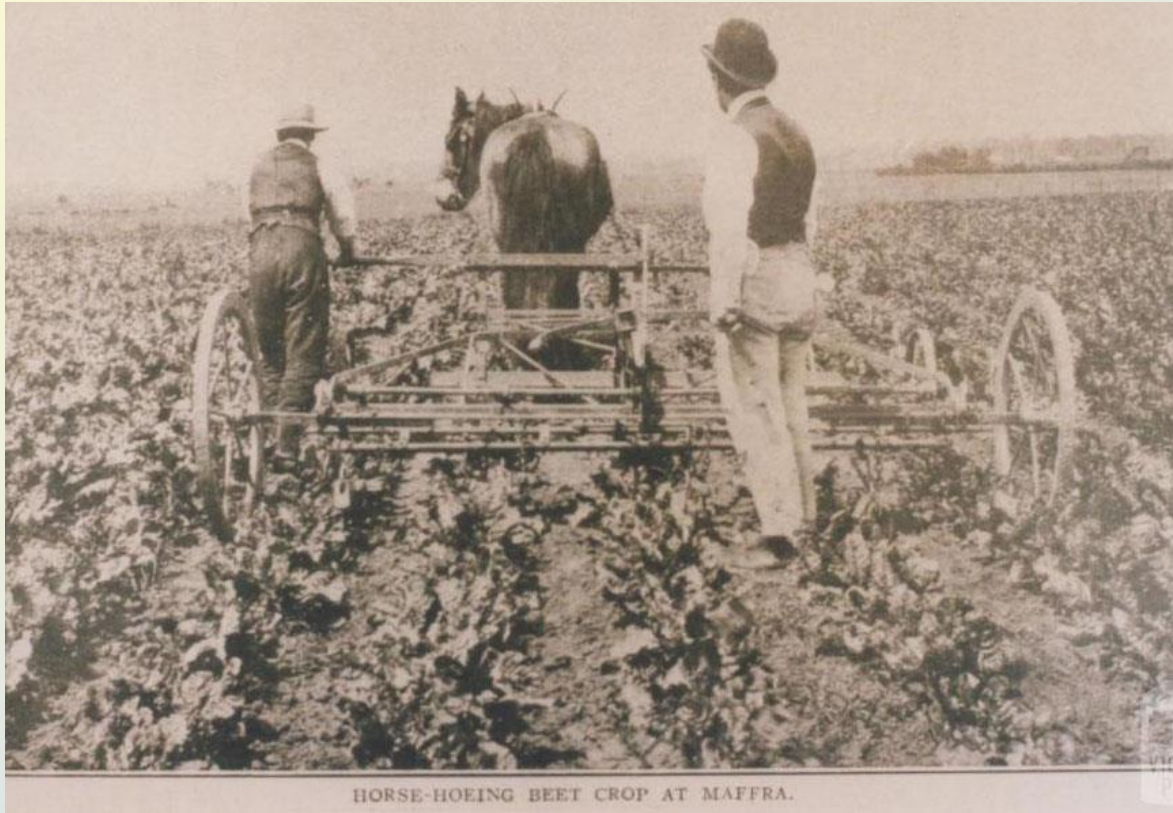
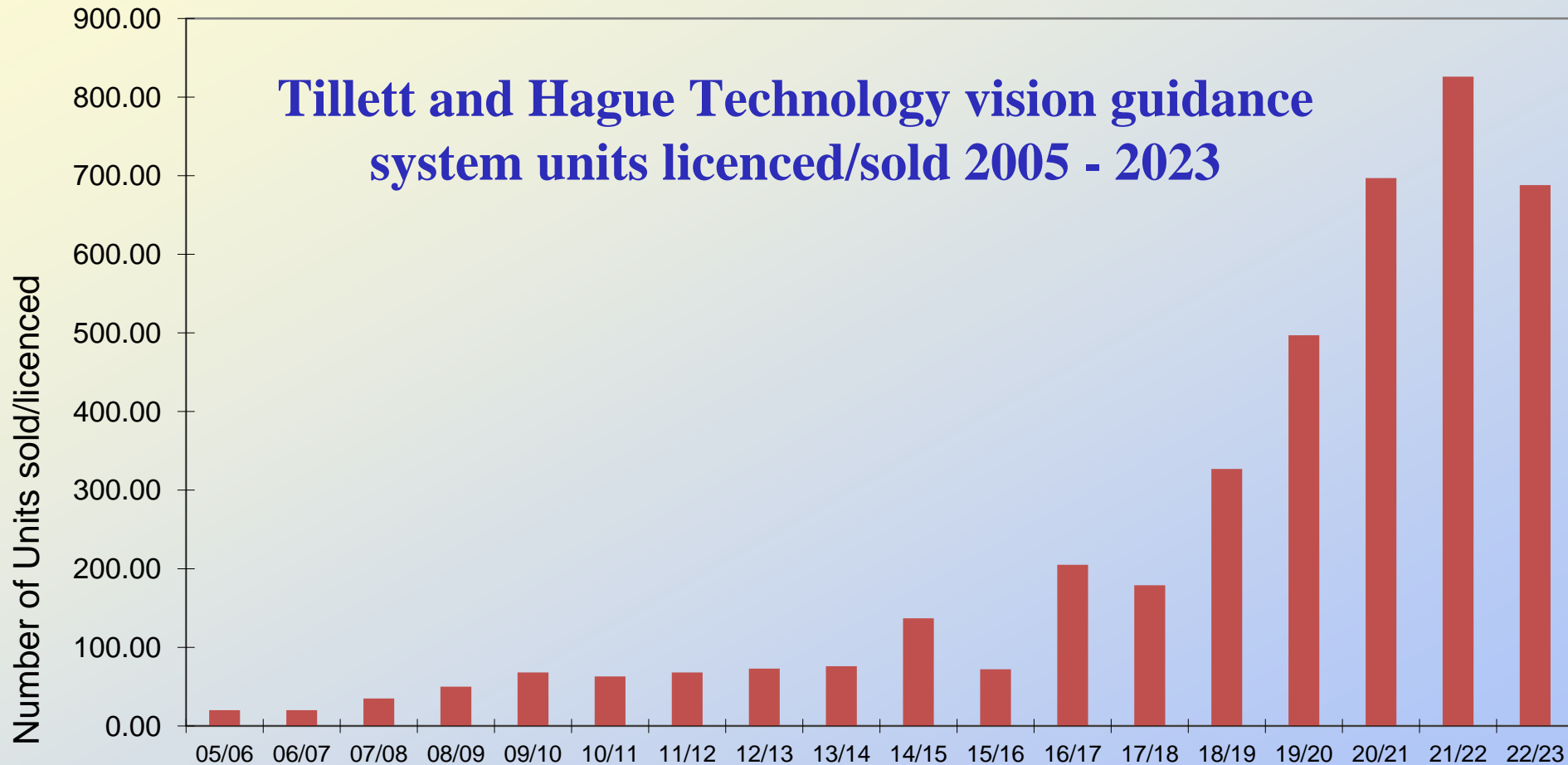


Mechanical weed control advances over time and future options – Nick Tillet



Upward trend in guided hoe sales



- Companies newly into the guided hoe market include: Pottinger, Kverneland, Väderstad and Lemkin.

Mechanical weeding strategies

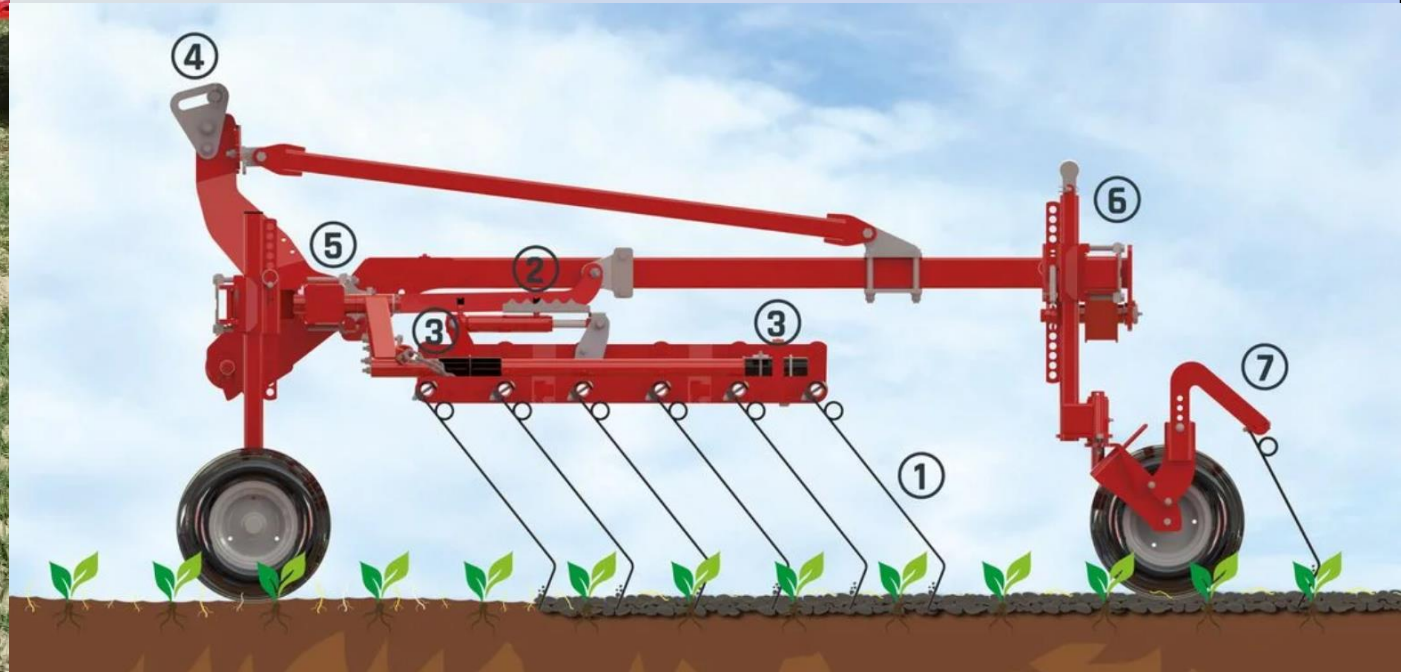
- Gentle disturbance of whole area relying on crop robustness for selectivity

- Aggressive cultivation of uncropped area only



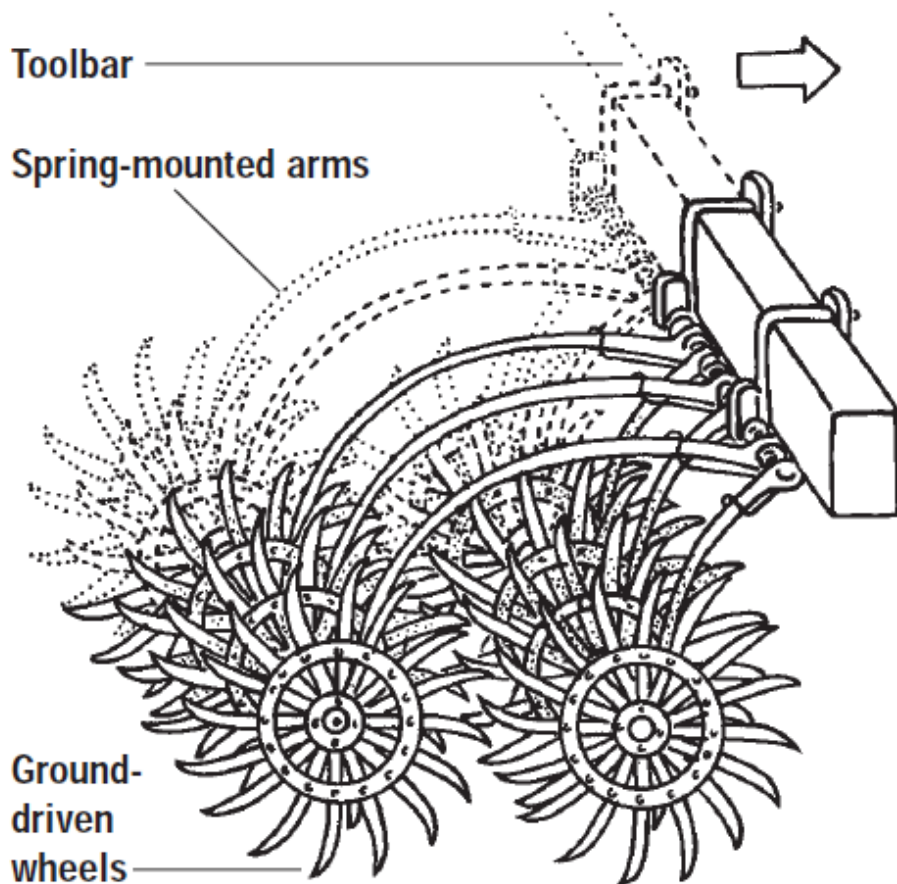
Uniform overall tined harrowing

- Mode of action is desiccation requiring dry conditions
- Need to follow ground contour for uniform depth control
- Tine angle adjustment of aggressiveness



Uniform rotary harrowing

- Mode of action is desiccation requiring dry conditions
- Need to follow ground contour for uniform depth control
- Better tolerance to trash than spring tines (I am told)



Skill and concentration needed keep hoe blades aligned



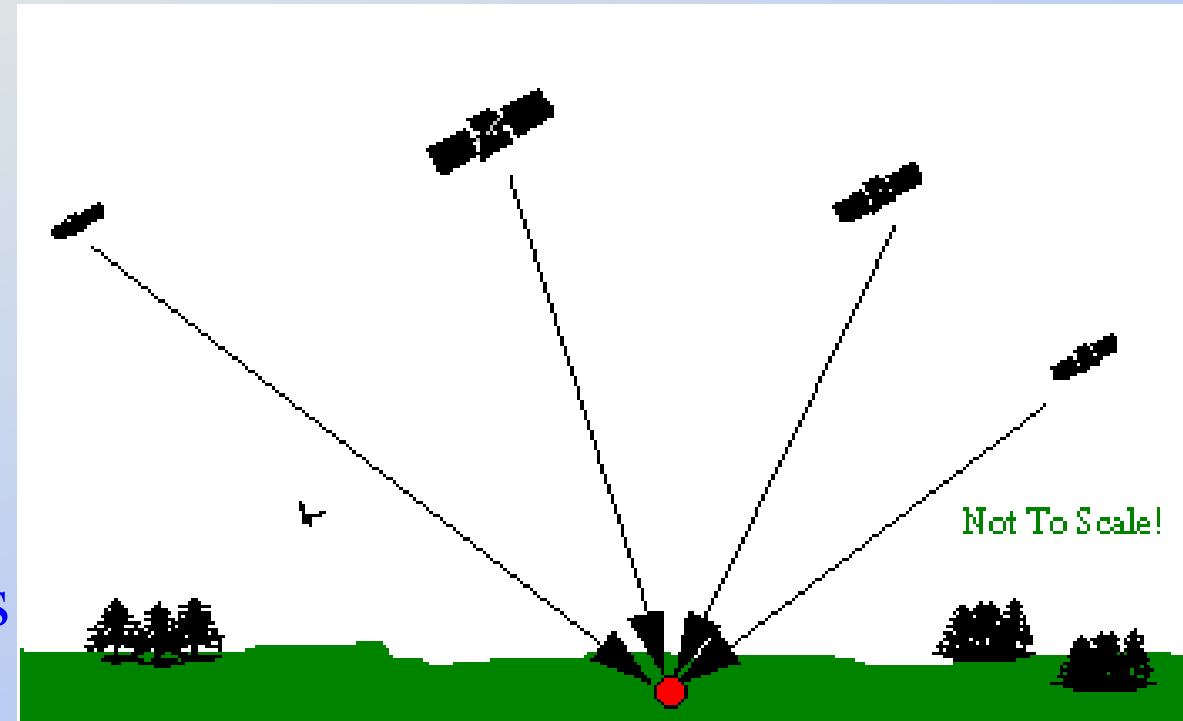
Mechanical feeler row guidance

- Buffalo system 1970's onwards - right
- Modern John Deere feelers - below



RTK GPS guidance

- Satellite constellations and atmospheric conditions are changing all the time
- Pass to pass repeatability over short periods better than absolute accuracy
- RTK bit substantially reduces variability but not eliminated
- Planting time and hoeing time absolute positional errors are additive so error doubles
- Total error normally insufficient for inter-row hoeing
- GPS tractor guidance at drill time keeps rows straighter and more parallel than manual driving



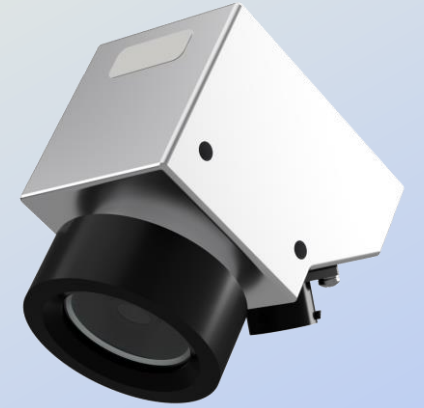
Optical sensors

- Traditional optical sensors only provide a spot measurement
- Prone to erroneous readings in a highly variable scene
- Computer vision gave data from a large area from which pattern could be extracted



Making computer vision based row guidance work

- Understand, optical filters, sensor sensitivity and camera controls to maximise information content.
- Pre-processing image to minimise variable lighting effects.
- Use digital filtering to extract the underlying planting pattern
- Track rows through a series of images back to cultivators out of camera's field of view.
- and finally implement a control system to place the cultivators relative to the crop plants.



Farming is a business

- Tools must be cost effective
- Luckily our proof of technical feasibility coincided with new affordable digital camera and computing hardware
- First system licenced in 2001
- Follow on research project to increase workrate
- SRI closed 2005 and we continued as a private company



Inter-row soil engaging tools

- Huge variety
- Modes of action: desiccation, burial and root cutting
- Wide range of soil types
- Side guides for aggressive cultivation without crop burial
- Soft spoked finger wheels for in-row



In-row cultivation – reciprocating blades



In-row cultivation – rotary blades



Tillett and Hague Technology

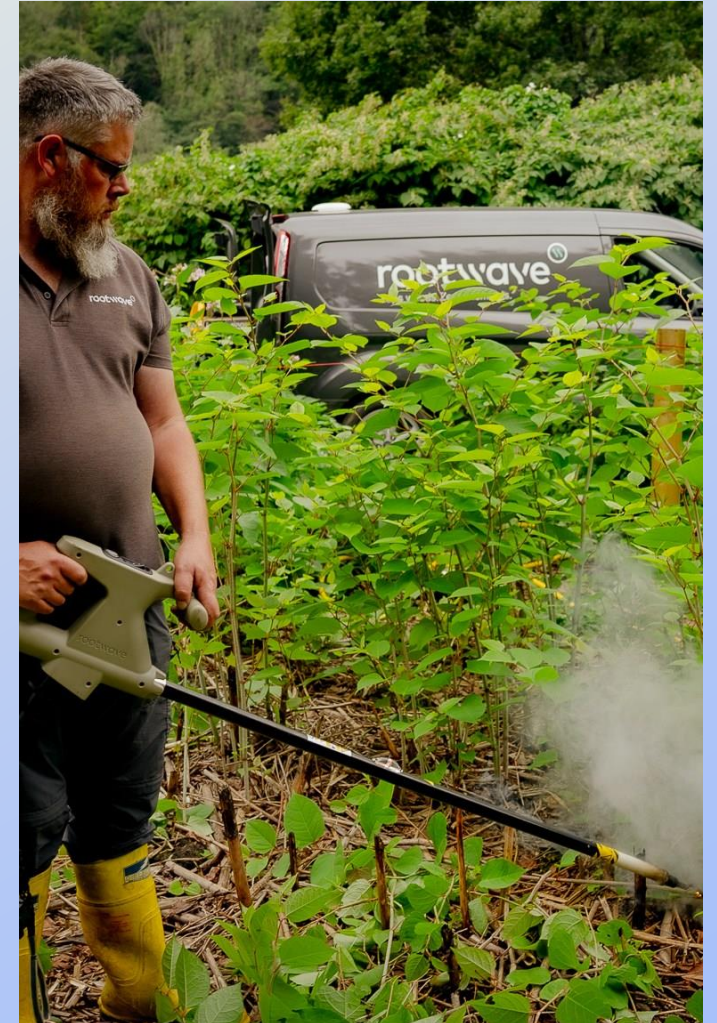
Thermal

- Wide variety of techniques
 - *Flaming (8-36kg/ha, rapid cell rupture)*
 - *IR (easier to target than flame)*
 - *Steam, hot water and hot foam*
- Low soil disturbance
- Generally slow
- Very high energy



- Dates back to 19th Century, but being revived
- Potentially good on deep rooted weeds
- Slow
- Safety issues

Electrocution



Lasers are sexy! - 20th Oct 2018 headline

The Guardian



'We'll have space bots with lasers, killing plants': the rise of the robot farmer

Tiny automated machines could soon take care of the entire growing process. Fewer chemicals, more efficient - where's the downside?

Laser weeding

- Fast acting and concentrates energy
- Requires very high precision targeting
- Slow
- Safety issues

Californian Laudando & Associates Robot 2023



Carbon Robotics –
Tractor
mount 2023



Carbon Robotics Robot -
4.3 tonnes, 73Hp



Future mechanical weeding options

- Going wider and faster for higher workrates
- Improve ease of guidance setup and performance robustness
- Integrating technologies e.g. using vision system to gather data as well as guide implements
- Doubling up on treatments for more efficient operation e.g. hoeing and targeted fertilizer application
- Research and education on how to fit mechanical weeding into integrated weed control strategies
- Cultivation probably remains the most versatile and cost effective
- Full life cycle evaluation of alternative weeding options

Questions?

