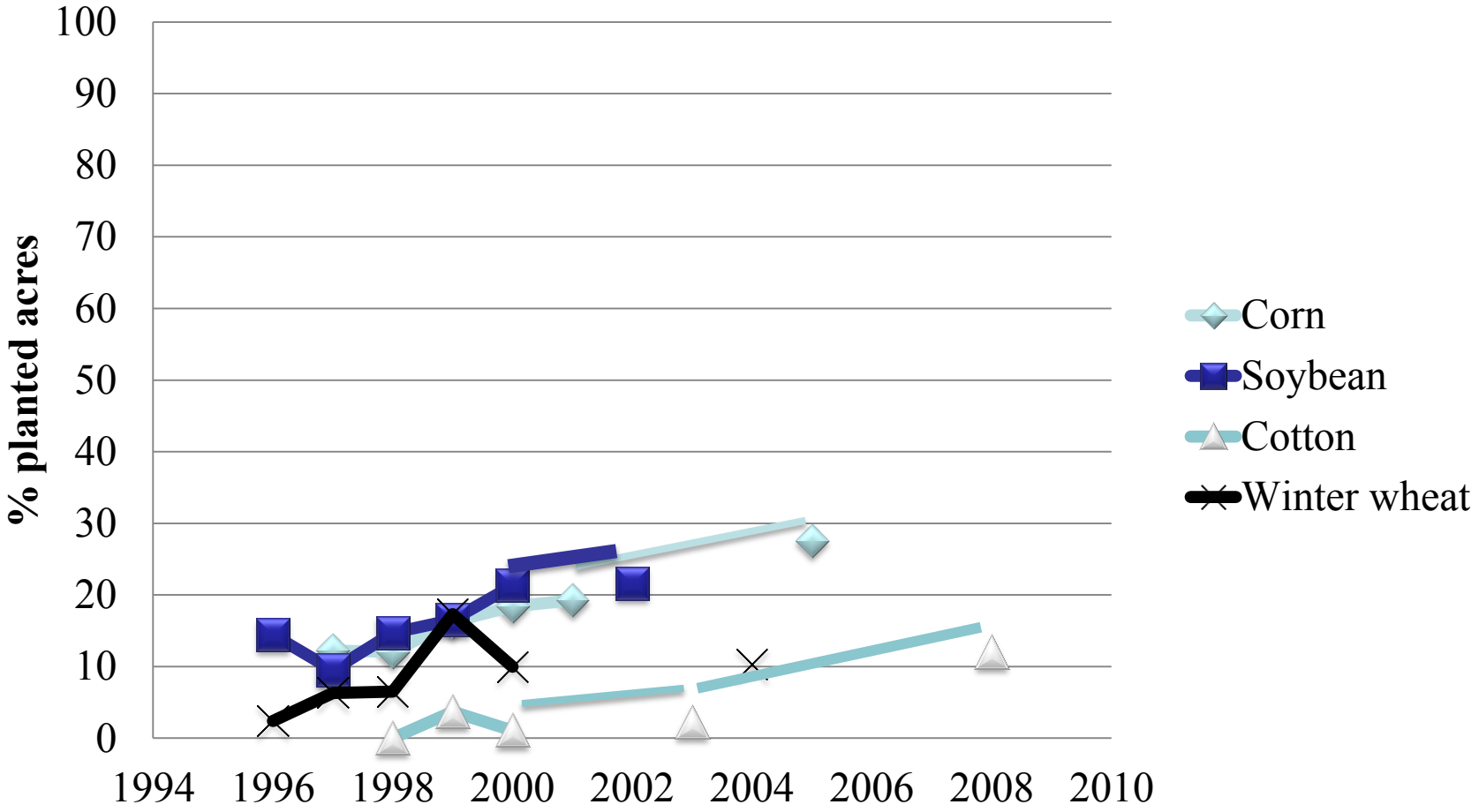
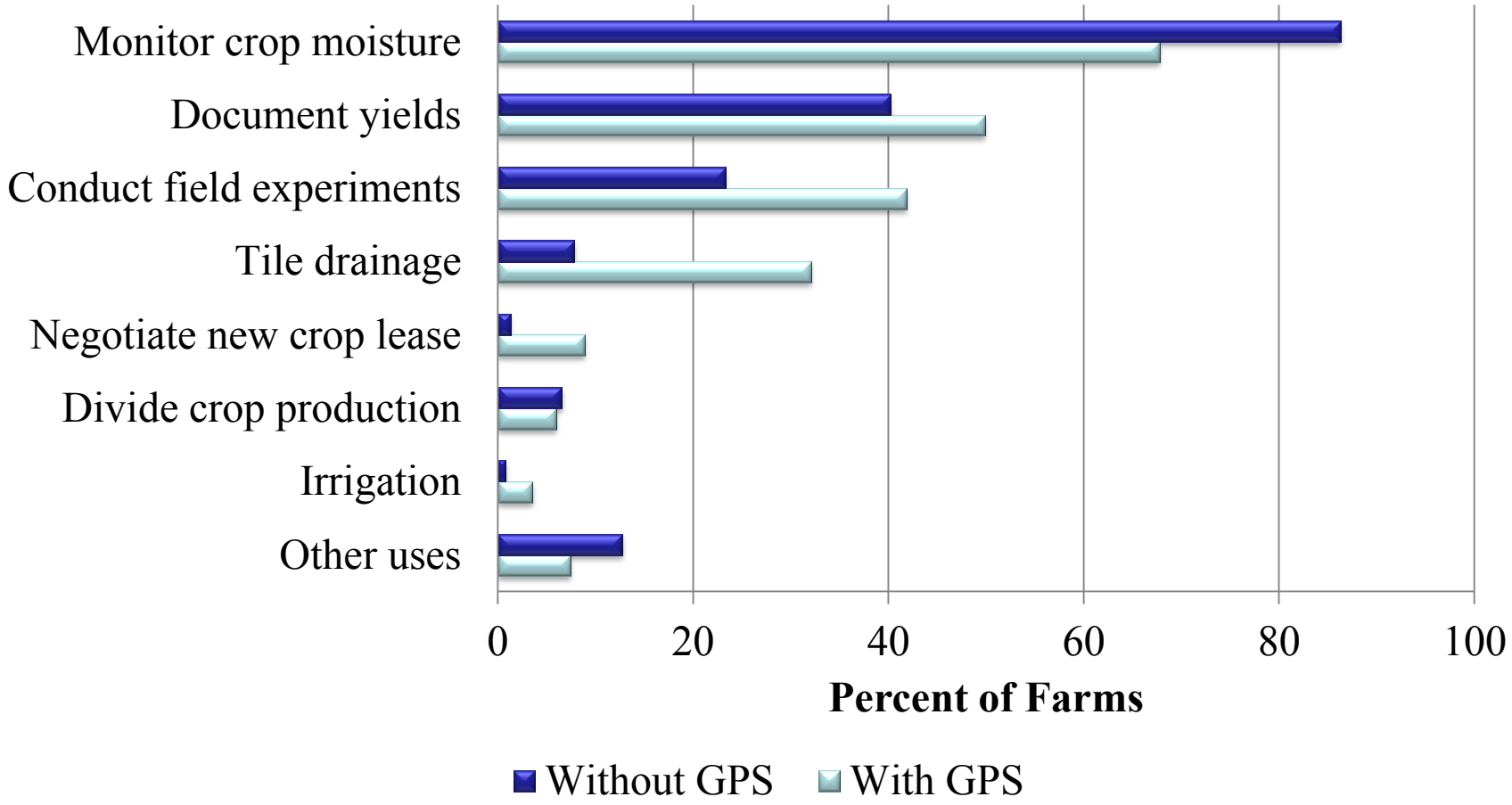
Adoption of Yield Monitors Slow



Source: USDA-ARMS Data, Griffin 2009

Yield Monitor Use For Soybeans



Source: USDA-ARMS Data, Griffin 2009

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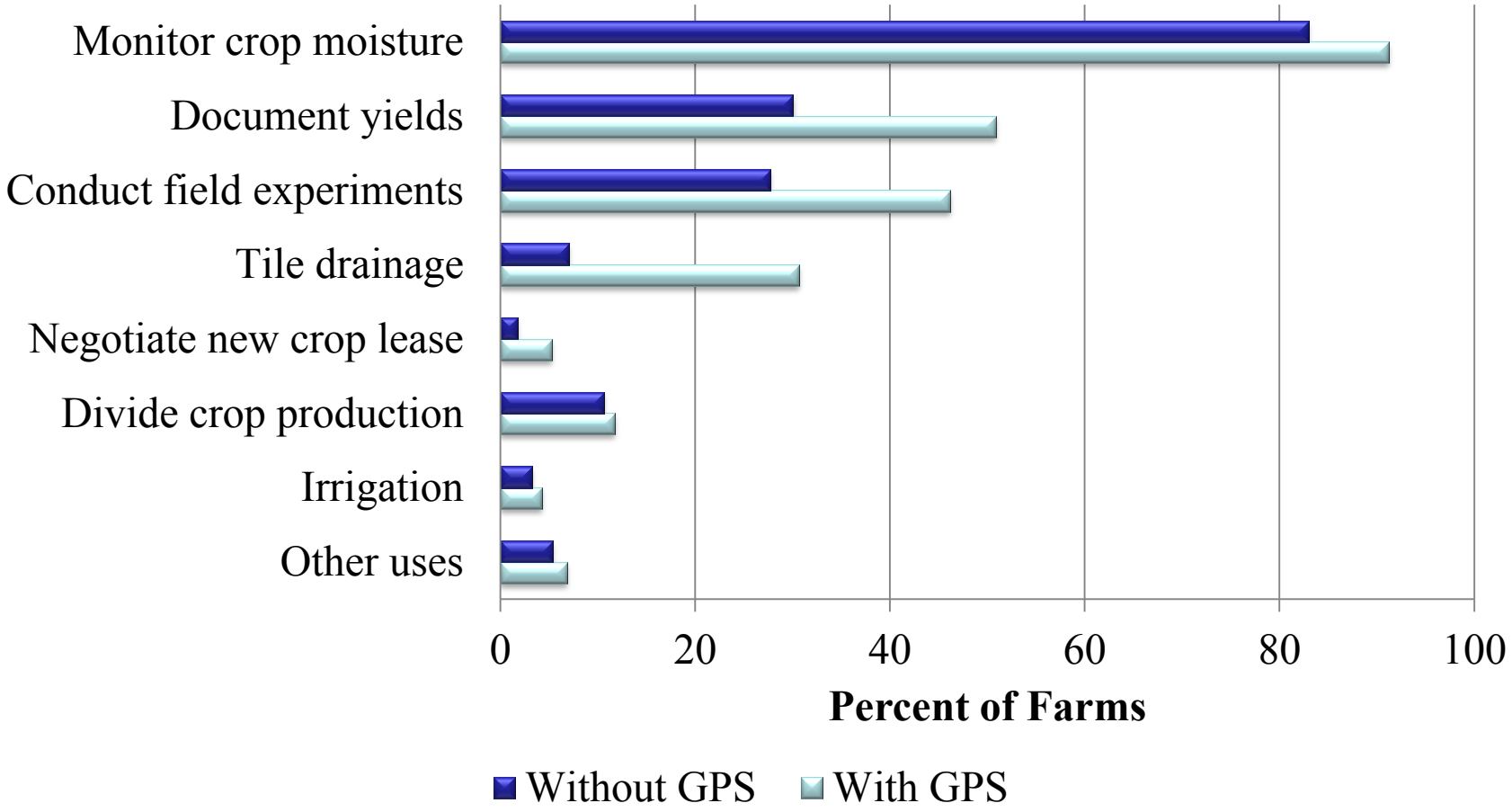
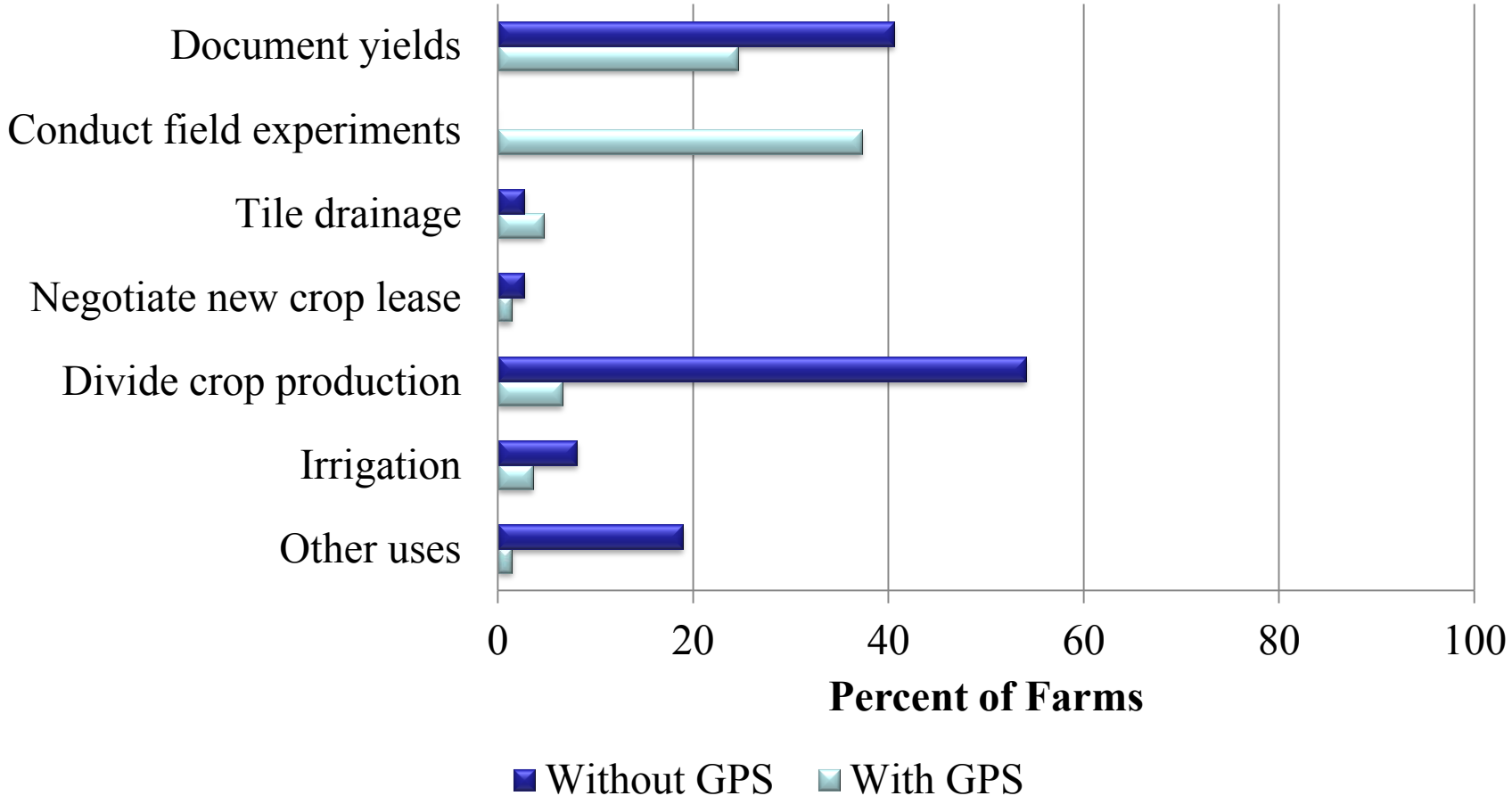
Yield Monitor Use for Corn



Source: USDA-ARMS Data, Griffin 2009

Yield Monitor Use for Cotton in the US



Source: USDA-ARMS Data, Griffin 2009

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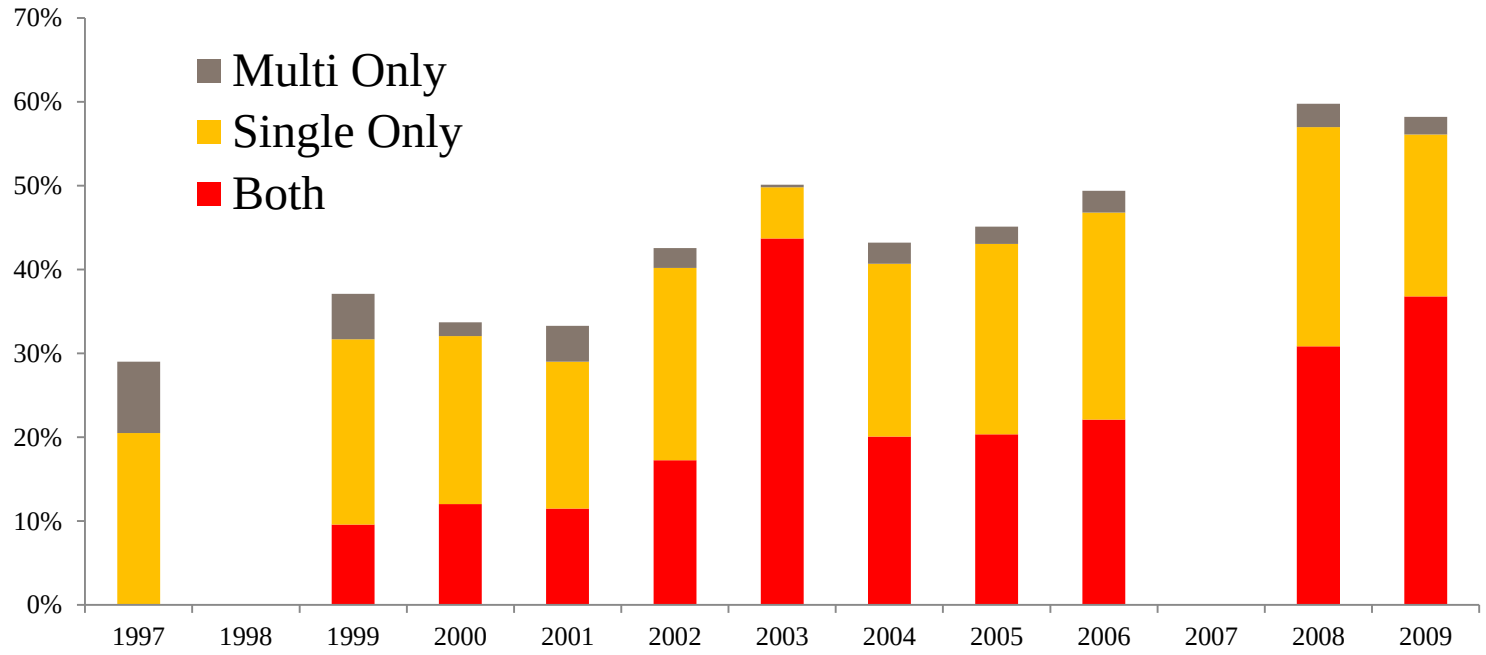
VRT Fertilizer Offered by Service Providers

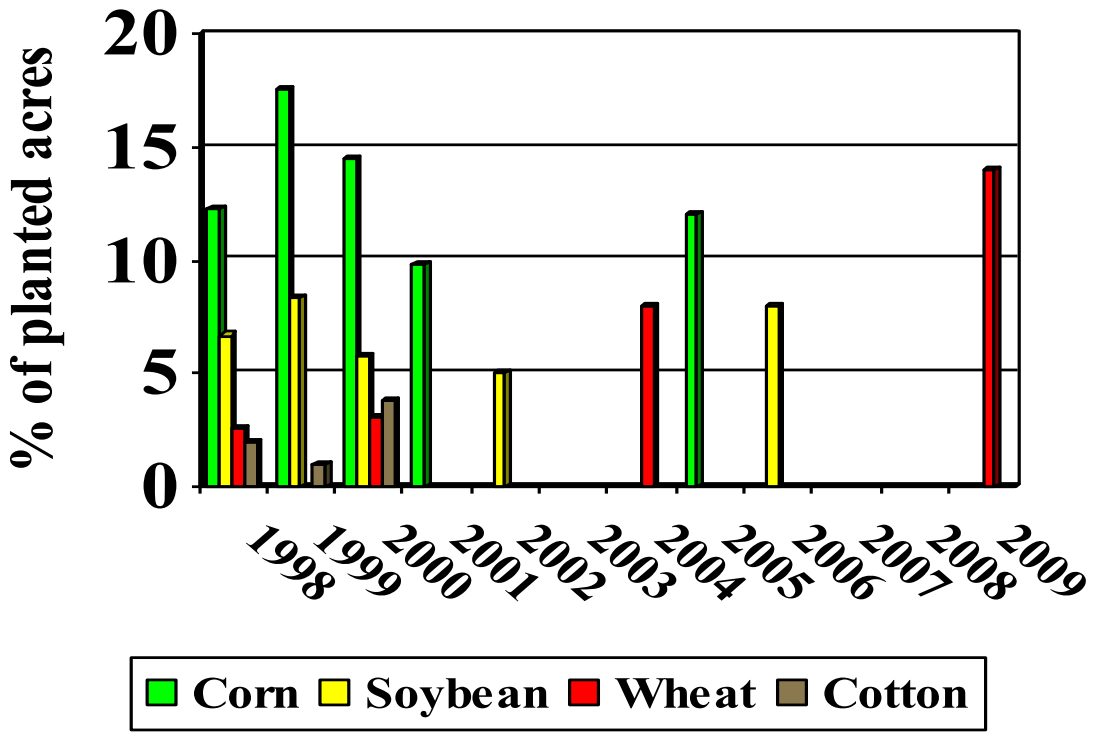


2013 & 2011 data not exactly comparable, but suggests that single nutrient VRT application service about the same and multi-nutrient VRT service increased.

Sources:Whipker and Akridge, 2009; Erickson, Widmar & Holland, 2013

Use of VRT Fertilizer Has Not Kept Pace with Service Available

- Around the world, modest area of commodity crops managed with VRT fertilizer



Source: USDA ARMS

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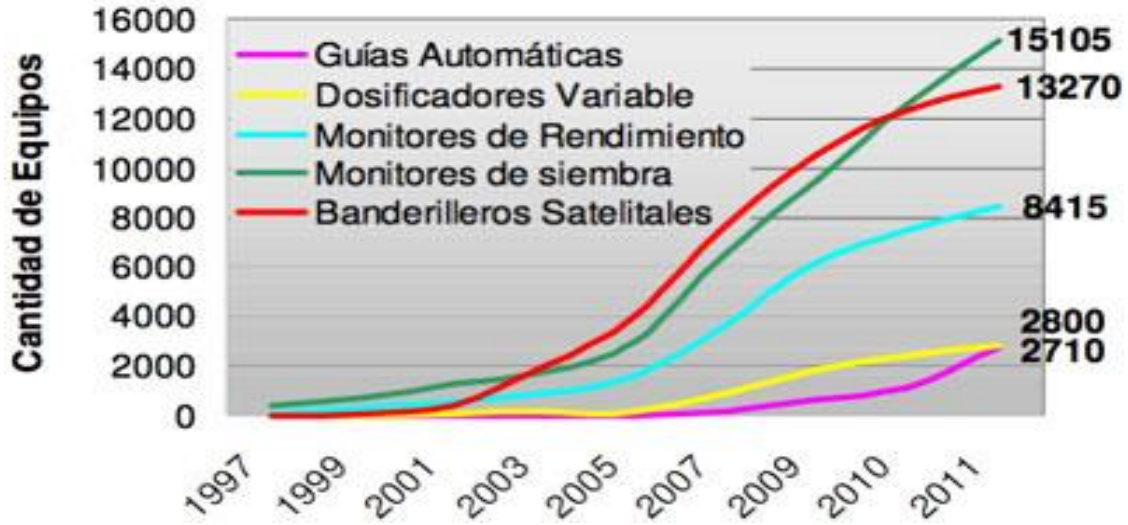
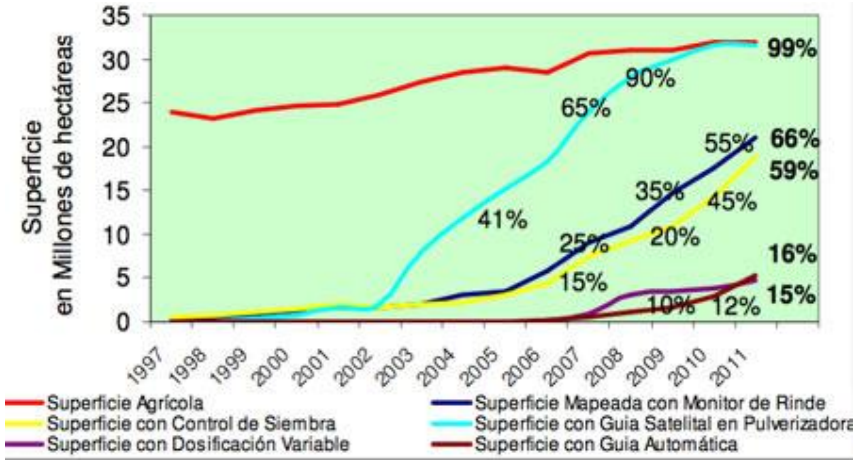
Precision Ag in Australia

- Strong interest in PA for sugar driven by:
  - Economics
  - Environmental concerns
- Public sector research in PA for viticulture
- Australia led in use of GPS guidance in part motivated by soil compaction and profitability of controlled traffic.

PA Trends in Argentina

- Rapid growth in GPS guidance
- Many yield monitors, but not clear how data is used.
- Variable rate fertilizer less than 20% of crop area





Sources: Mario Bragachini, INTA, Manfredi, Argentina

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Precision Agriculture in Brazil

- Strong interest in Precision Ag for sugar – both guidance and VRT
- Growth in use of GPS guidance
- Interest in VRT fertilizer, but often very coarse resolution (e.g. 5 ha grids).
- Adoption slowed by:
  - High cost of technology – in part due to taxes
  - "No Frills" preference because of high capital costs and composition of the labor force

Precision Ag in Western Europe

- Focus of adoption research has been on classic PA , but adoption modest.
- Use of on-the-go sensing for fertilizer application probably highest in the world because:
  - Relatively higher N prices
  - Higher grain prices
  - Environmental regulation limits N use in some countries
  - Government support for N sensor use
- Interest in GPS guidance growing especially in areas with relatively large farm size such as eastern Germany

Precision Agriculture in Africa

- Use of classic PA technology on farms in South Africa and on some large scale estates elsewhere.
- Traditional African agriculture is very site-specific, but little use of PA technology
- Rethinking PA for African smallholder farmers to identify uses that solve African problems:
  - Counter top soil testing machines for fertilizer shops
  - Using cell phones to communicate remote sensing and other sensor based pest management information
- May need a different label to communicate with development donors – smart farming? Sustainable intensification?

PA Economics Reminder

- Profitability of Precision Agriculture is Site-Specific
- Strong relationship between estimated profits and adoption
- Classic PA technologies (e.g. VRT) only strongly profitable in higher value crops
- In bulk commodity crops embodied knowledge PA (e.g. GPS guidance) are the only technologies widely adopted

Economic Drivers of Site-Specific Crop Management

- A crop response to one or more inputs with a relatively narrow optimal range
- A factor that can be measured reliably that relates to crop response to an input
- Accurate and precise measurement of field variability
- Accurate and precise application of crop inputs
- Input(s) and output valuable enough to justify the cost of data collection, decision making and variable rate application

PA Lessons Learned

- Most widely adopted ag technology of the 20th century is embodied knowledge tech.
- The most widely adopted PA technologies are embodied knowledge tech (e.g. GPS guidance)
- Quickly adopted PA technologies are those that are easy to use and show short term & visible benefits.
- Widely adopted technologies usually initially respond to some specific local need:
  - Argentina – yield monitors provide professional farm managers with new information
  - Australia – GPS guidance facilitates controlled traffic
  - Western Europe – N Sensors help farmers deal with N regulation.

PA Next Steps Hypotheses

- In most of the world VRT will achieve widespread adoption only when it becomes an embodied knowledge technology – probably as equipment mounted on-the-go sensing
- Ag robotics will entail a dramatic rethinking of mechanization – When human being less incentive for ever larger farmer farm equipment.
- Nanotechnology provides small, cheap sensors
- The future of satellite remote sensing in PA is as a foundation on which sensor and scouting data is used to make decisions.

Take Home Messages

- Embodied knowledge PA (e.g. GPS guidance) is successful for bulk commodity crops
- Information intensive PA (e.g. VRT) most successful in higher value crops.
- Widely adopted PA technology usually:
  - Responds to some local need
  - Is easy to use
  - Shows quick and highly visible benefits
- Adapting PA technology to new areas (e.g. Africa) depends on identifying problems that PA can solve.

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Thank You

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