Plant & Food Research
Rangahau Ahumāra Kai

Changes and impacts of tillage in cropping systems

Trish Fraser and Erin Lawrence-Smith

The New Zealand Institute for Plant and Food Research Limited

Before the Europeans arrived

- Māori were accomplished agriculturalists/ horticulturalists
- Had staple diet of seafood and birds for protein, and *aruhe* (fern root) and cultivated crops:

kumara (sweet potato), taro, hue (bottle gourd) uwhi (yam) and kānga (maize)

Photos: Mike Burtenshaw

- The further south they settled, found it harder to grow these crops
  - Taro and gourd - only in the north island
  - Yams - as far south as Tolaga Bay
  - Sweet potato - as far as Banks Peninsula (and a little further)
  - Rhizome of bracken (*Pteris aqulina*) thus became a principal vegetable

Photo: Graham Harris

- An ‘industrious cultivator’ was a respected member of the community – although called “*ihu oneone*” or “soiled nose”

Soil cultivation by Maori

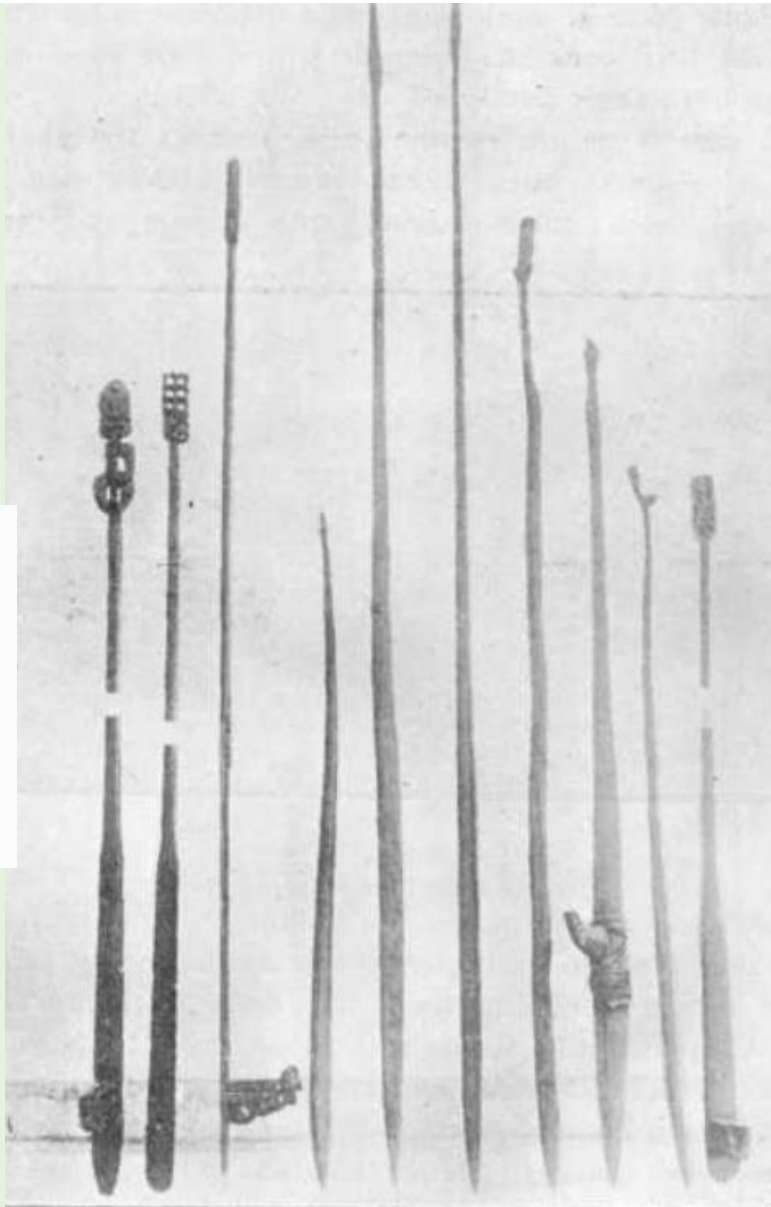
- Maori had a very good working knowledge of soils (or *oneone)* - 27 names for soil types

e.g. *paraumu*, a dark fertile soil and *parahuhu*, an alluvium soil, both favoured for sweet potato growing

- They used wood ashes as a manure, but had not considered watering plants
- Range of tools used for cultivating crops
  - *ko, kaheru, timo (or timotimo or tima)*

  and *wauwau (or pinaki and ketu)*
- A wooden club, a *patupatu*, was employed to break up clods

timo



Cultivation (early 1800's)

- Cultivation was all manual and very labour intensive
- They did not invert the soil, but rather just disturbed surface

Wauwau, pinaki and *ketu*

Carved step of a *ko*

Digging with a *ko*

Beginning of mechanisation

- Horses were first introduced to New Zealand in 1814
- **3rd May 1820**: Missionary John Butler turned the first furrow at Kerikeri, writing in his journal:

  ‘I trust that this day will be remembered with gratitude, and its anniversary kept by ages yet unborn’
- Maori growers rapidly took up the new technology and supplied food to the early settlers

Early European plough

Early plough, c. 1830s-1840s (Alexander Turnbull Library, MNZ-1592-1/2; F)

Cultivation early 1900's

c 1910

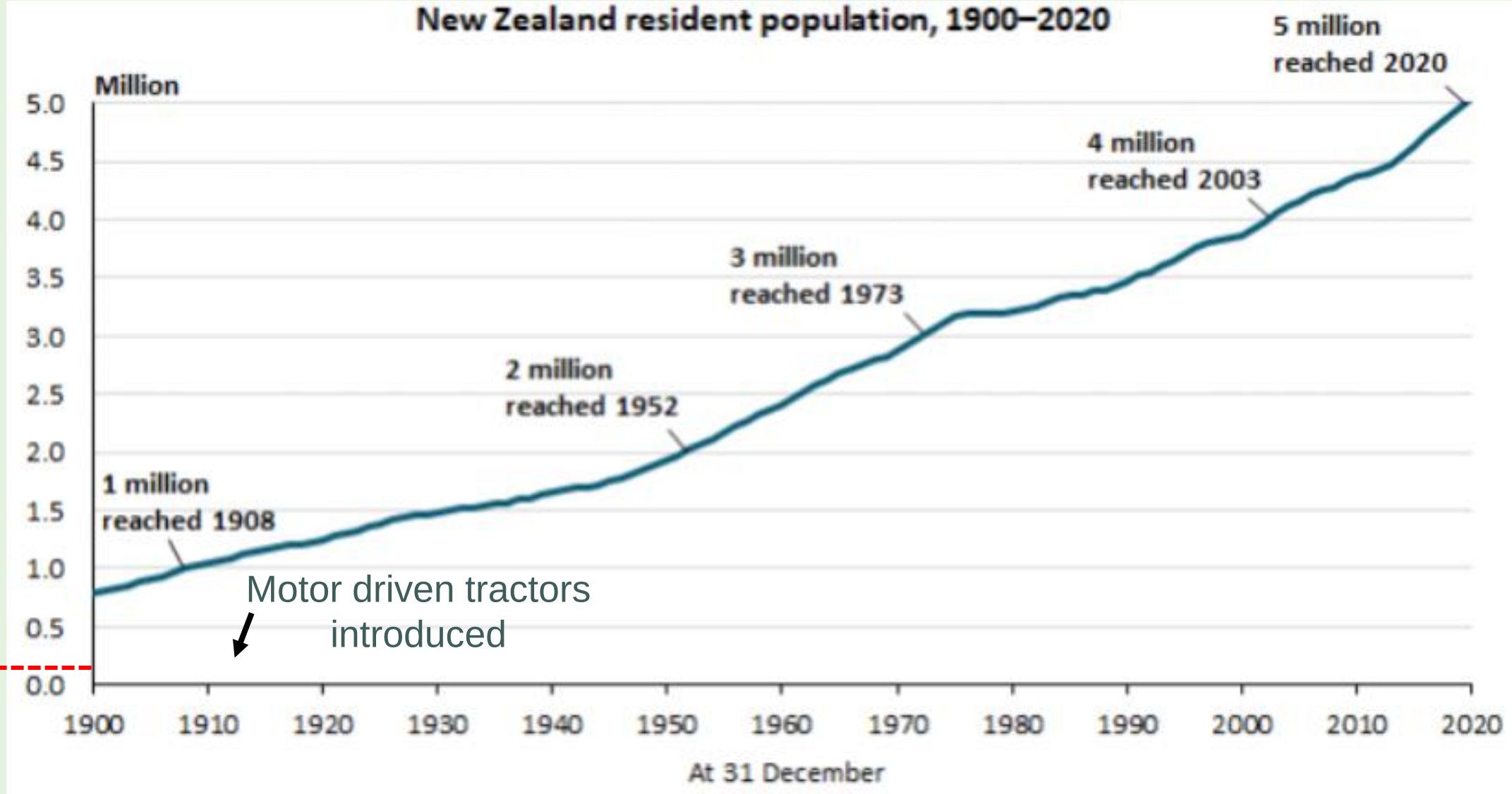
1900-20

Increased mechanisation...

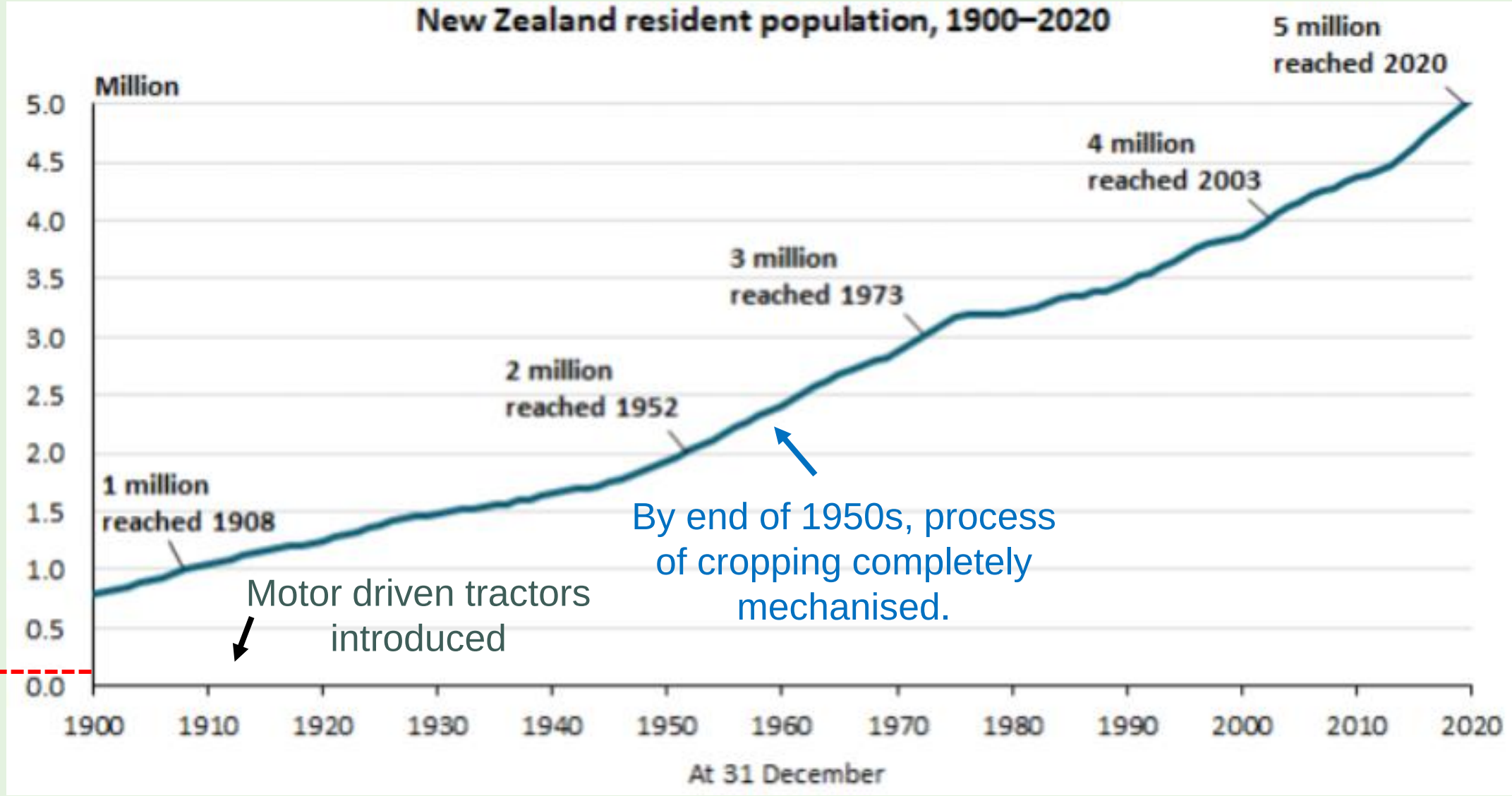
WW 1 time

About 1930’s/40’s

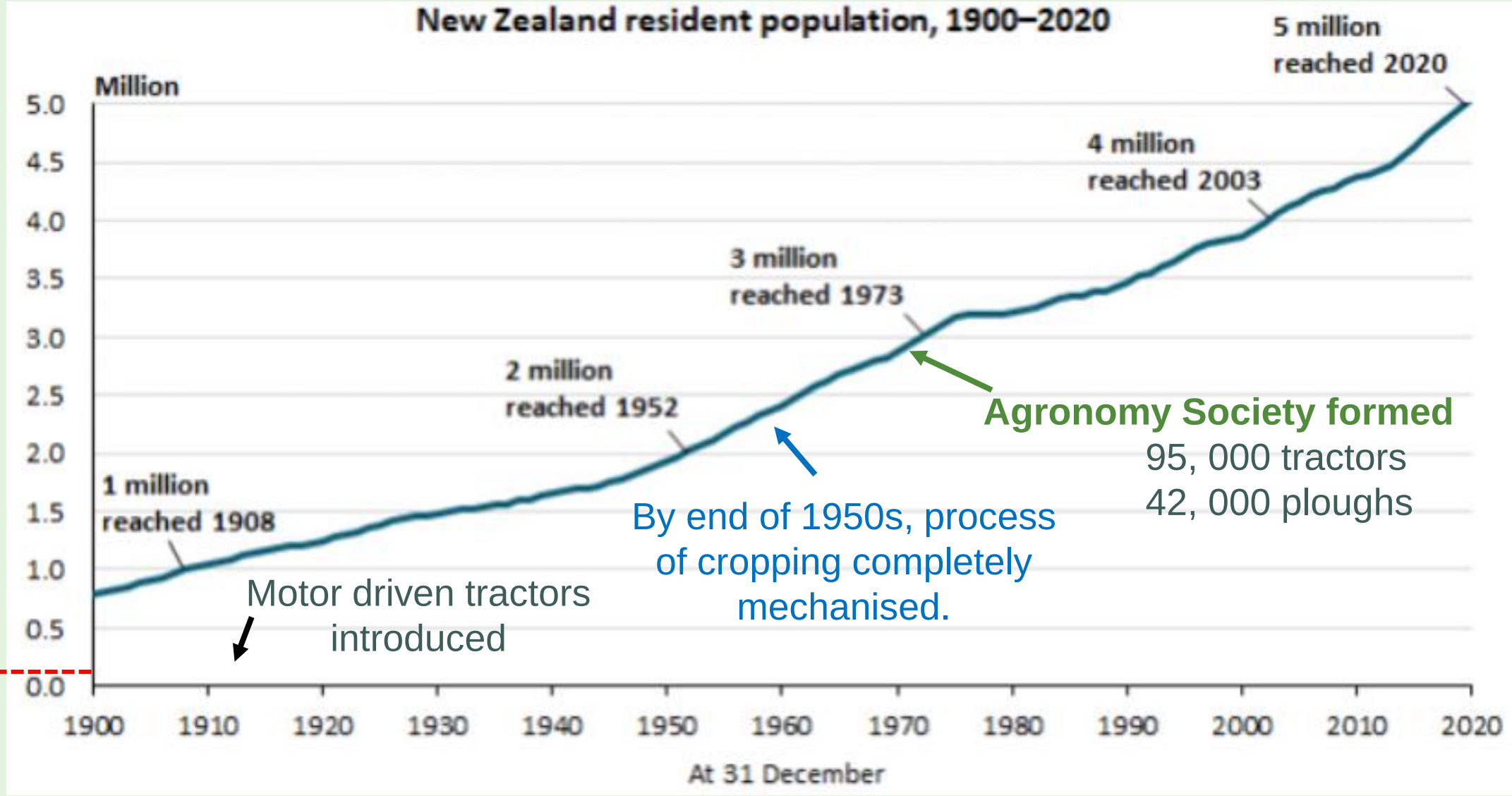
NZ's changing population



NZ's changing population



NZ's changing population

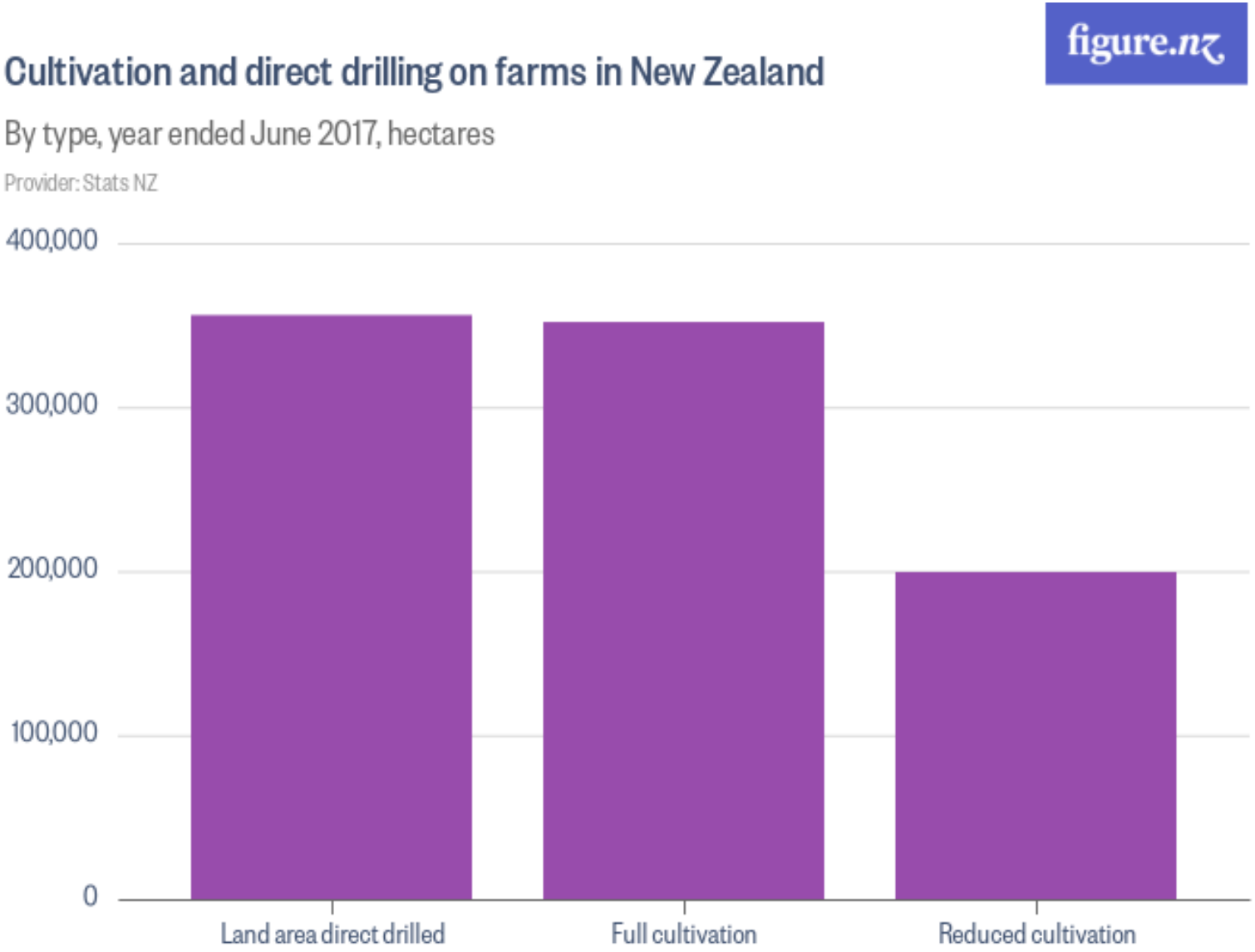


Wide range tillage implements/ varying intensities...

Tillage practices

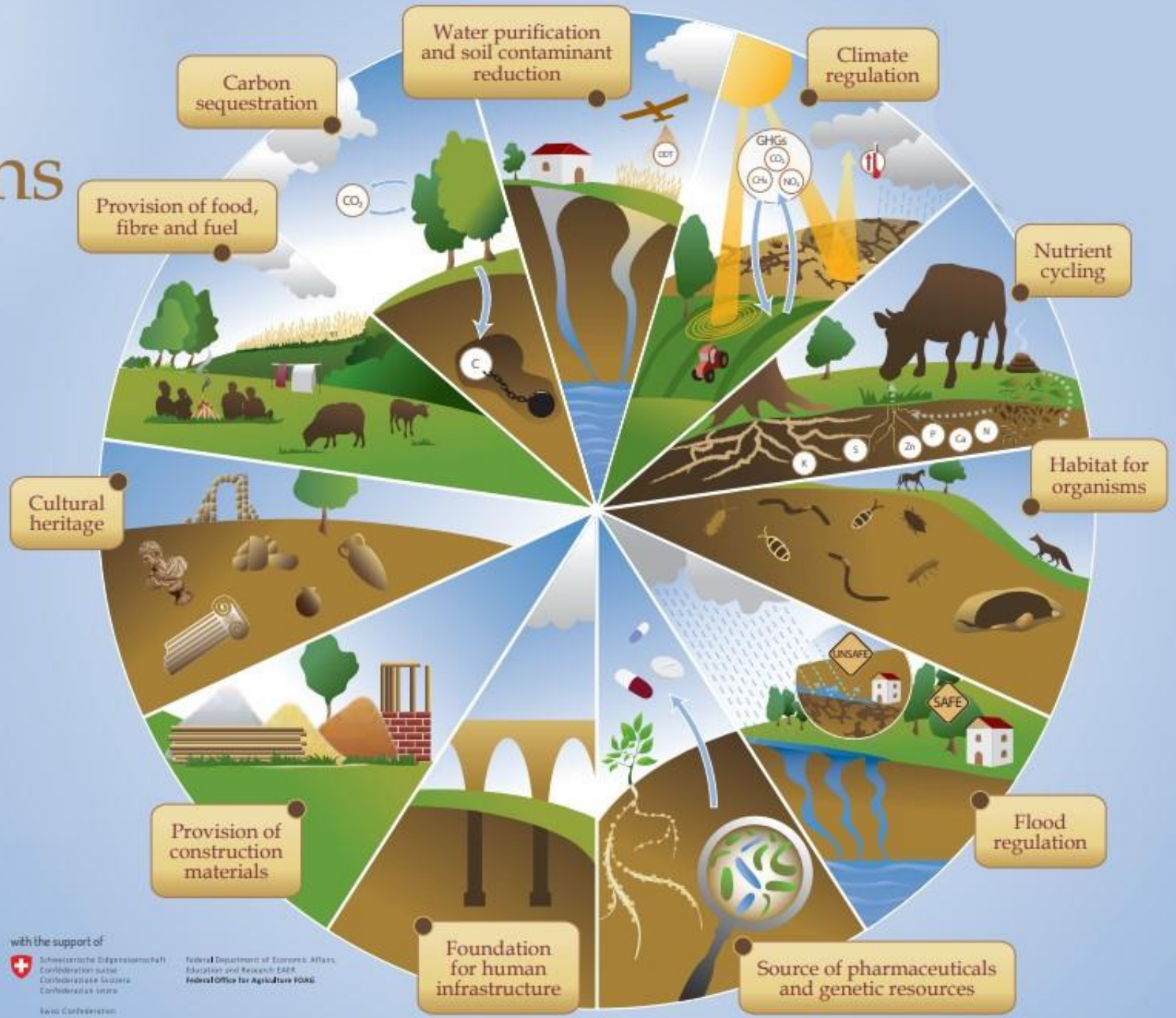
1 pass?

Areas and types of cultivation on farms in NZ (2017)



Soil functions

Soils deliver ecosystem services that enable life on Earth



Food and Agriculture Organization of the United Nations

with the support of

Federal Department of Economic Affairs, Education and Research EAER
Federal Office for Agriculture FOAG

Soil is a living mixture of

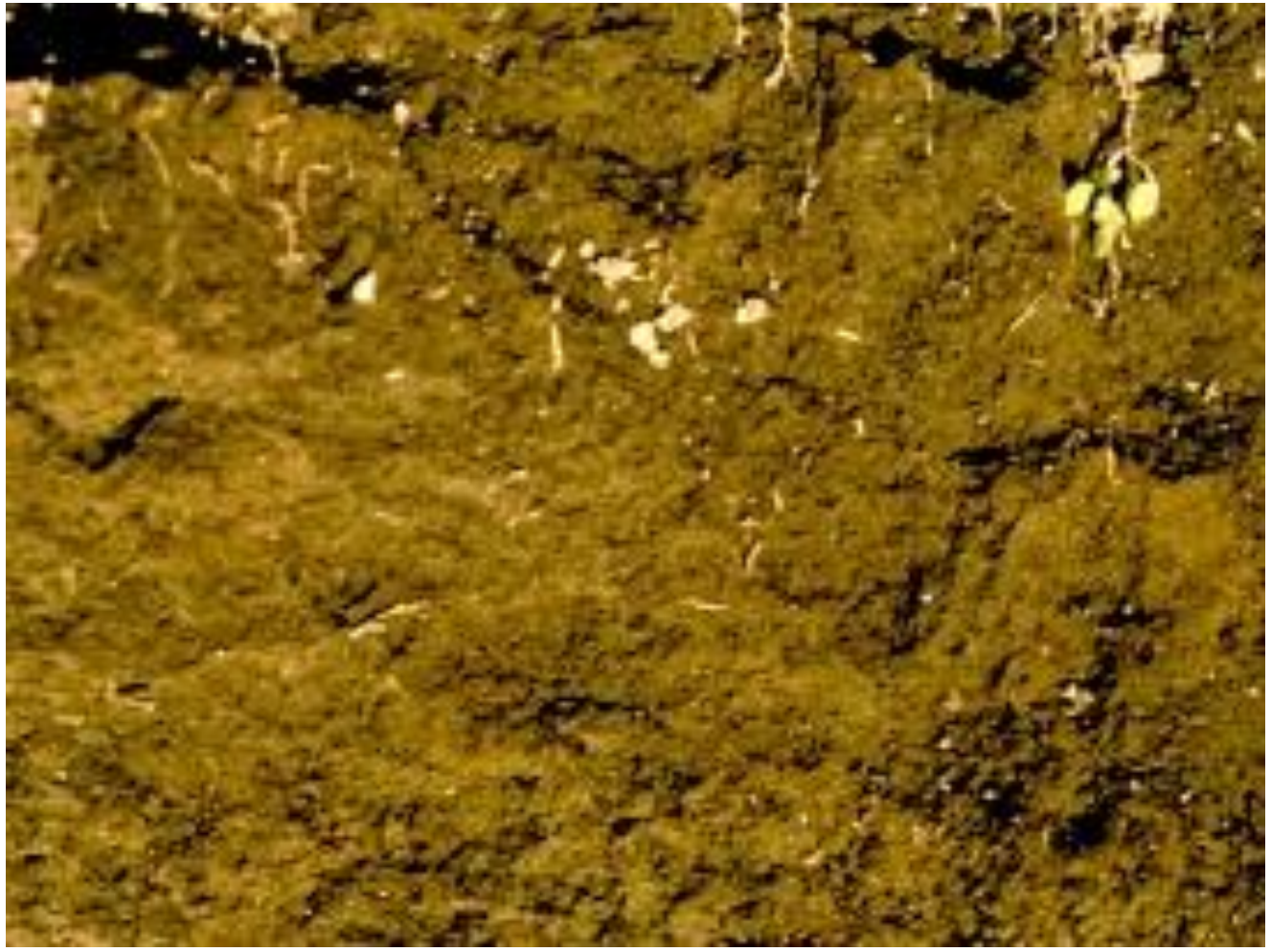
- minerals
- organisms
- organic matter
- air
- water

Cultivation can

- bury crop residues
- kill weeds
- soil water and air movement
- drainage
- root growth and development
- increase mineralisation

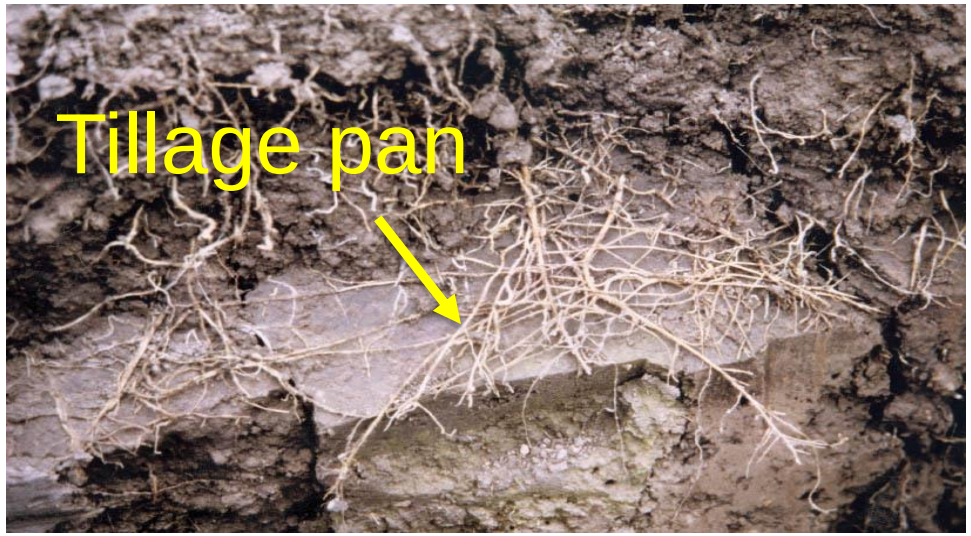
But too much can lead to poor soil physical structure...

- Restricts seedling emergence
- Limits infiltration of air and water
- Promotes surface runoff



- Restricts root penetration

Soil structural degradation



Subsoil compaction

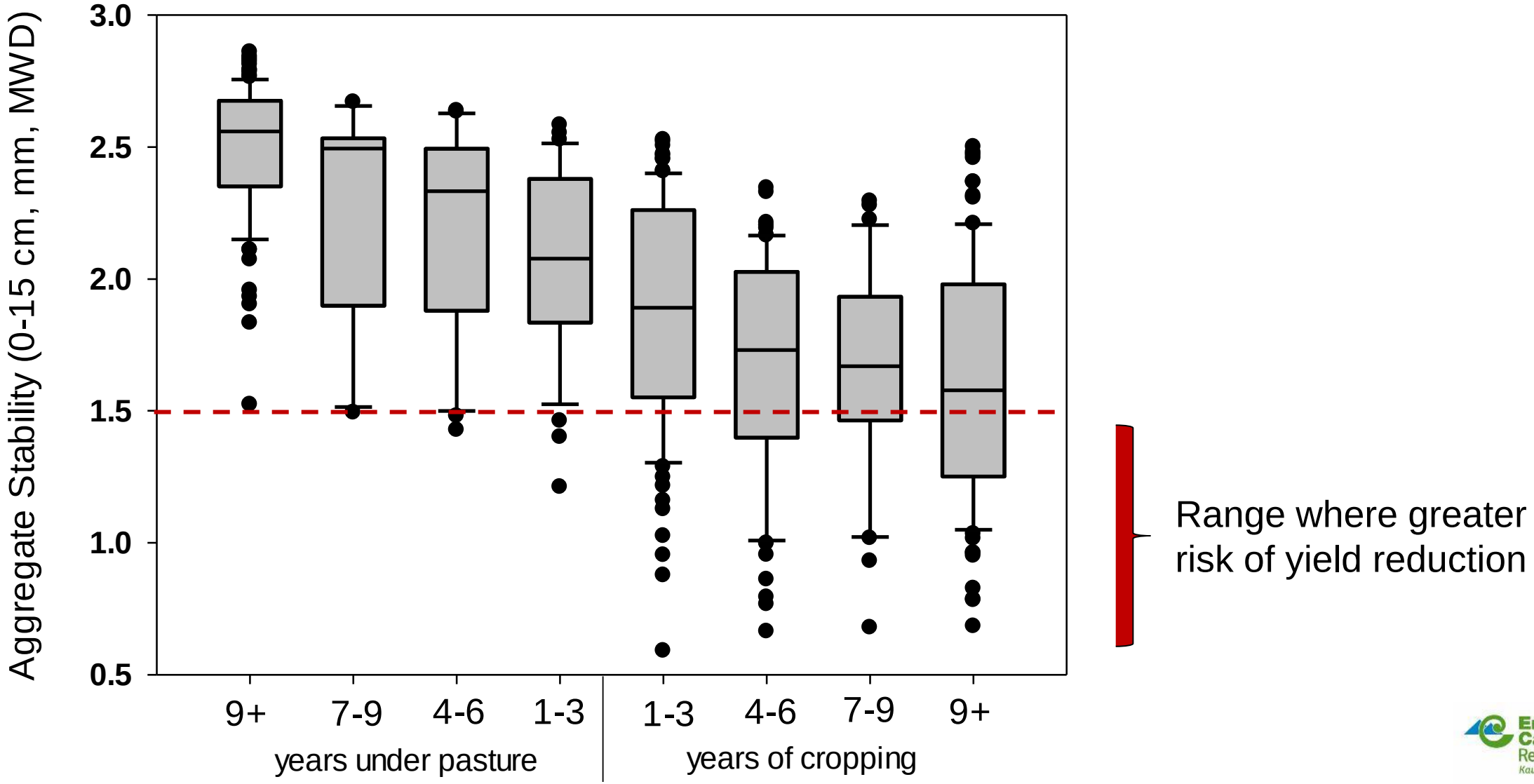
Surface compaction

Surface sealing (capping)

Consolidation / compaction

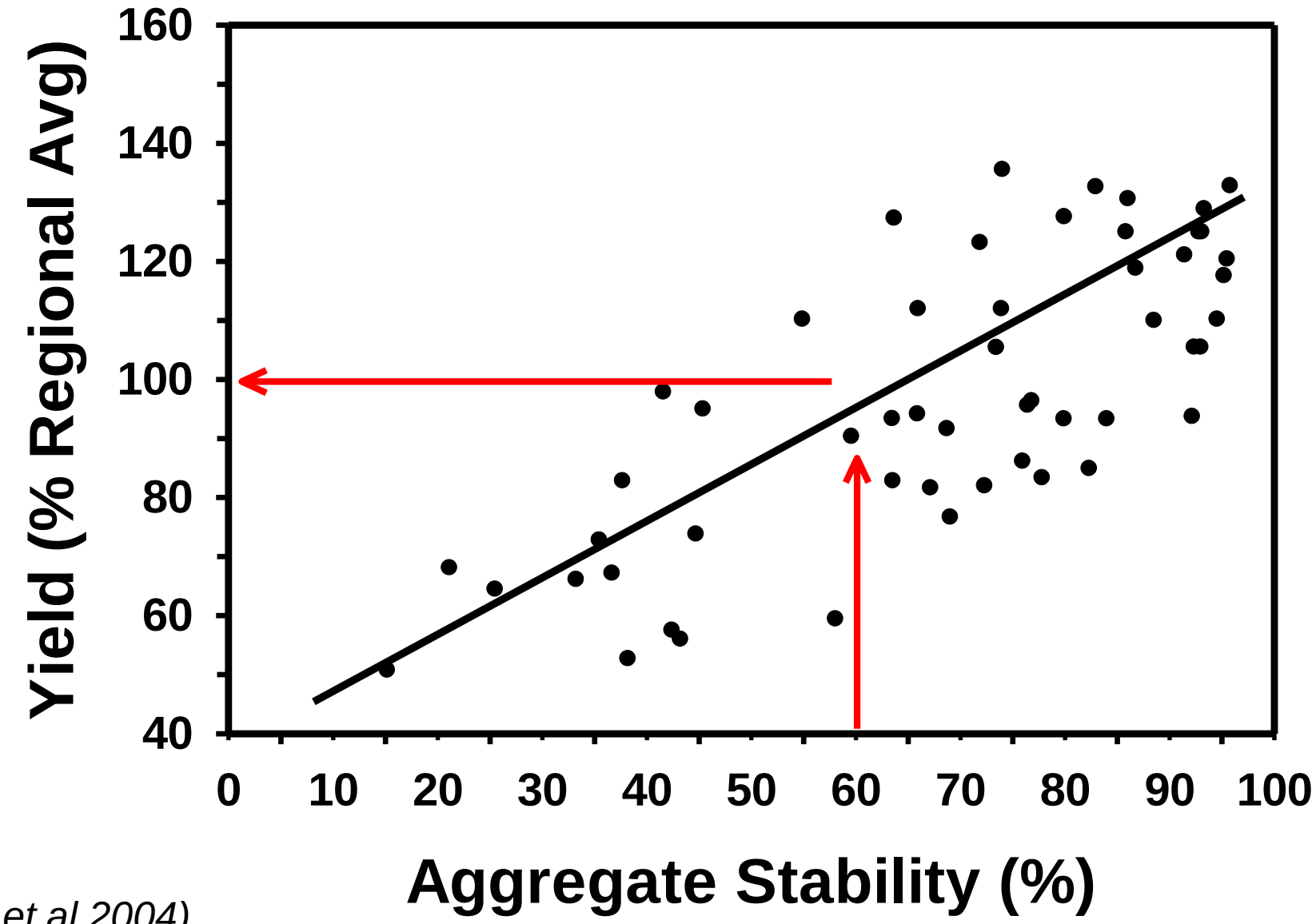
- Limits topsoil rooting volume
- Reduces soil water holding capacity
- Requires more work to prepare a seedbed

Effects of cropping history on aggregate stability



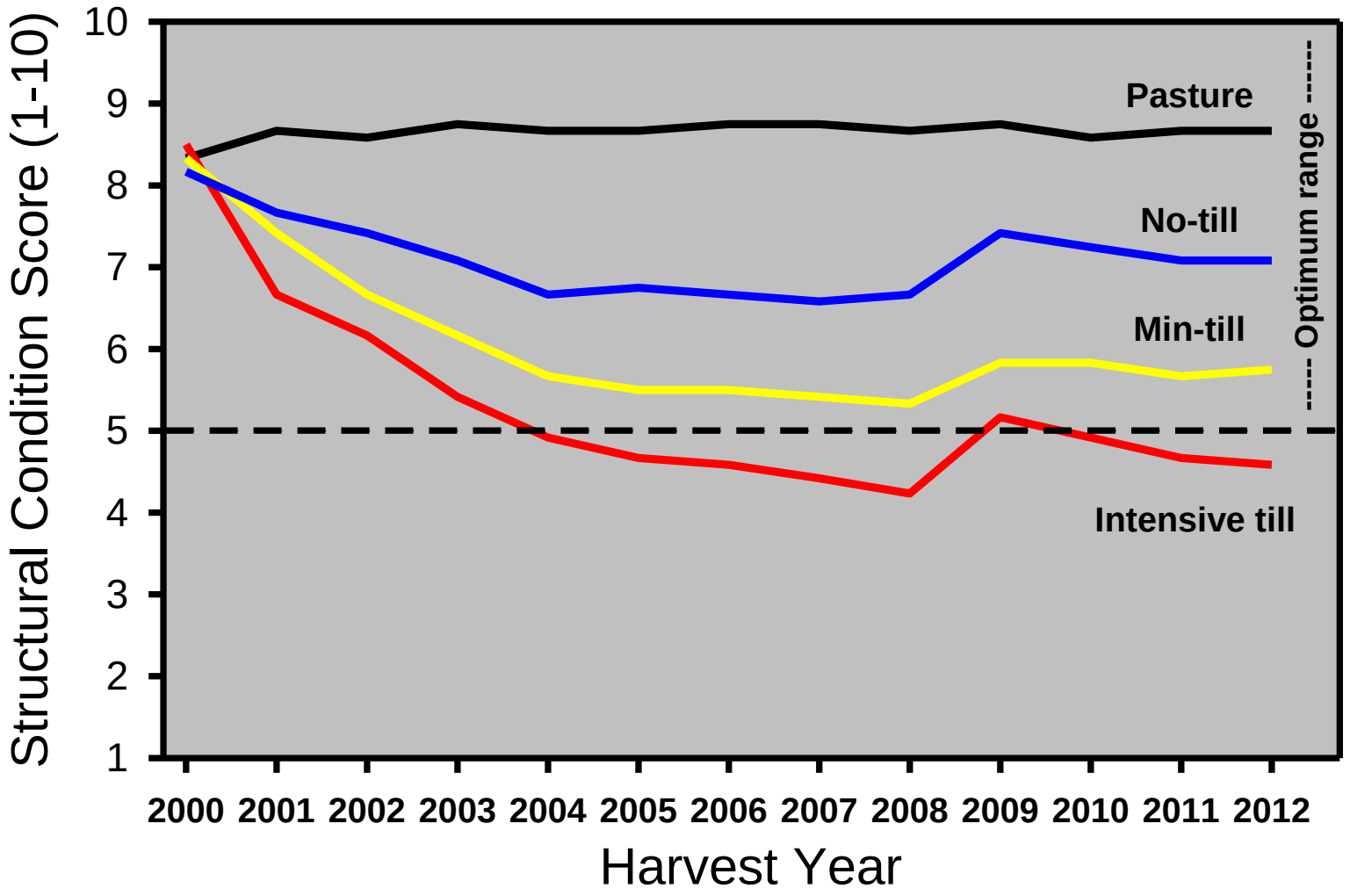
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Soil structural stability and plant productivity



(from Beare et al 2004)

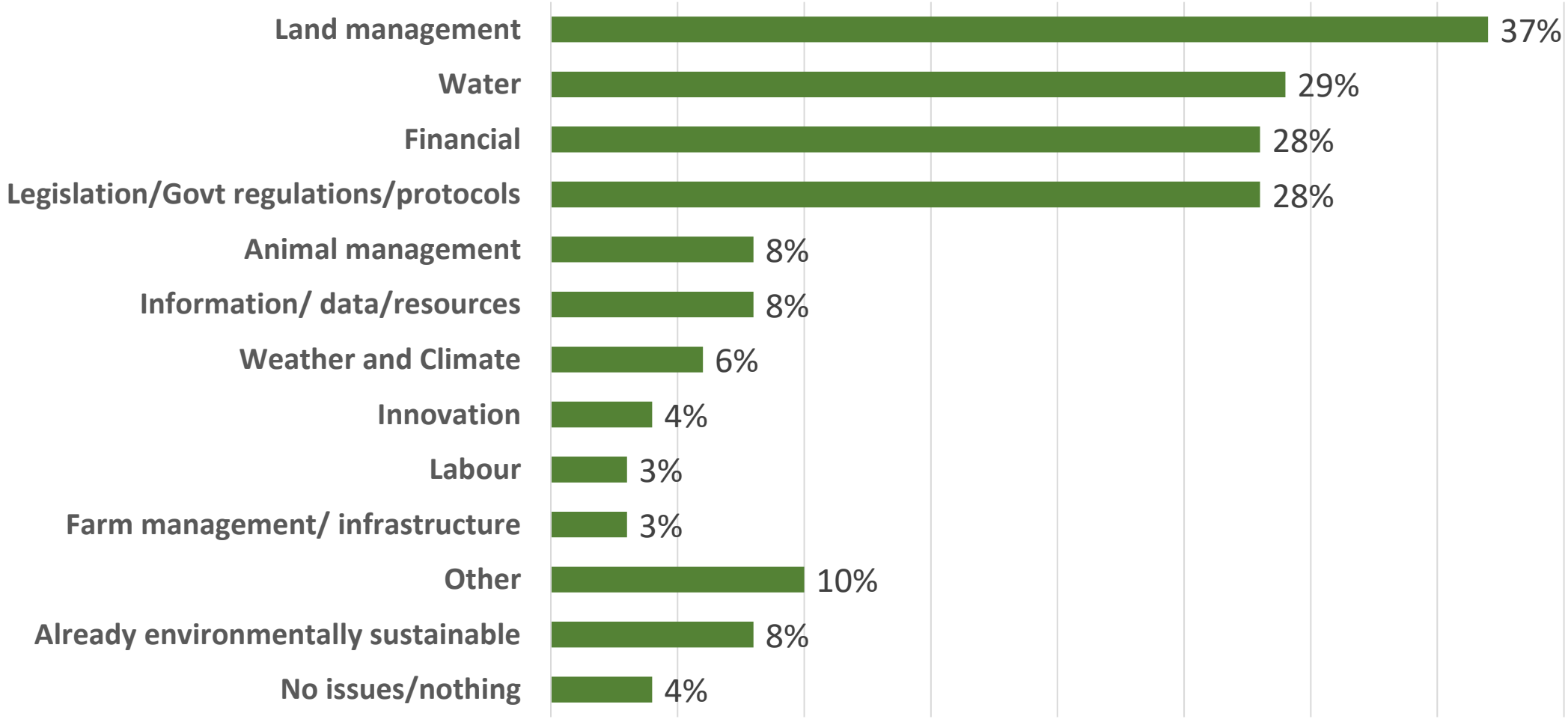
Soil structural condition – impacts of tillage



Visual score card

MPI survey of farmers

Key issues in making farm more environmentally sustainable for the future:

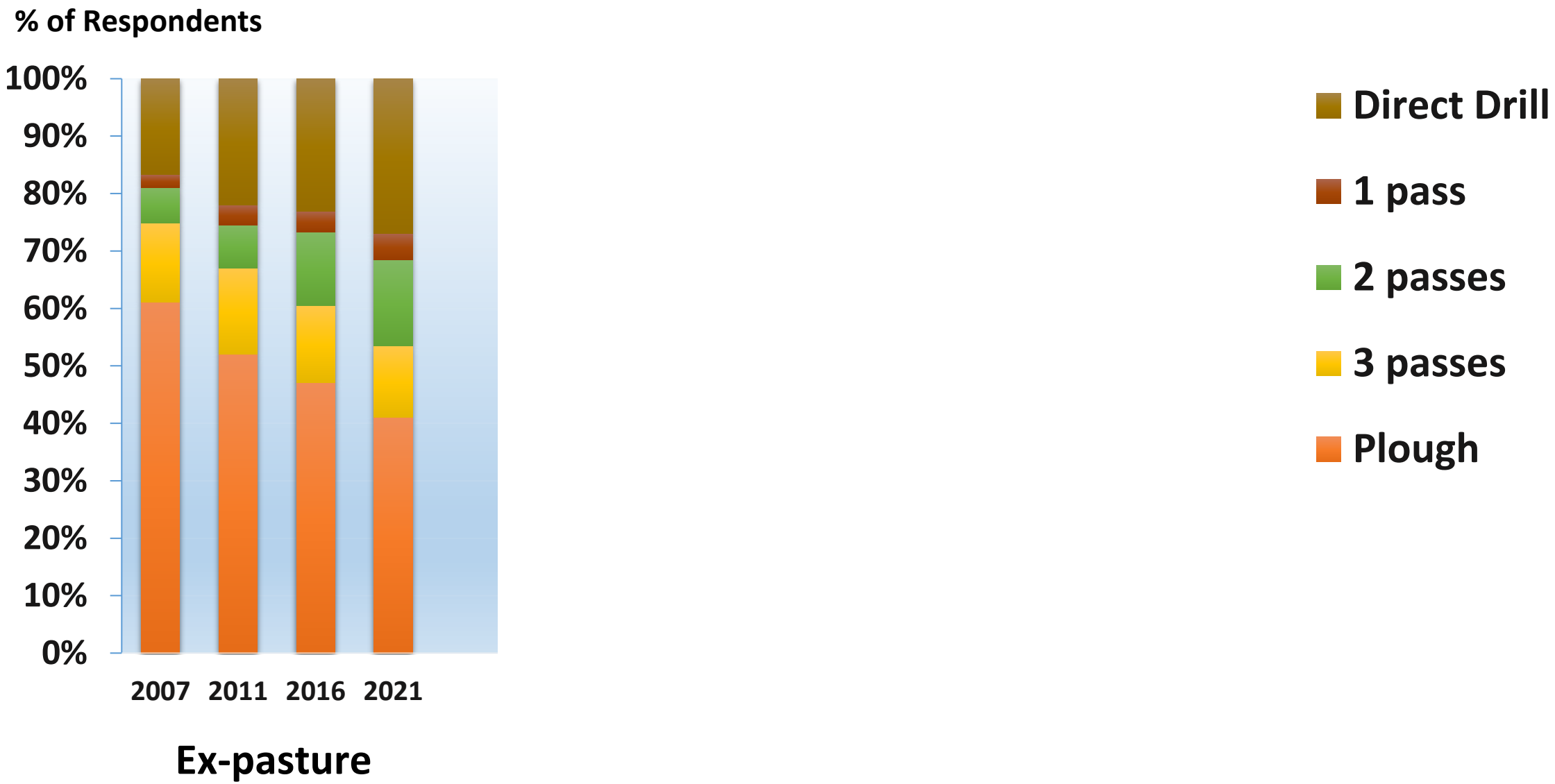


Foundation for Arable Research Surveys

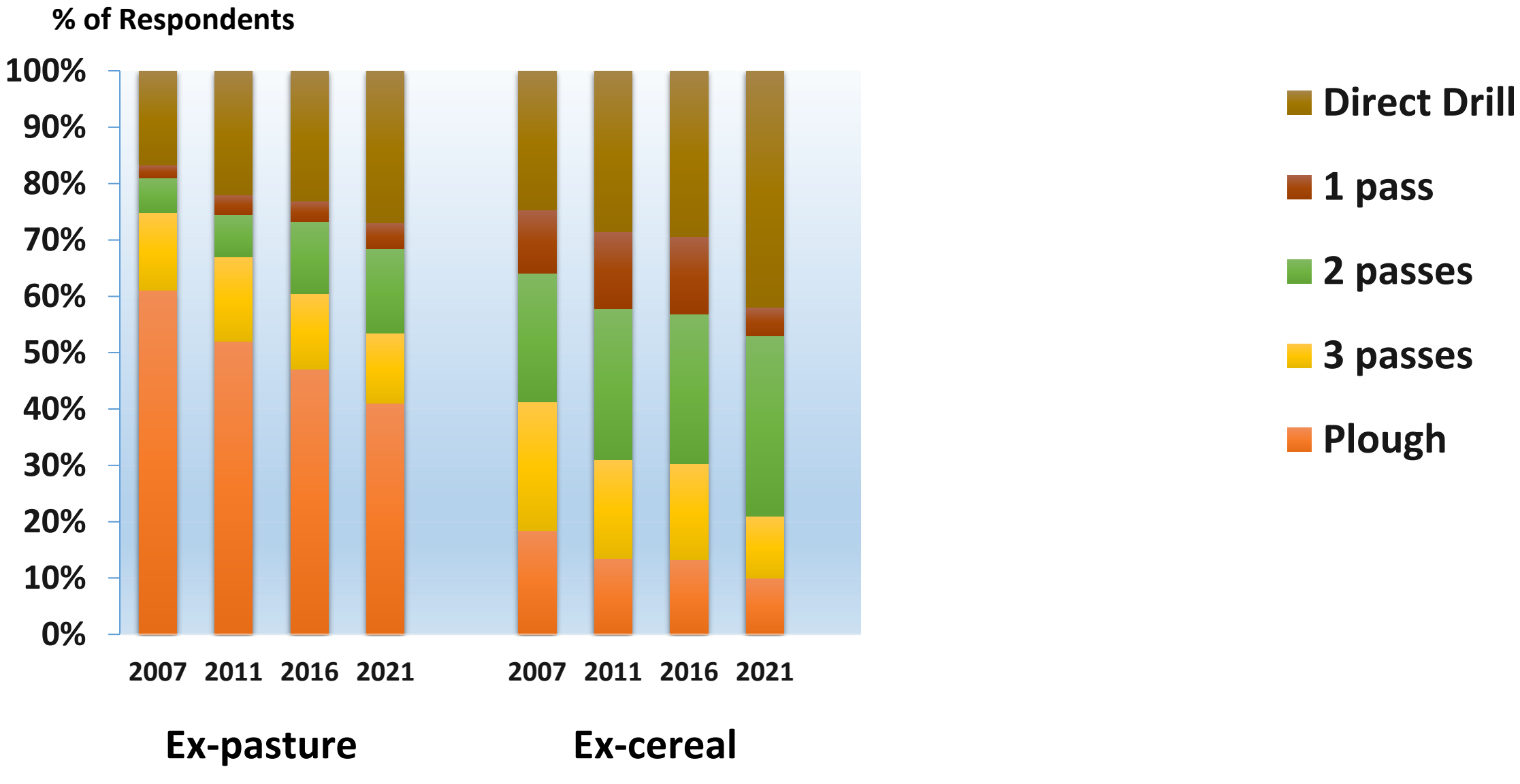
- Grower surveys were conducted by FAR in:
  2007, 2011, 2016 and 2021

- We included questions on tillage practices

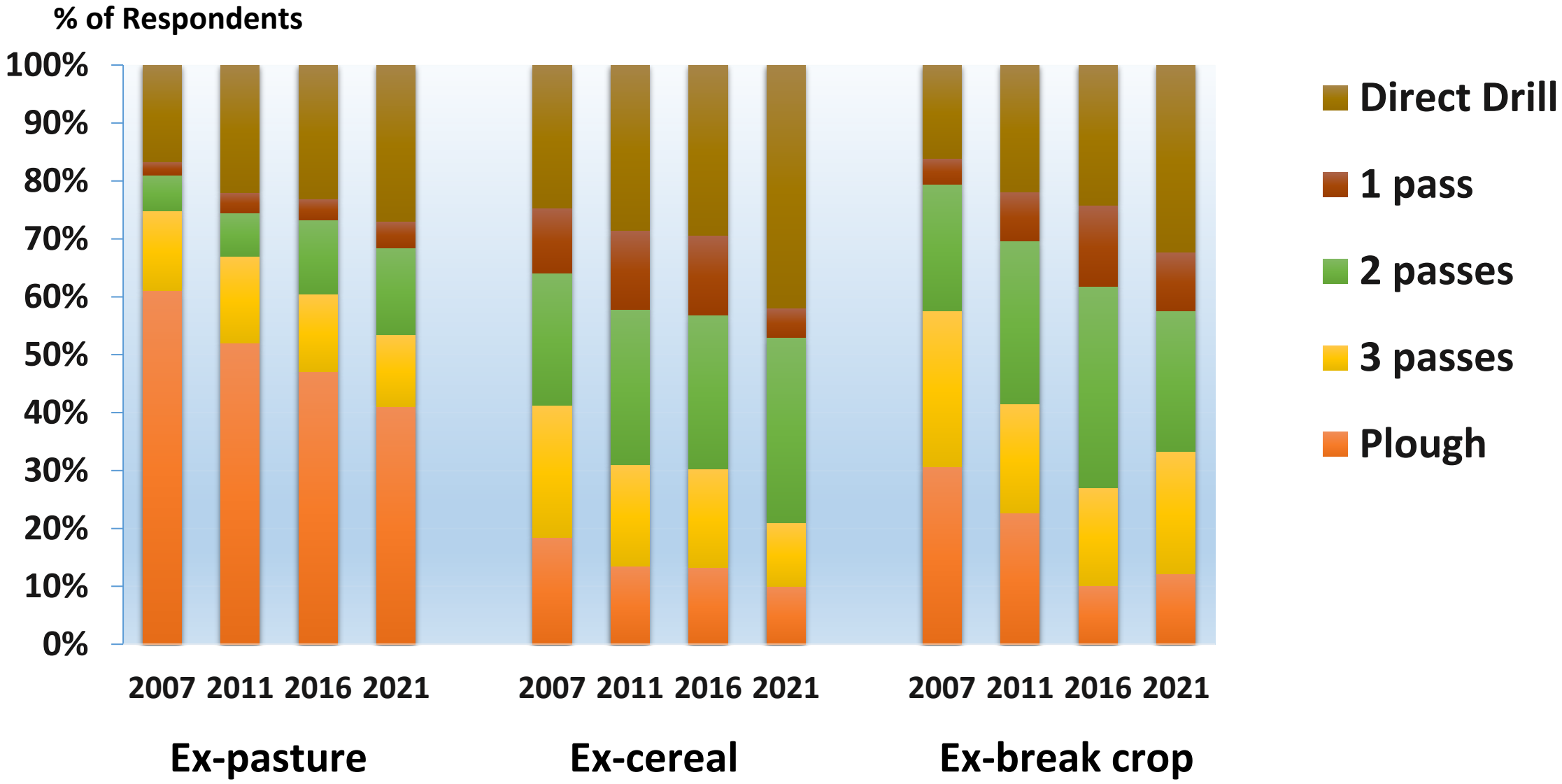
Tillage changes over time



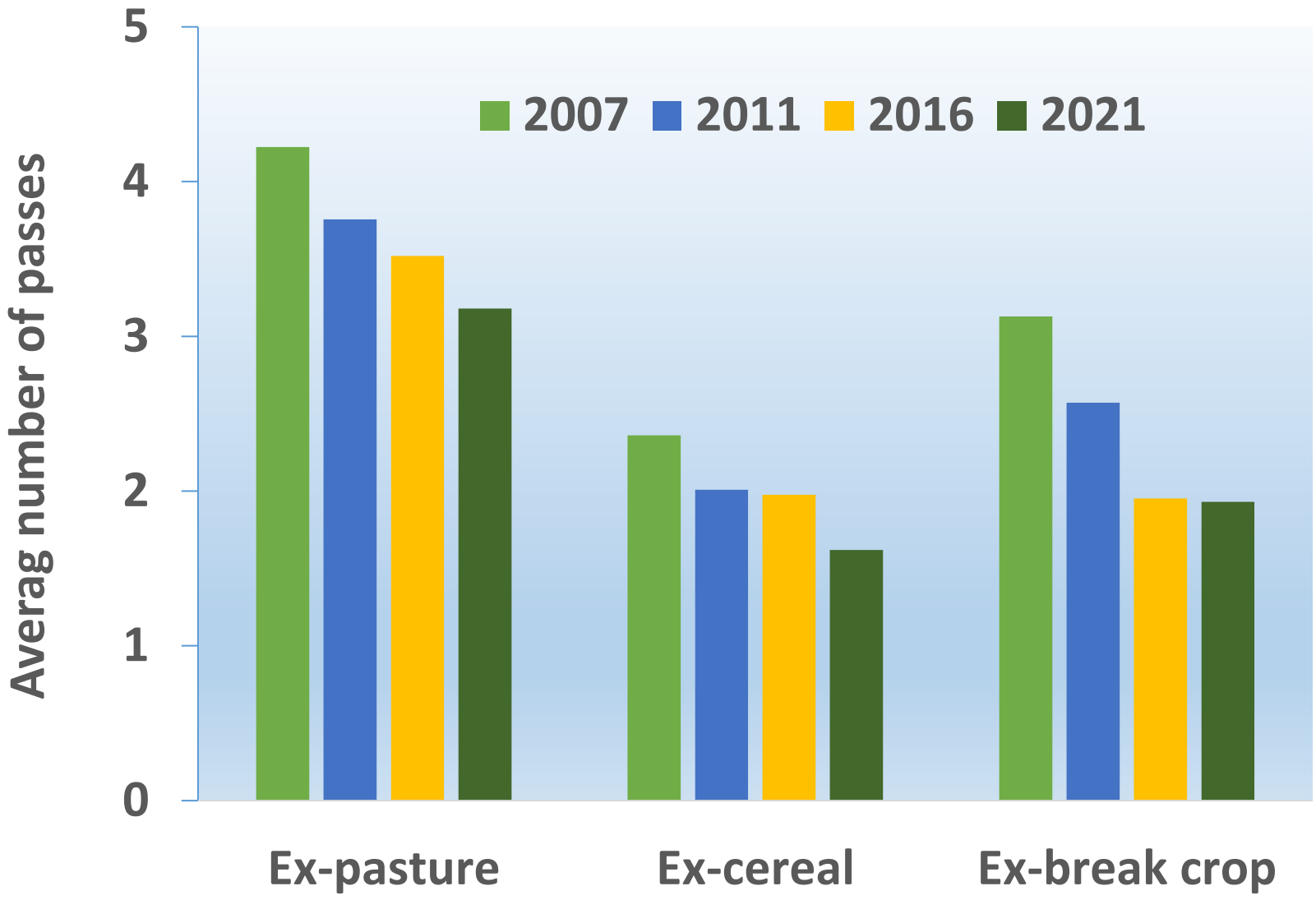
Tillage changes over time



Tillage changes over time



Number of tillage passes



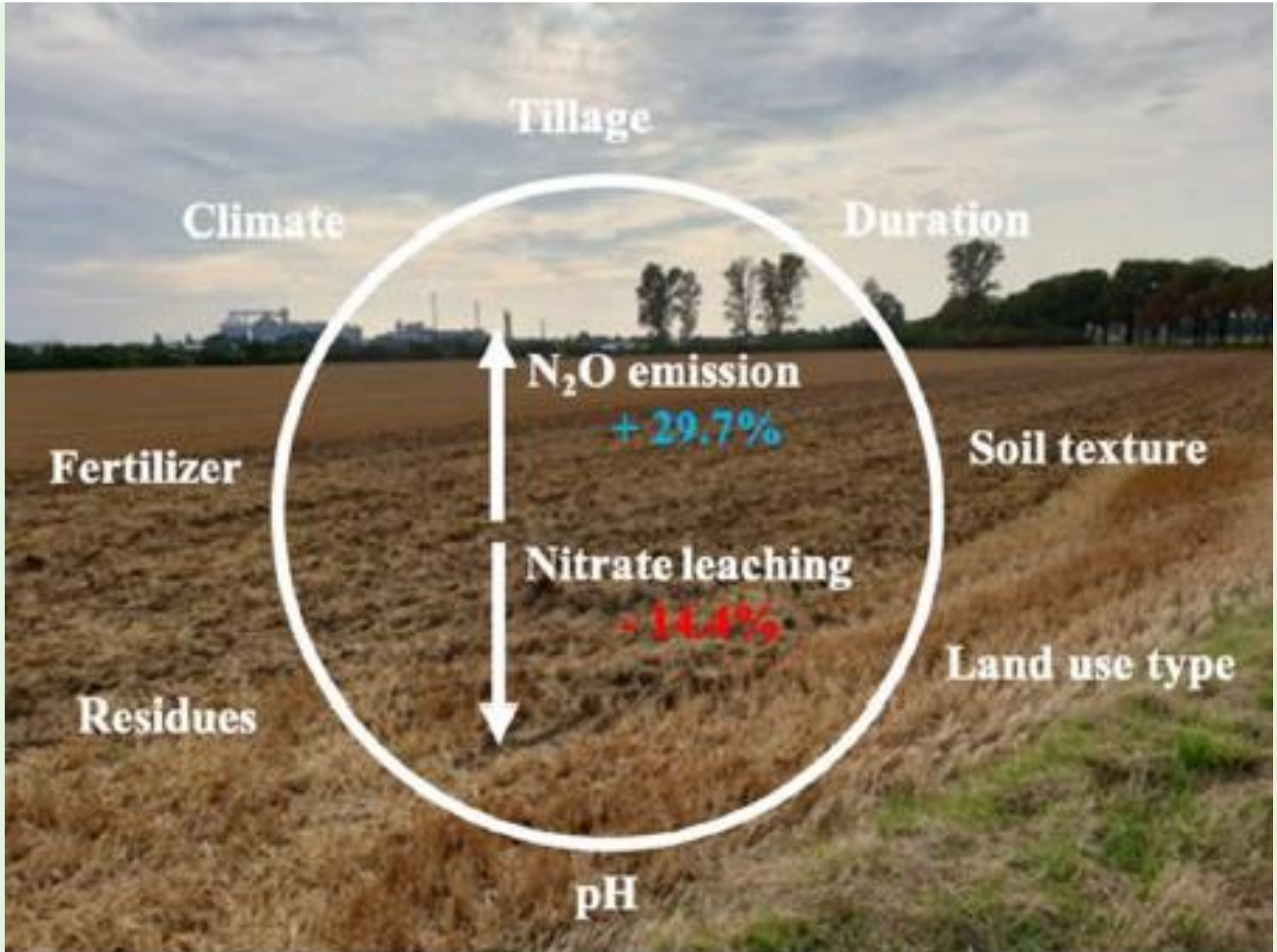
To till or not to till?

Two recent comprehensive reviews of the literature:

1. Assessing no tillage effects on soil hydraulic properties
   (*Wei Hu and colleagues*)
   No tillage resulted in a reduction in soil hydraulic properties
   in the short term; may be benefits longer term

2. Li et al 2021 conducted meta-analysis of overseas data
   Investigated return of crop residues ...

Li et al 2021 meta-analysis – return of residues to arable land



Alternative approaches being considered...

Deep ploughing periodically

Strip-tillage

- 87 % said not using / tried strip tillage in NZ

Plant & Food Research
Rangahau Ahumāra Kai

Thank you

plantandfood.co.nz

FAR