Managing Risk and Reward for Transgenic Forages on the Landscape

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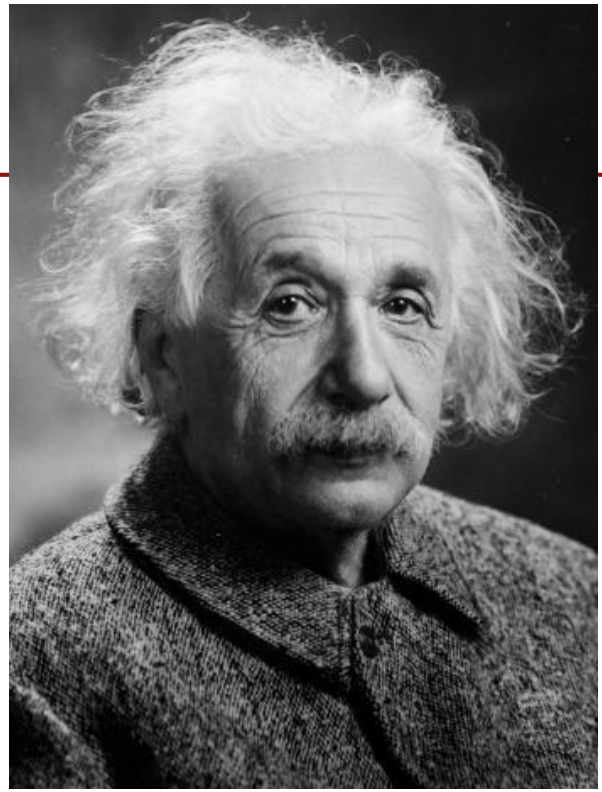


Albert Einstein

“You can’t solve tomorrow’s problems with yesterday’s technology”

Dr. Norman Borlaug, Plant Breeder

- Father of the Green Revolution
- Winner of the Nobel Peace Prize

"Genetic modification of crops is not some kind of witchcraft; rather, it is the progressive harnessing of the forces of nature to the benefit of feeding the human race."

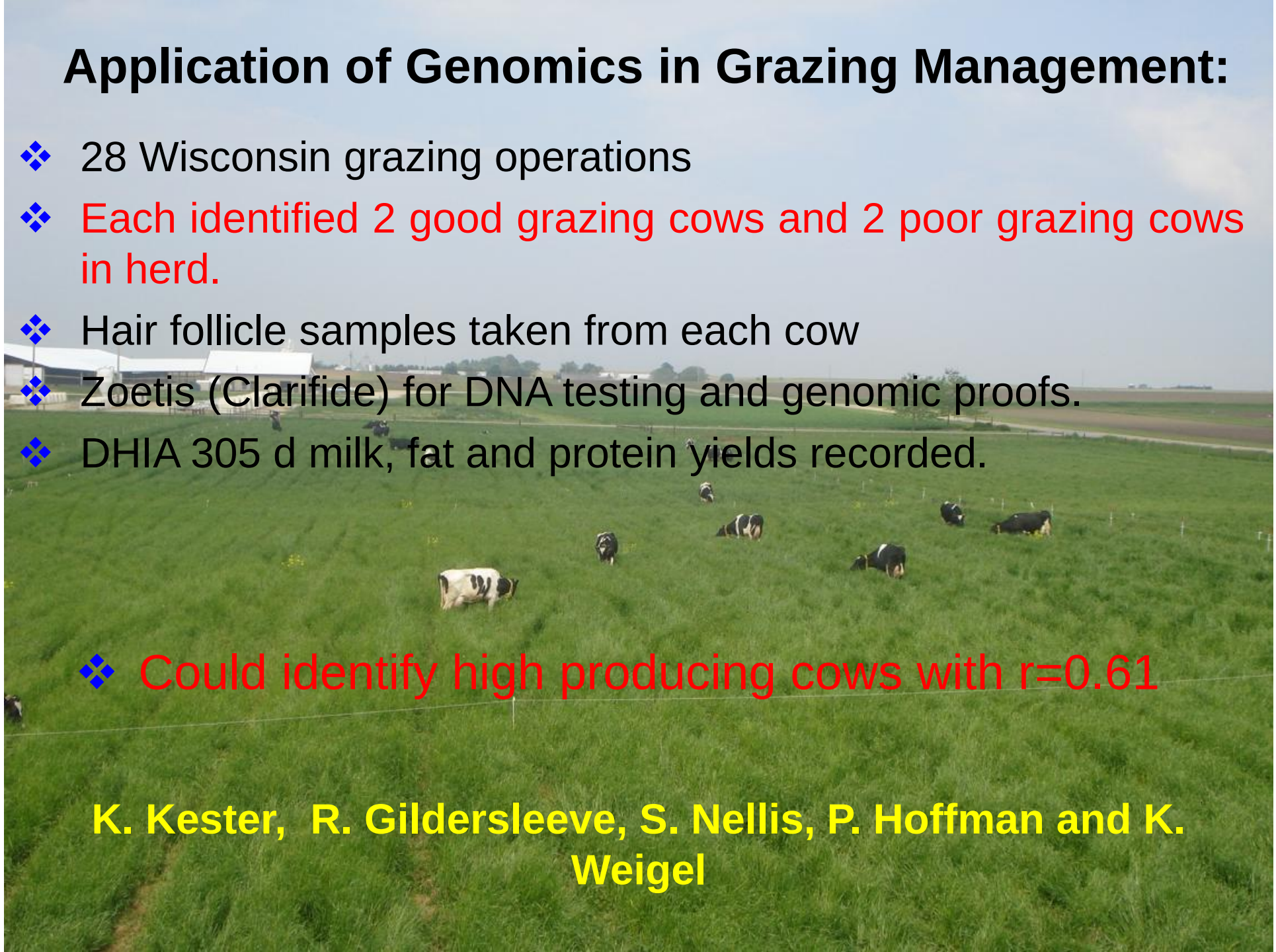
- Genetic modification of plants and animals has occurred throughout history
  - e.g. teosinte to corn, ryegrass types, breeds of cattle, horses, dogs, cats

Genetic modification of plants and animals

- New breeding techniques being developed
  - Genomics - know gene location/proximity to other genes
    - Use of marker genes in breeding
    - Genomic selection (Profiling)

Application of Genomics in Grazing Management:

- 28 Wisconsin grazing operations
- Each identified 2 good grazing cows and 2 poor grazing cows in herd.
- Hair follicle samples taken from each cow
- Zoetis (Clarifide) for DNA testing and genomic proofs.
- DHIA 305 d milk, fat and protein yields recorded.



- Could identify high producing cows with r=0.61

K. Kester, R. Gildersleeve, S. Nellis, P. Hoffman and K. Weigel

Genetic modification of plants and animals

- New breeding techniques being developed
  - Genomics - know gene location/proximity to other genes
    - Use of marker genes in breeding
    - Genomic selection (Profiling)
  - Modification and addition of new genetic material

Genetic modification of plants

- Potential for new traits
- Cost of new traits
- Management of new traits - Stewardship

Potential of new GM traits

- Improved herbicide resistance
- Improved insect/disease resistance
  - *Defensins* - small host defense peptides.
- Improved agronomic traits
  - Leaf retention

Potential of new GM traits

- Improved herbicide resistance
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  - *Defensins* - small host defense peptides.
- Improved agronomic traits
  - Leaf retention
  - Drought/salt tolerance
- Improved forage quality
  - Reduced lignin
  - Increased bypass protein
  - Phytase – improved phosphorus availability to animal
- Nitrogen fixation by corn?

Cost of genetically modified cultivars

- Cost of Roundup Ready Alfalfa clearance - $100 million
- Cost of reduced lignin clearance - $20 million
- The “Valley of Death”
- CRISPR – modification of RNA, not DNA

Need to properly define breeding techniques

- Align treatment of a methodology in health and environmental safety regulations with risk.
- For example:
  - Mutagenesis is generally ignored in political discussions.
  - Transgenesis produces far fewer changes and unintended consequences.
    - Genetic distance for trait source
    - Gene regulation (turning gene on/off)

Stewardship

Thoroughly research plant impact on environment

- Failures with conventional plants
  - Dandelions brought in as ornamental
  - Kudzu
  - Verticillium in alfalfa
  - Dutch elm disease (elm bark beetles)
  - Emerald ash borer
  - Anthracnose fruit rot

Biosecurity is Crucial

- Largest current losses due to movement of diseases, insects, and animals in conventional systems
  - Mediterranean fruit fly
  - Mad cow disease
  - Zebra and quagga mussels – cost to hydroelectric plants
  - Burmese pythons – killing native storks, etc. in Florida
  - Feral hogs

Stewardship

- Thoroughly research plant impact on environment
  - Failures with conventional plants
  - Biologic management
    - Consider pollen distribution

Pollen mediated gene flow in alfalfa hay and haylage production

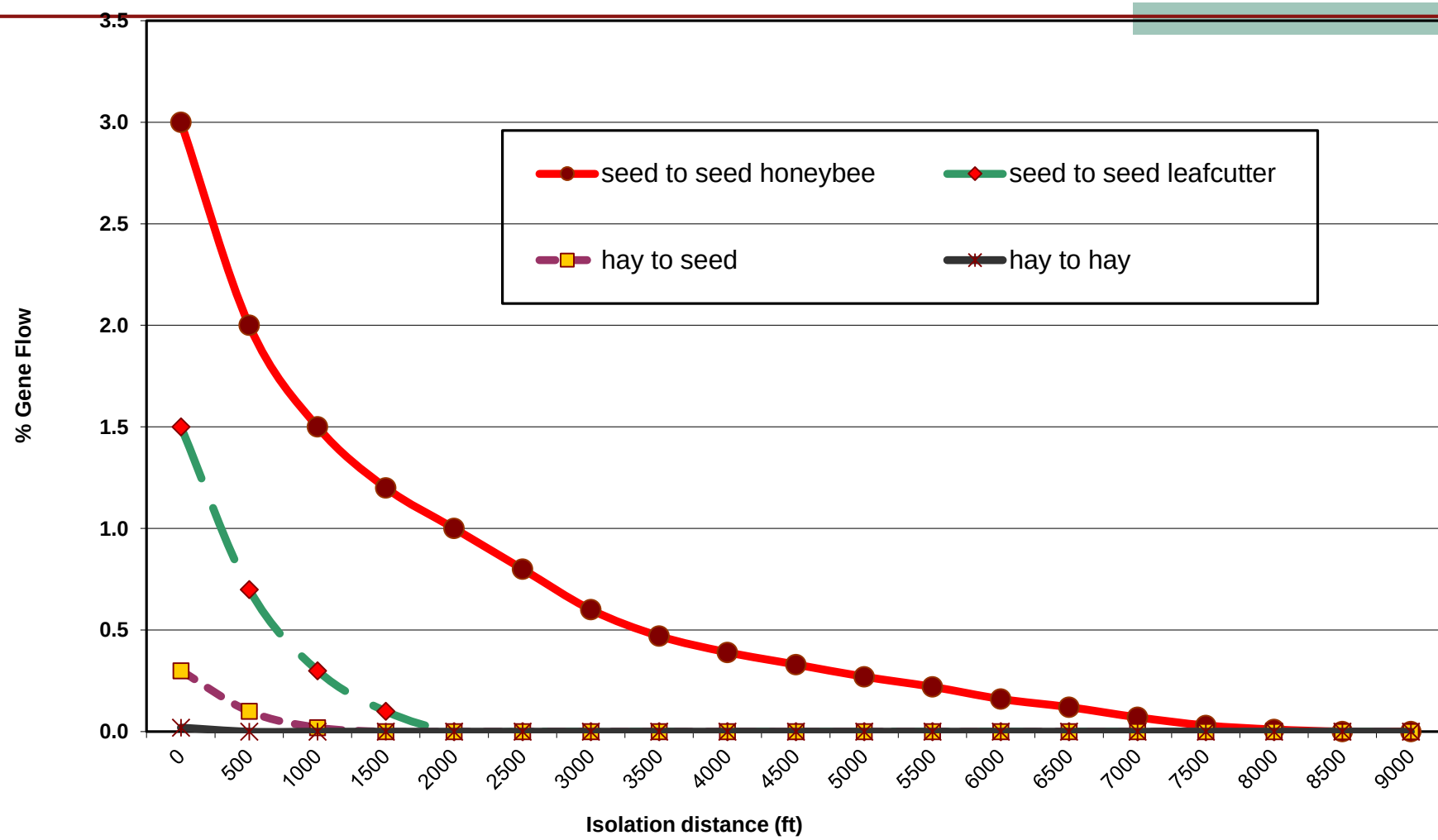
Pollen flow does not change genetics of the parent plant

For example,
If a Holstein cow is bred by an Angus Bull

The offspring is a cross –
but the Holstein mother has not changed genetically

With alfalfa we are harvesting the mother plant
- not the offspring as in grain crops.

Distance alfalfa pollen can move



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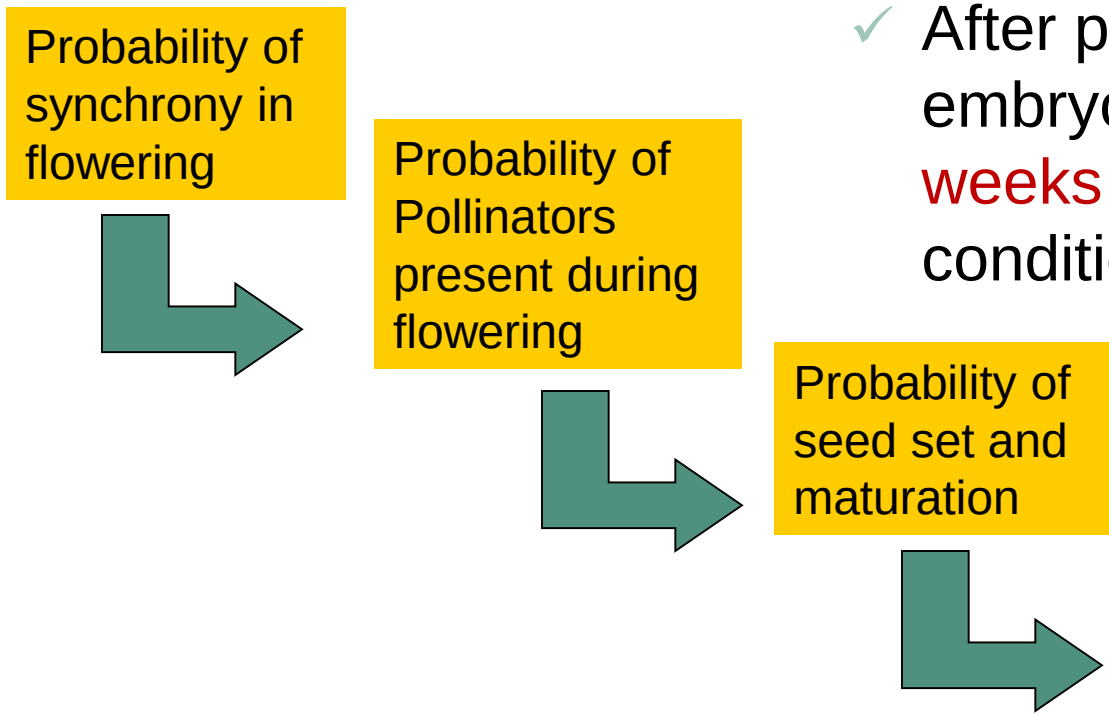

- After pollination, alfalfa seed embryos require 4 to 6 *additional* weeks of adequate growing conditions to ripen.

Putnam, 2005

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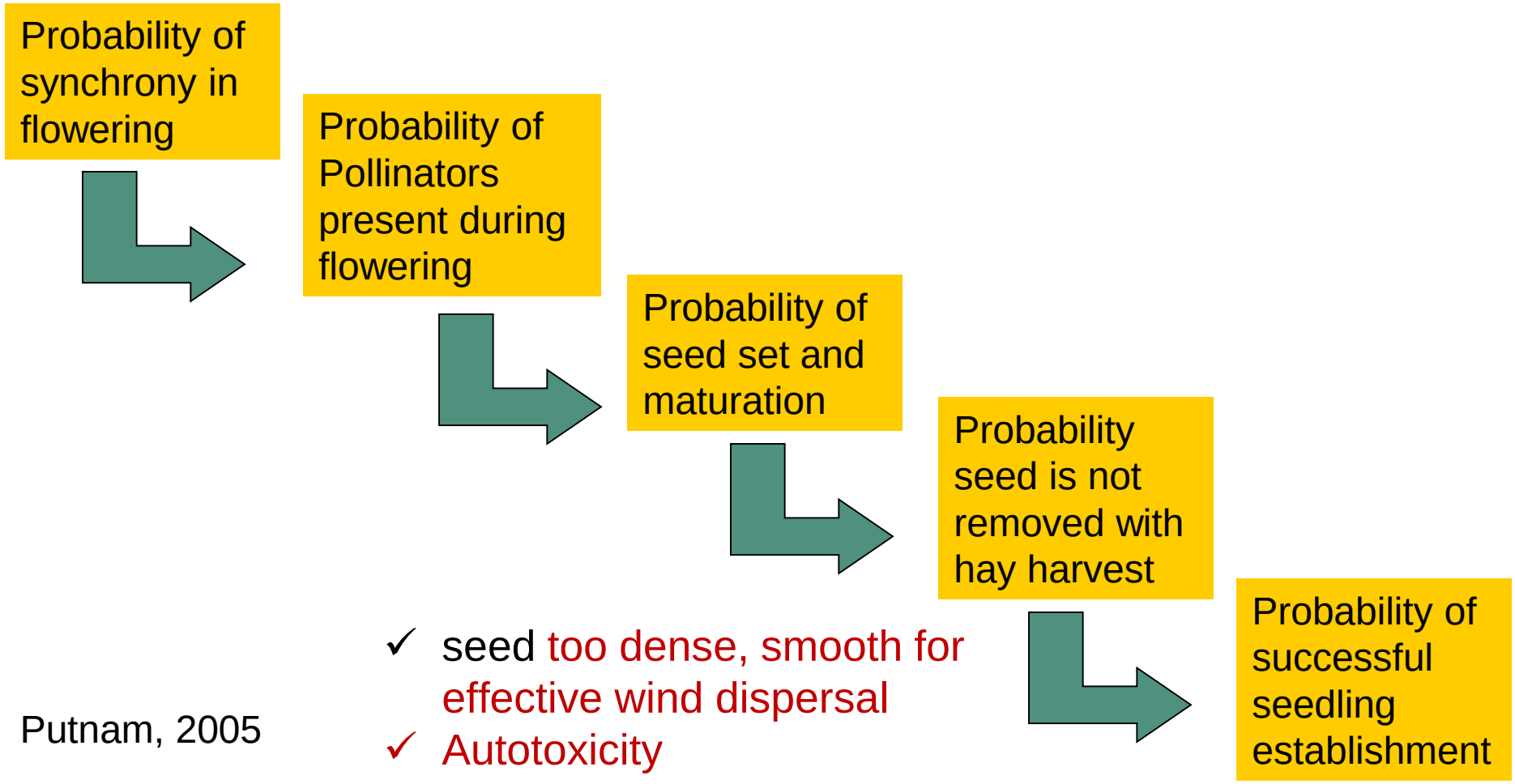

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    - Use multiple pesticides on pesticide resistant plants
      - Roundup resistant plants

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    - Use multiple pesticides on pesticide resistant plants
      - Roundup resistant plants
    - Maintain genetic diversity
      - Plant genetically different cultivars
        - Tropical Race 4 on Cavendish Banana
      - Plant susceptible acreage

US Biotech Alfalfa Stewardship Program

- Biotech trait contained while approvals are pending in key export markets for hay and seed
- All biotech alfalfa seed is produced in twelve US grower designated production zones or in remote areas with extraordinary isolation
- Grower zones have been set up for production of conventional alfalfa only
- HarvXtra is being sold in Western U.S only under specific stewardship conditions, including the requirement to be only fed on-farm until export approvals are obtained (no sale into retail hay markets)

Canada Biotech Alfalfa Stewardship Program

- Group coordinated by Canadian Seed Trade Association has developed a co-existance plan for conventional and biotech hay in Eastern Canada
- Hay-to-Hay Best management practices have been identified around crop rotation, harvest management, volunteer management and other key points
- A key point for containment is that major Canadian production companies **require genetic testing of stock seed for the GE traits prior** to planting seed production in Canada
- No biotech seed production is currently being done or is being planned for Western Canada

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The Future

We always

overestimate the change that will occur in the **next two years**

and

underestimate the change that will occur in the **next ten.**

Bill Gates