Establishing small seeded pasture legumes into existing grass pastures

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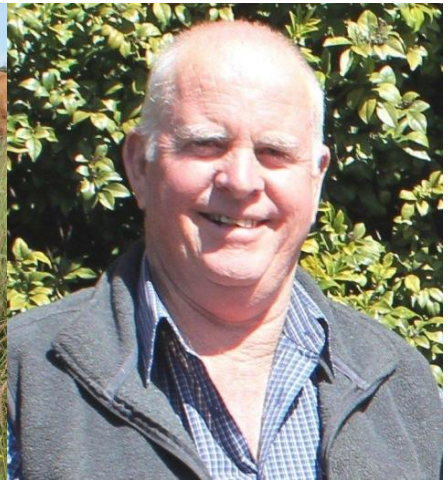

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MEAT & LIVESTOCK AUSTRALIA

Queensland Government

Overview

Section 1: Background &trial results

- Legumes production benefits
- The challenge of establishing legumes into existing grass
- Legume establishment trial results

Section 2: Recommendations

- The establishment timeline
  - Planning, fallowing, sowing/emergence, early growth
- Adapting trial results to commercial paddocks
- Trade-offs

Some comments/results challenge *conventional* recommendations!

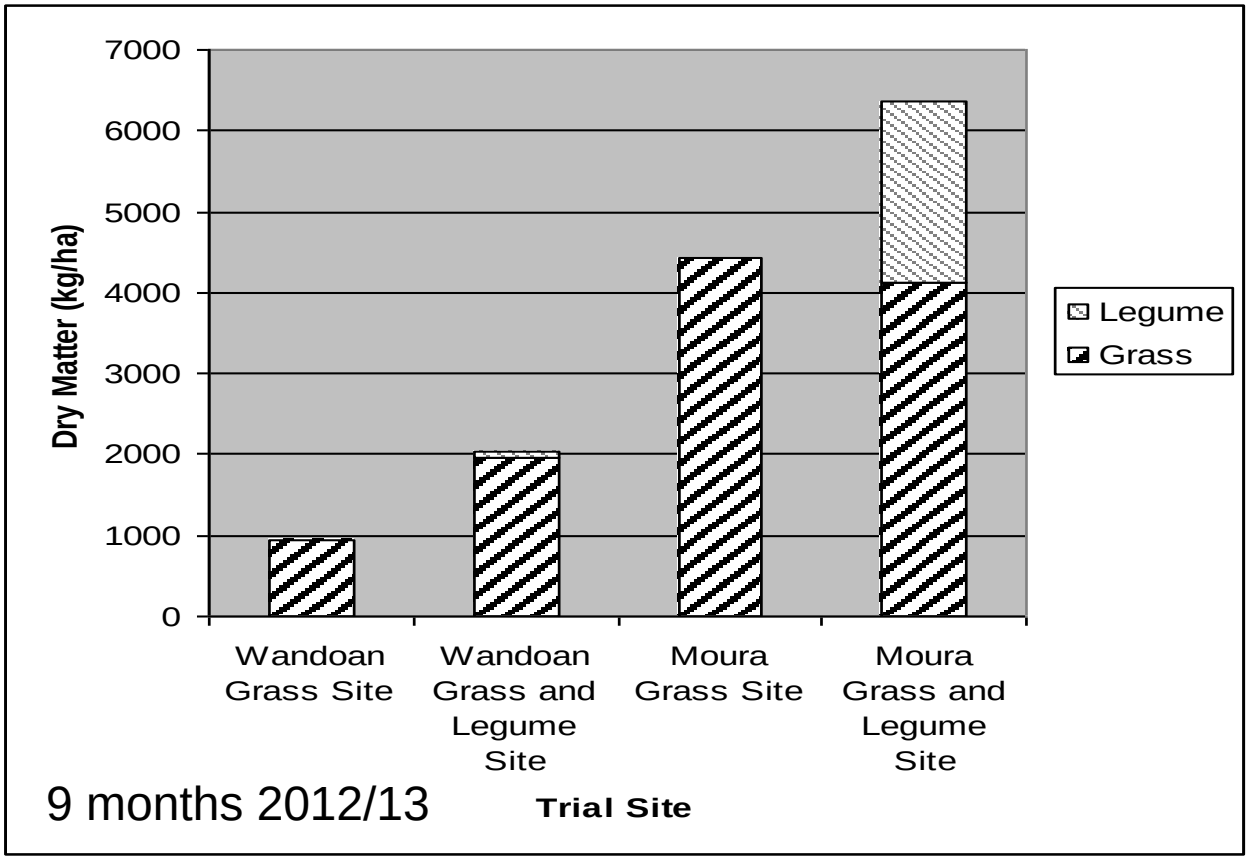
Legumes - “Huge potential”

Potential benefits:

- Improved animal performance
  - Stylos (native pastures): additional 40 – 60 kg/head/yr
  - Leucaena: additional 60 – 90 kg/head/yr

- Nitrogen fixation and cycling
  - Leads to improved grass growth and better quality
    - 40-100% in “rundown” project trials
    - 10-30% in native pastures (McIvor and Gardener 1995)

Legume productivity



On very low P soils (Colwell ~3-6 mg/kg)

High production needs high legume content!

Rules of thumb:

- **20-50% of total DM** produced coming from the legume
- **> 4 plants per square metre** (depends on the size of individual plants of different legume species)
- Lots of legume seedlings die, therefore need **high numbers** going into the **first winter**

Pasture legumes in northern Australia

Low ***successful*** adoption…

Huge potential!!!

Native pastures:

- Legume augmentation successful in ***some*** districts

Sown pastures:

- 70% of total area planted to grass only (Walker & Weston 1990)
  - But the 30% often failed
- All grass species affected by reduced N availability ('rundown')
- Majority of sown pastures are in Queensland (approx. 90%) (Walker & Weston 1990)

Legumes

Legumes are the most promising management option…

But, commercial results have been mixed

Poor establishment is the most common reason for failure

(Peck *et al*. 2011)

The challenge…

Grass ***competition***!

Very few seedlings can survive…

Legume establishment

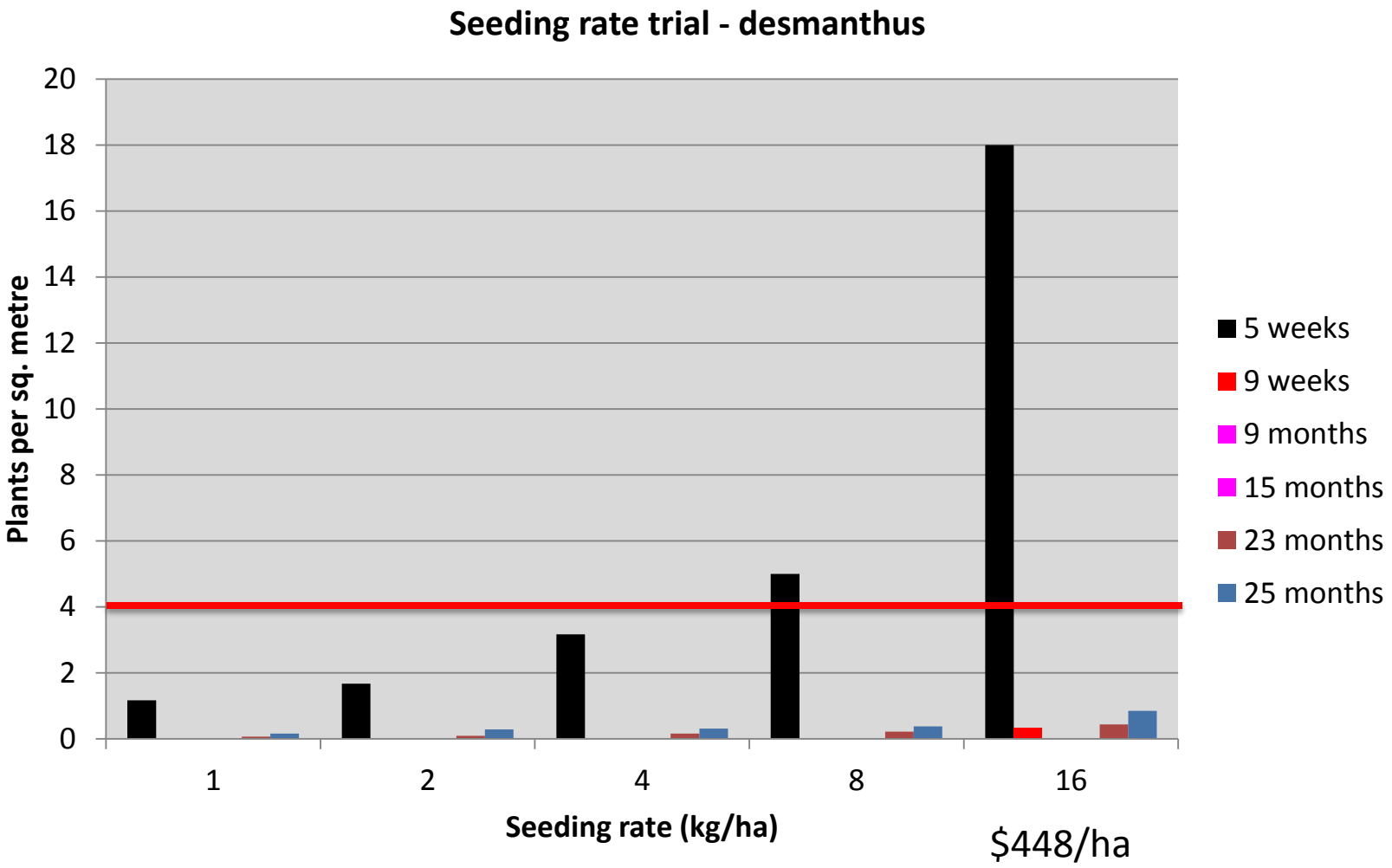
Industry routinely uses **low cost = *low reliability*** establishment techniques

Most commonly used (and recommended) techniques are:

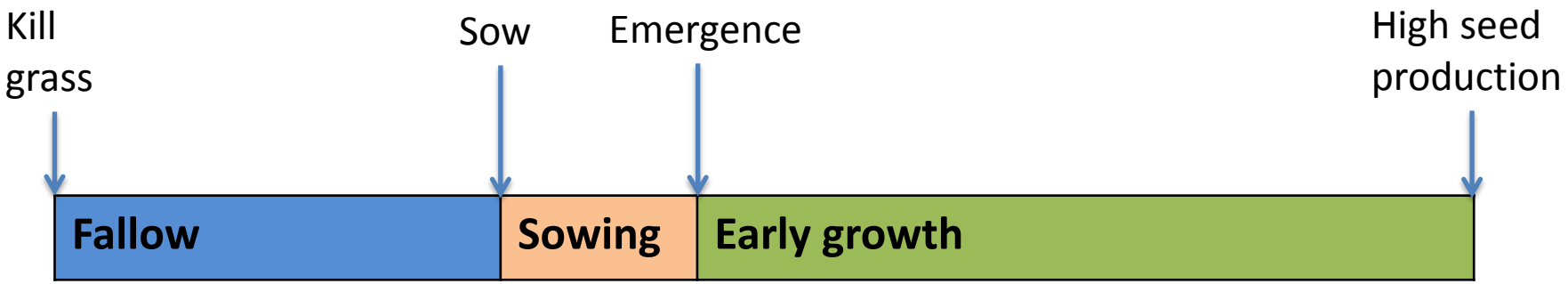
- Broadcast or fly into existing grass with no (or little) seedbed preparation
- One pass cultivation while seeding



Broadcasting into existing grass



What are the options to improve legume establishment?



15 current trials on different aspects of legume establishment

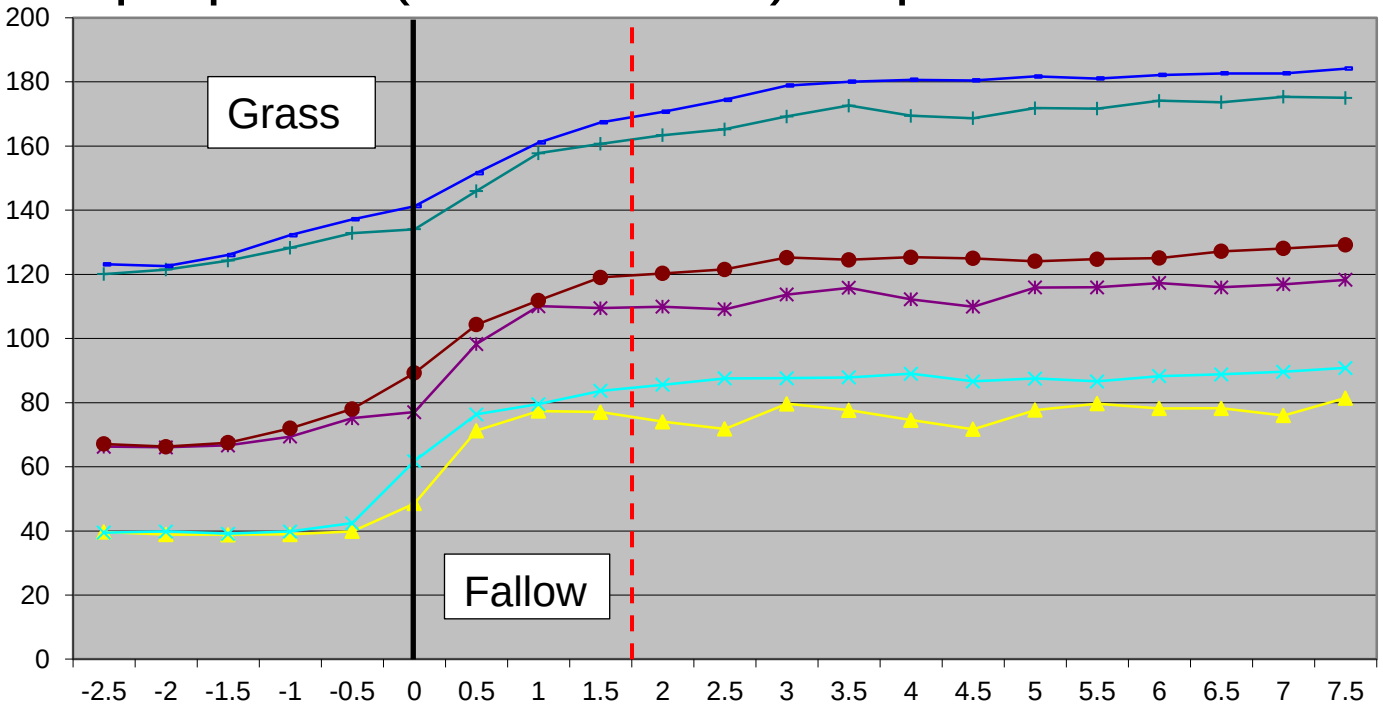
Fallow trial

Strips >5m wide needed to store moisture in centre of strip like a cultivated paddock

Fallow trial – soil conductance (Chinchilla)

How wide should the prepared strip be?

Research suggests that the grass growing beside the prepared strip will extract water for up to 1.5 - 2 m into the prepared (and fallowed) strip

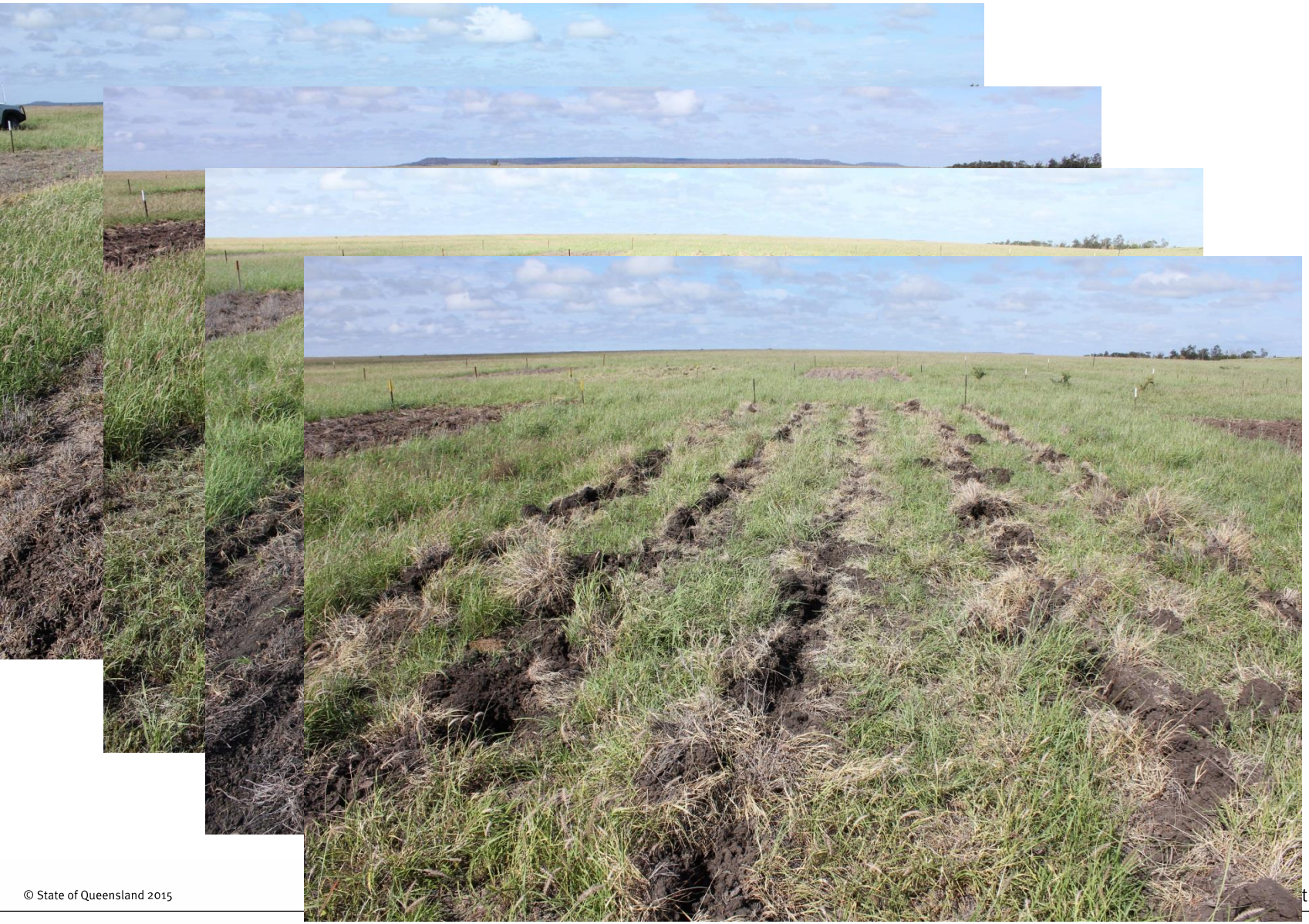


Fallow: How wide should a strip be?

Fallowing and seed bed preparation trials

Fallow period	Seedbed treatment	Post plant weed control
No disturbance	None	Nil
Disturb at plant	Slash	Nil
	Deep rip	Nil
	Cultivate (tynes)	Nil
	Cultivate (discs)	Nil
	Spray	Nil
Short fallow (2-4 months)	Zero tillage	+/- Selective herbicide
	Cultivate	+/- Spinnaker
	Cultivate then spray	+/- Selective herbicide
Medium fallow (4-6 months)	Zero tillage	+/- Selective herbicide
	Cultivate	+/- Spinnaker
Long fallow (9-12 months)	Zero tillage	+/- Selective herbicide
	Zero tillage	Selective herbicide 2 summers
	Cultivate	+/- Spinnaker
	Cultivate	Spinnaker 2 summers

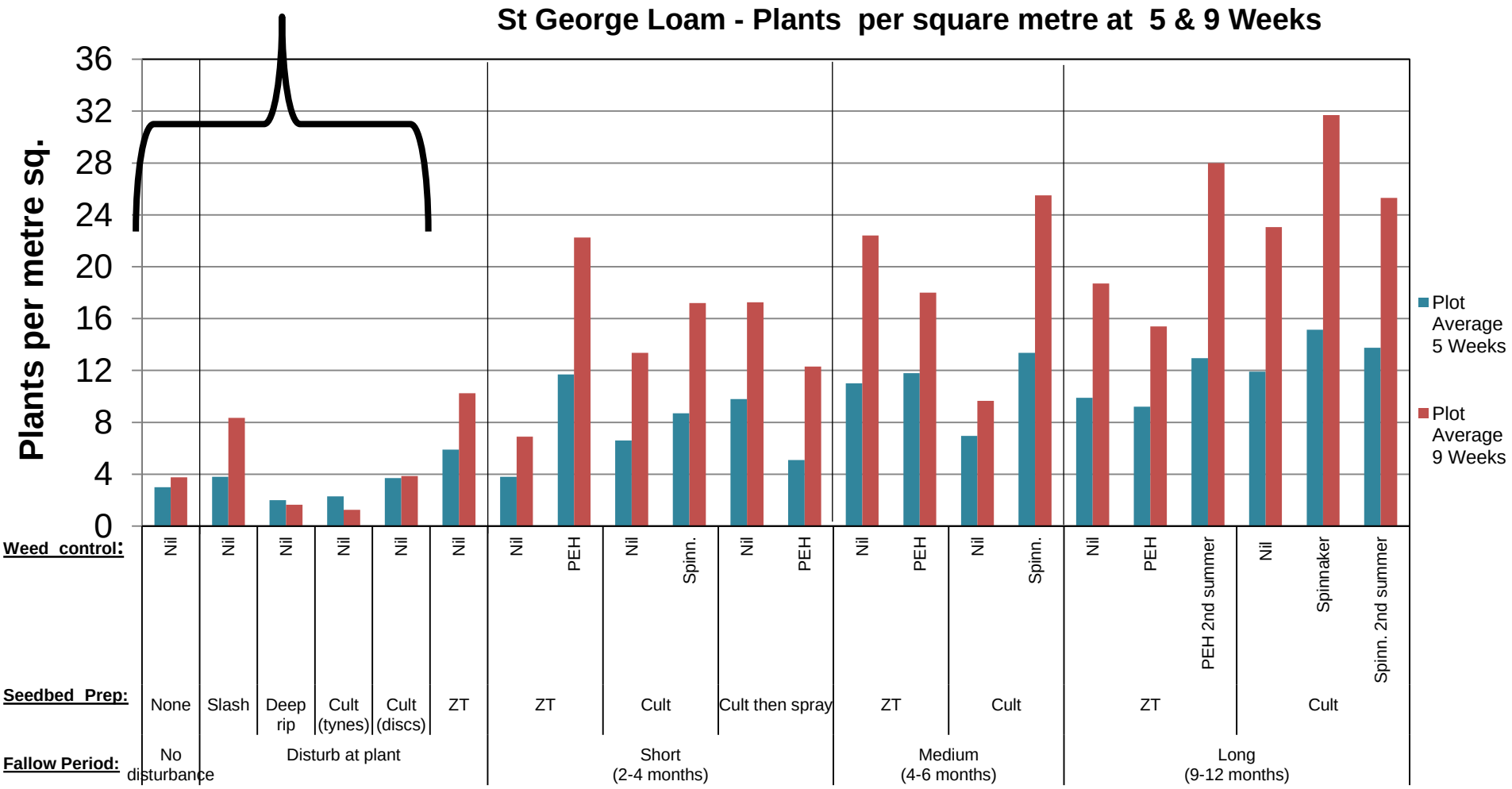
Fallowing and seed bed preparation trials



Longer fallows = more plants

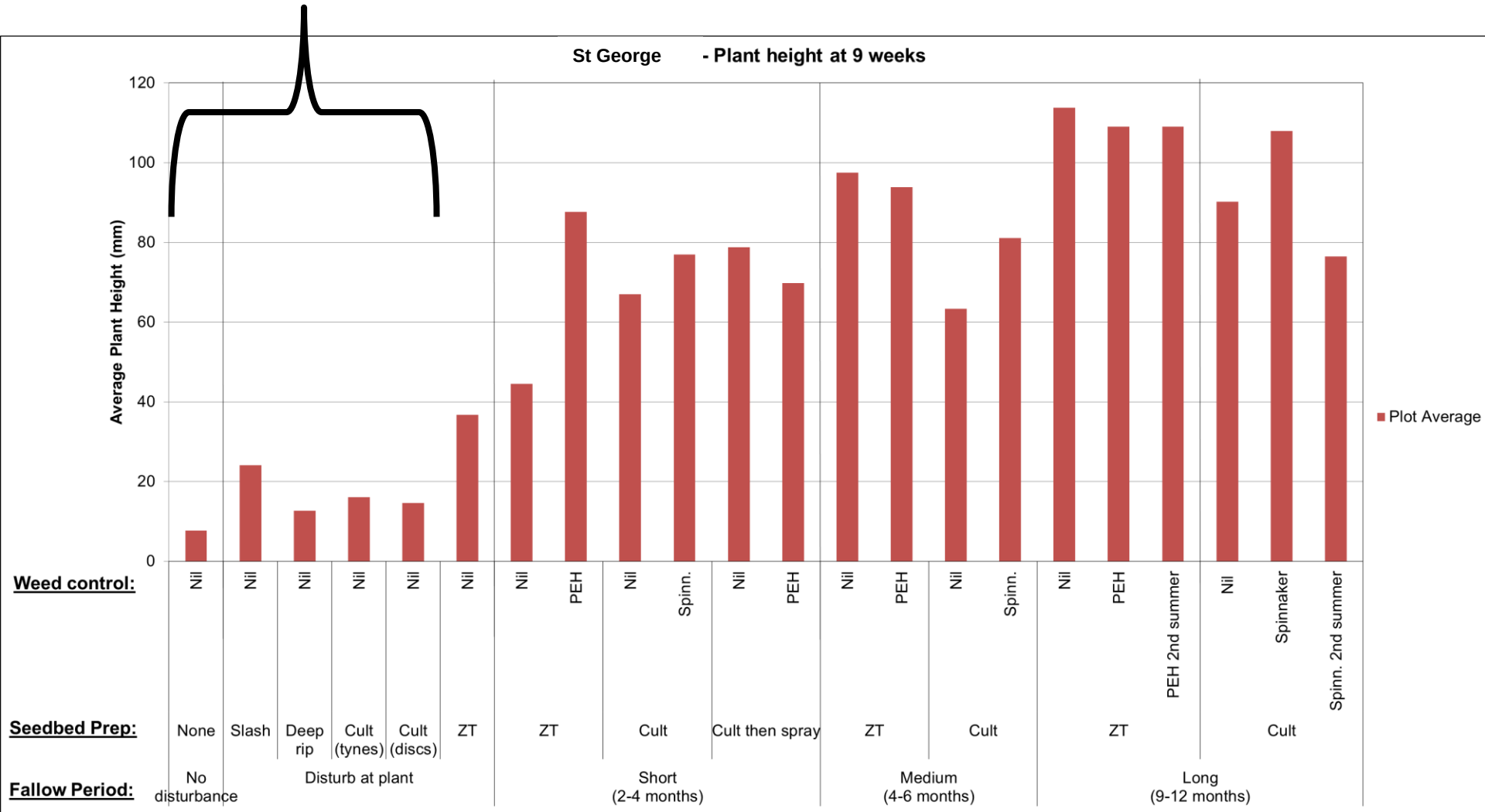
St George: sown 6-7 Feb 2015
First germinating rain: 20mm 1st Mar, 16mm 11th; good autumn and winter; dry spring

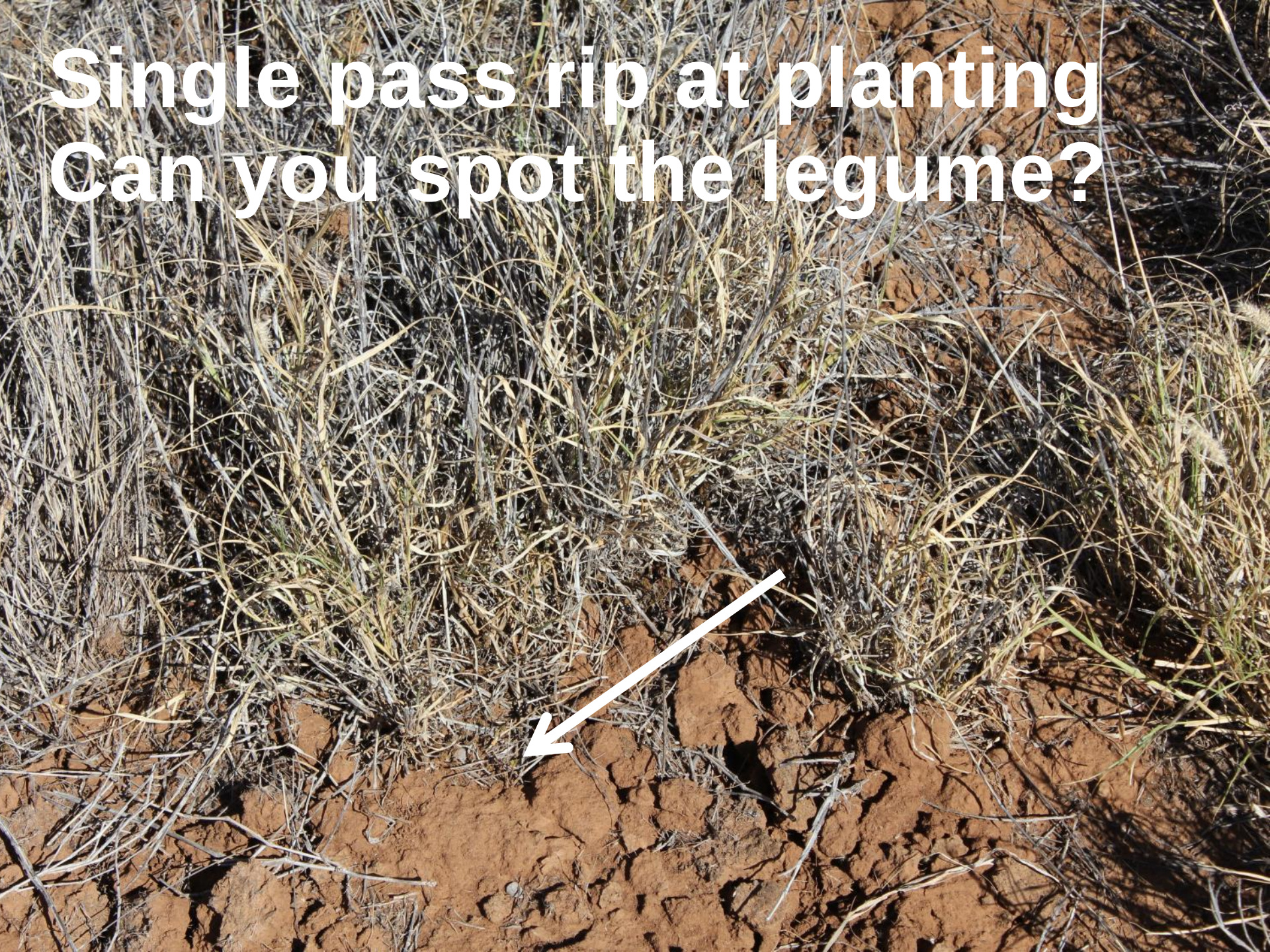
Industry standard practices



Longer fallows = more plants + bigger plants

Industry standard practices




Single pass rip at planting
Can you spot the legume?

A closer look..


1 month after germination.
weak moisture-stressed seedlings,
struggling with competition..


Same day, long fallow plot..


Canon


Canon


Can you spot the legume?
Single pass rip at planting

A closer look..

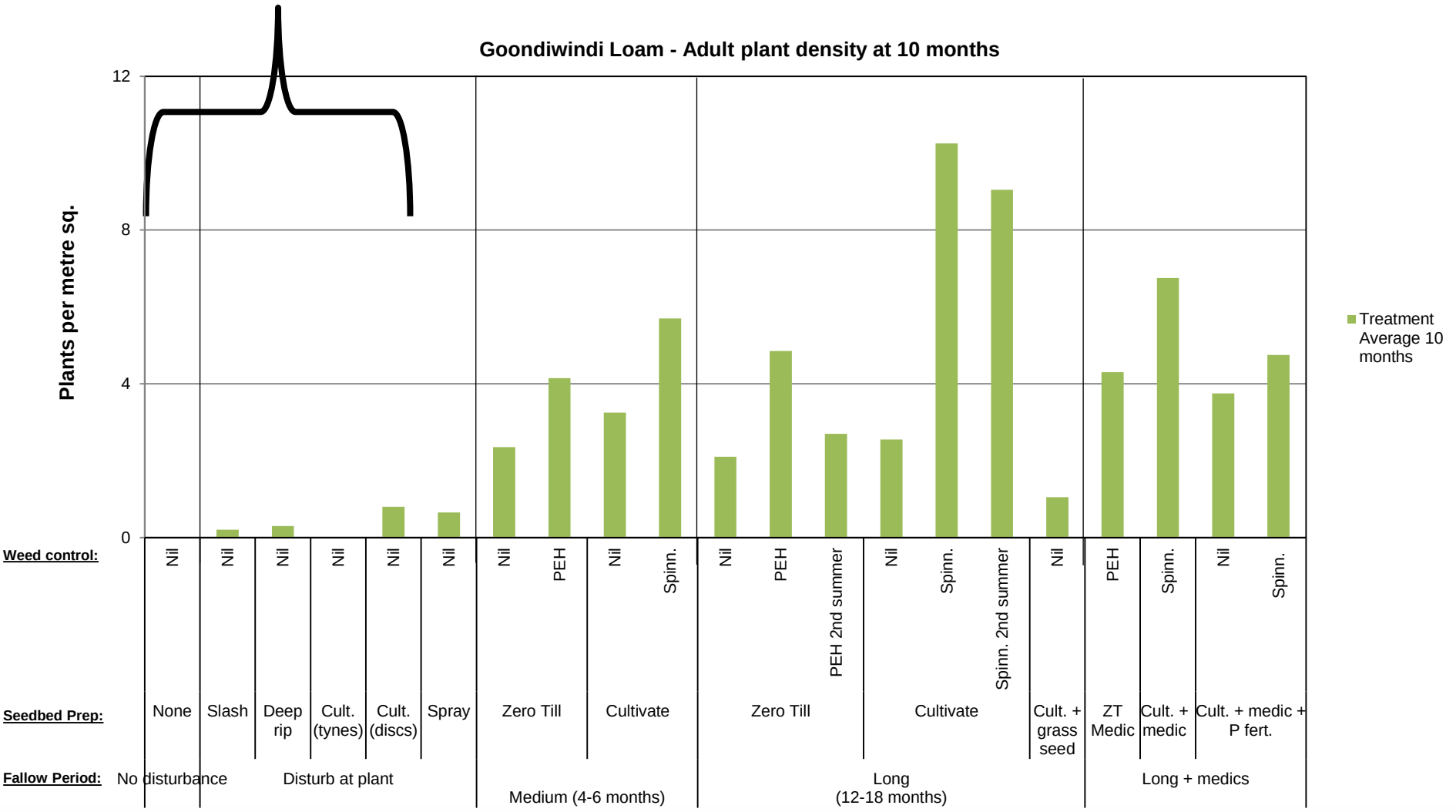
Again, weak moisture-stressed seedlings, struggling with competition..


Same day, medium fallow plot..

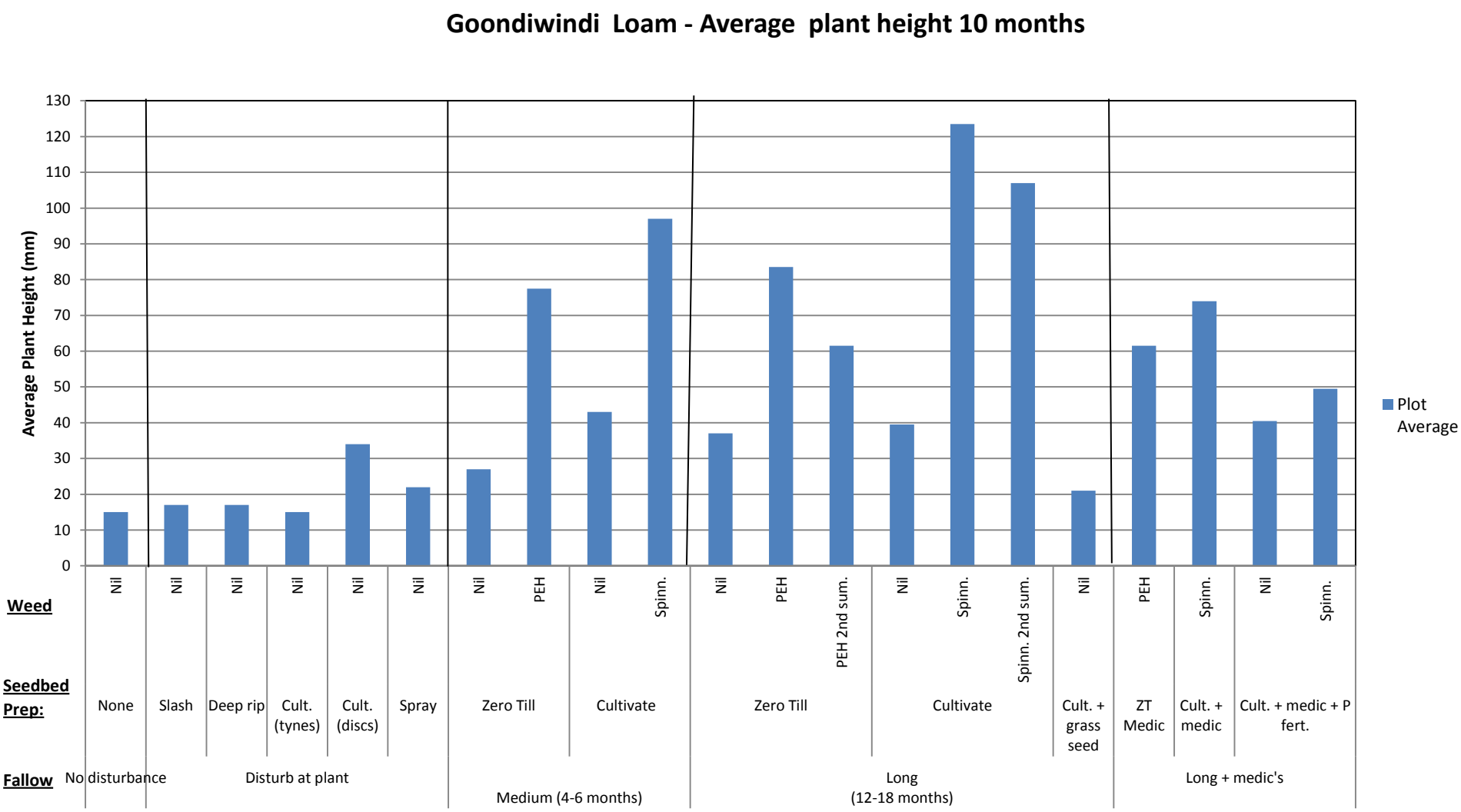

Canon

Post emergence herbicide = more plants where weeds are a problem

Industry standard practices



Post emergence herbicide = bigger plants where weeds are a problem

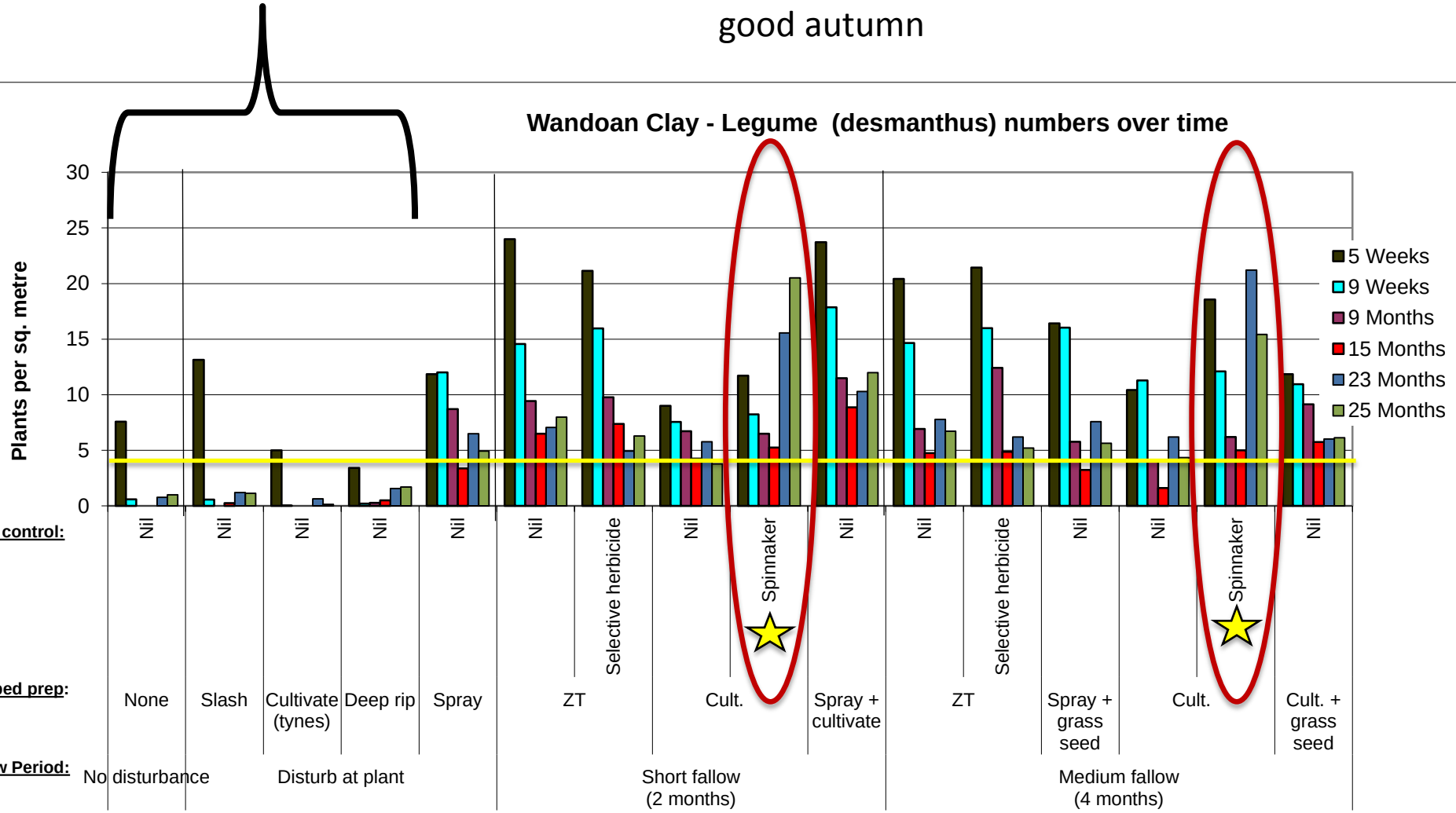


Better agronomy = more plants 2 yrs on…

Fallowing and controlling grass competition

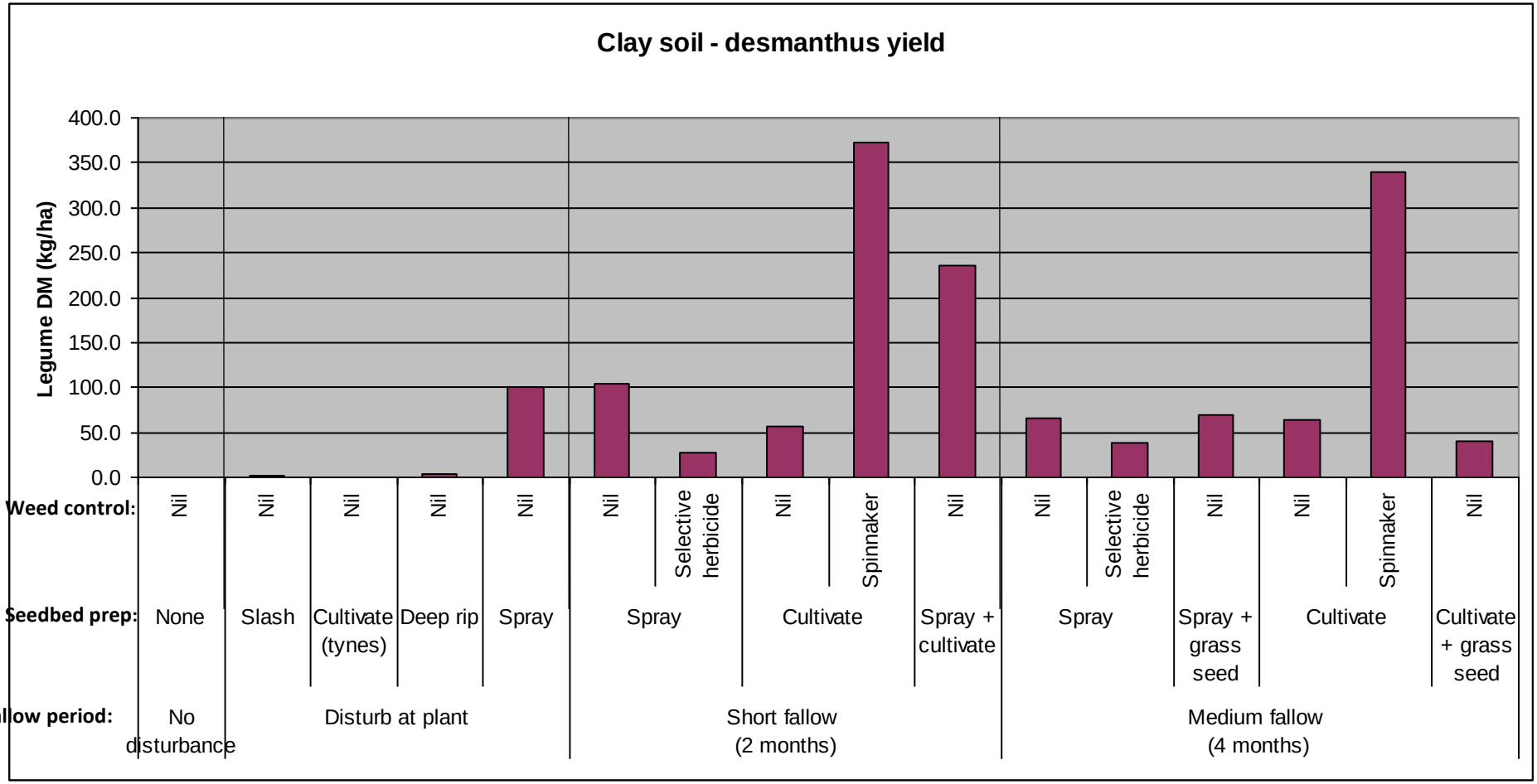
Industry standard practices

Wandoan – sown 13th Feb 2013
First germinating rain - ~40mm 15th Feb; good autumn

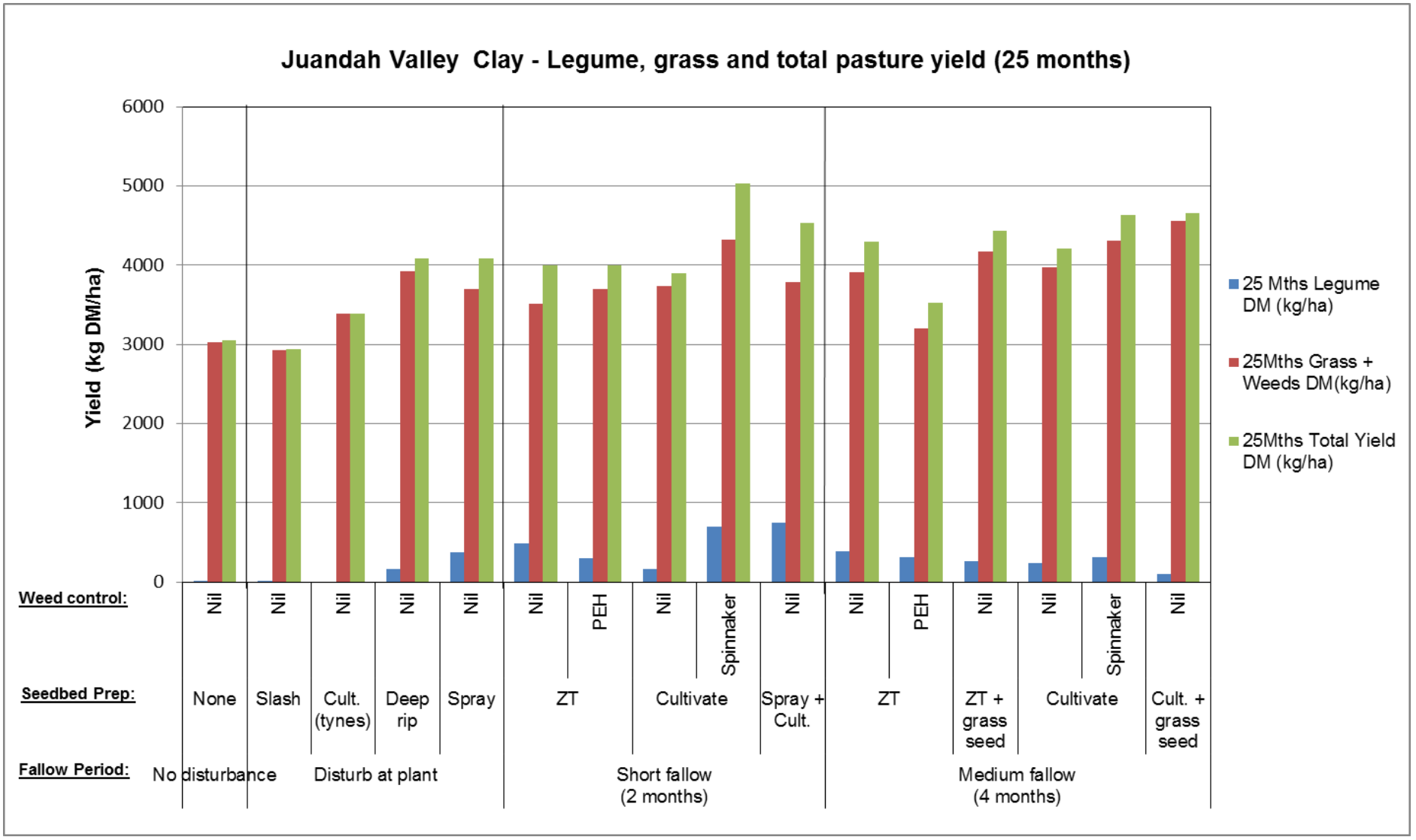


Legume yield – 15 months

Reduced grass competition = more legume growth (+ more seed)



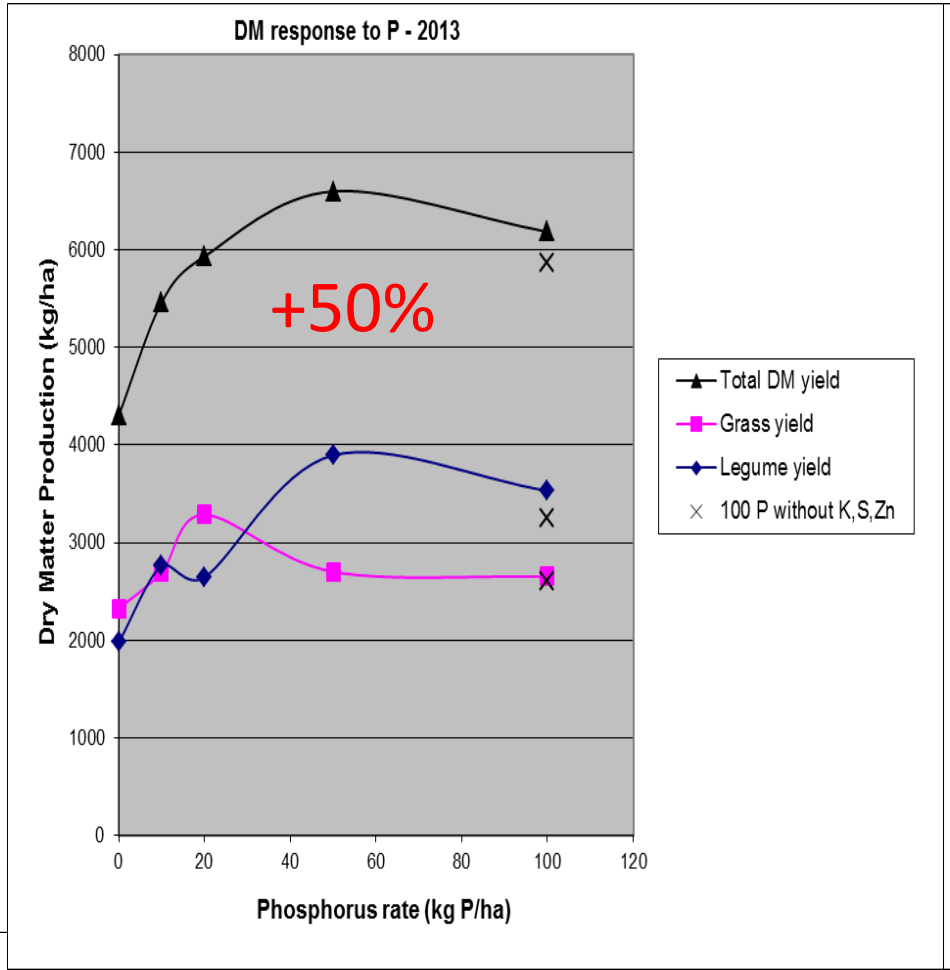
Killing the grass = renovation effect



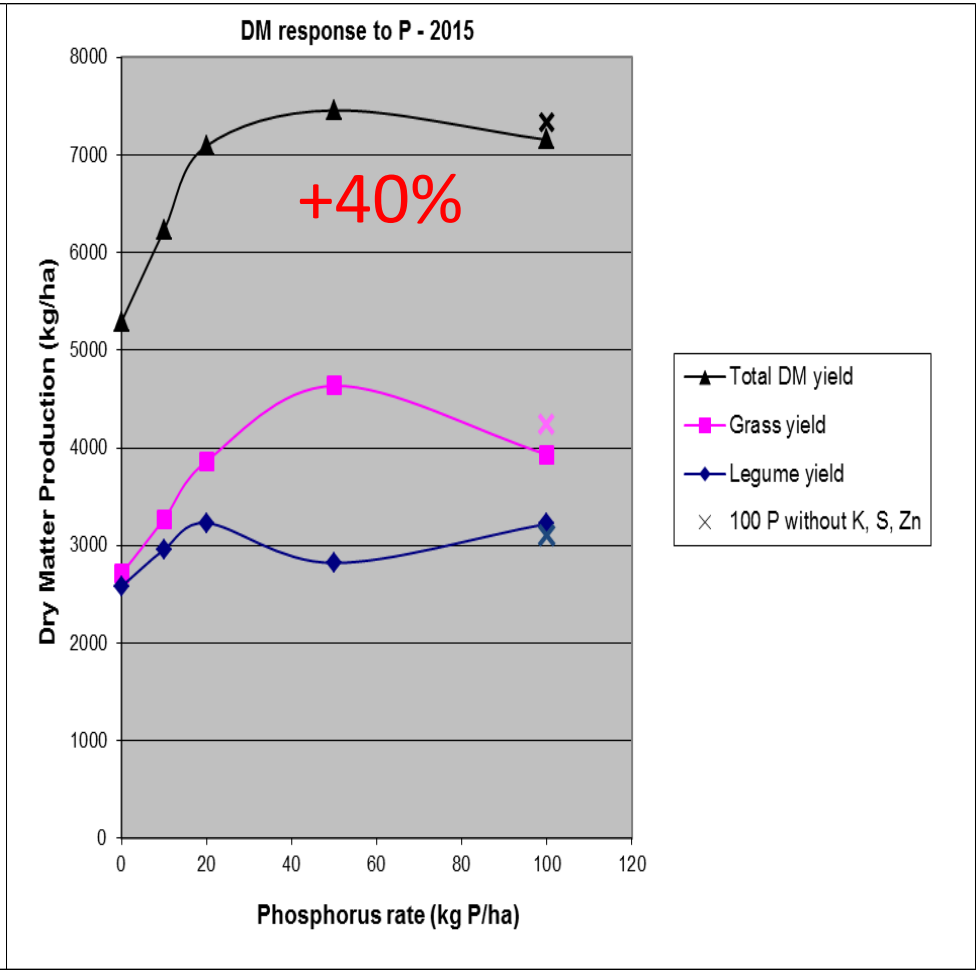
Fertiliser can dramatically improve productivity on deficient soils

Caatinga stylo at Moura

After first summer



After 3rd summer



Section 1: General conclusions

Legumes present a huge opportunity for the grazing industry in northern Australia

- Trials demonstrate large production benefits from some commercially available legumes
- Current ***successful*** adoption of legumes is very low (<5% by area)

Most common reason for low rates of ***successful*** adoption of legumes is poor legume establishment

- But industry recommends and uses **low cost** and **low reliability** techniques
- The production benefits of successfully incorporating a legume warrants a greater investment in reliable establishment

Section 1: Specific conclusions

The most commonly used establishment techniques should ***not*** be recommended with competitive grass pastures:

- No disturbance XX
- Slash XX
- One pass cultivation
  - Tynes XX
  - Discs XX

Spray at plant ?

- Timing is critical

Some fallowing improves establishment

Longer fallows are likely to improve establishment in early years (first 2-5 years)… and *potentially* long term!

Post emergence weed control improves seedling growth

Drilling seed improves emergence on loamy soils relative to broadcasting when using ZT fallows, inconclusive in our trials on cracking clays and/or with cultivation

Questions??

Section 2 - Recommendations

Section 2: Adapting trial results to commercial paddocks to improve the ***reliability*** of establishing legumes

- The establishment timeline
  - Planning, fallowing, sowing/emergence, early growth
- Trade-offs

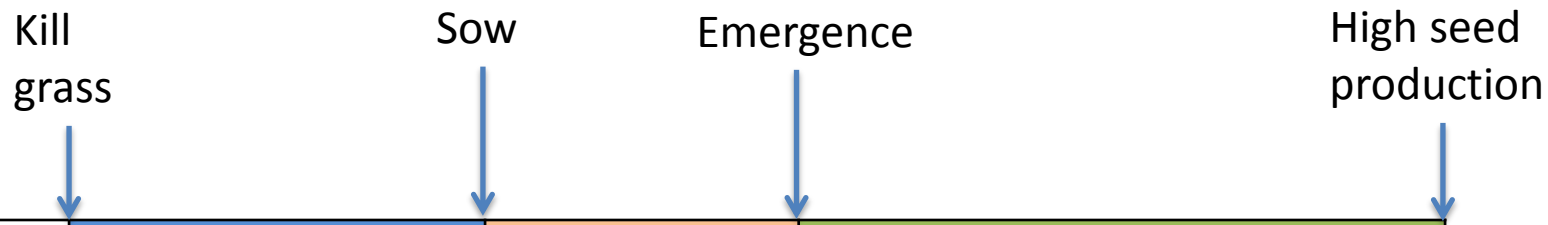
Tons and tons of seed sown…
very few good legume pastures to show for it!

Industry needs to improve the ***reliability*** of establishing legumes

What is the measure of success??

- A lot of "legume paddocks" have low legume numbers (need >4/m^2)
- Low legume numbers = no/low returns!
- **$/kg of seed** is a **poor** indicator
- **$ per legume plants** or **DM produced** in the pasture in **3 – 5 years** time is the **best** indicator

Establishment timeline



Planning	Fallow	Sowing	Early growth
1. Which paddock 2. What method 3. What legume	1. Store moisture 2. Kill grass (weeds) 3. Reduce seed bank 4. Fertilise	1. Timing 2. Seed placement 3. Soil surface 4. Rhizobia 5. Seed quality and rate	Aim for large plants before frost or dry season and seed set. 1. Weeds 2. Grazing 3. Insects

Planning

1. Which **paddock**?
   a) How big an area (destocking, planting costs)
   b) Which paddock to start with (generally higher production potential first)
   c) Soil tests (higher fertility soils, especially P&S)
2. Which establishment **method**?

   Fallow whole paddocks or strips… or no disturbance (cross fingers and pray to the weather gods)
   a) What is the starting condition
   b) What machinery is available
3. What **legume** suits the situation?
   a) Soil type and fertility level
   b) Rainfall/climate zone
   c) Short or long term pasture
   d) Seed availability

Method – starting condition

Method – trade offs

Cultivated fallows: **highest cost** = commercially most **reliable**

No fallows (no disturbance or one pass cultivations): **lowest cost = un-reliable**

- Low legume numbers = no returns

Strips (cultivated or zero-till): compromise between cost and reliability

Economic analysis:

- Quicker establishment generally higher overall returns (NPV)
- Fallowed strips may give higher B/C ratios than whole paddock

Fallow

Aim to store enough moisture to ensure:

- Emerging seedlings can survive until follow up rainfall
- Early growth is vigorous so plants are large to survive either first winter/frosts or dry season.

1. Kill existing grass and weeds
   - Often requires several cultivations or sprays to fully kill the pasture
2. Reduce the soil seed bank
   - Huge soil seed banks under most pastures
3. Fertilise if required
   - If deficient, legumes can respond strongly

Storing water in the fallow

When do I start land preparation?

Need to kill the grass early to ensure enough time (rainfall) to obtain a good profile of water at the planned planting time.

	Fallow length				
Region	12 months	7 months	5 months	3 months	2 months
Goondiwindi	135 (68)	80 (40)	65 (33)	55 (28)	40 (20)
Miles	140 (70)	90 (45)	85 (43)	70 (35)	50 (25)
St George	120 (60)	55 (28)	45 (23)	40 (20)	25 (13)
Emerald	140 (70)	80 (40)	80 (40)	65 (33)	60 (30)
Clermont	140 (70)	75 (38)	75 (38)	65 (33)	50 (25)
Banana	140 (70)	95 (48)	90 (45)	85 (43)	65 (33)

Average mm of stored water in the profile by January (Data from Whopper Cropper)

( ) Depth (cm) of wet soil

Pasture soils store between 90 – 200mm

Inland areas aim for > 50cm of soil moisture

Fallow – soil type and rainfall zone trade offs

Chance of follow up rain varies.

- High likelihood of rain don't require as much soil moisture in most years (coastal and monsoonal areas)
- Lower rainfall reliability districts require higher moisture storage (inland, sub-tropics)
- High SOI years don't require as much soil moisture storage

Water Holding Capacity of soils varies.

- Low: shallow duplex; coarse sands; shallow rocky soils
- Medium: Shallow loams or clays; deeper duplex; fine sands; clays with sub-soil constraints
- High: Deep loams and clays

Sowing to emergence

Small seeded legumes need to be planted at or near the soil surface…

Therefore they are sown but **do not germinate until rain** is received

1. **Timing** – sow when there is the highest chance of getting follow up rain
    - January/February for most of Qld for tropical legumes, stored moisture can extend this window
    - Autumn for medics and clovers
    - Shorter time period from sowing to emergence reduces losses
2. **Seed placement**
    - Seed to soil contact is critical
    - Sowing depth ~1cm for most small seeded legumes. If not good depth control it is better to place seed on the surface
3. **Soil surface condition**
    - Crusting
    - Cover
4. **Rhizobia** – big problem with soil temperatures and coated seed
5. **Seed quality and seeding rate**

Sowing to emergence – Seeding rate

The recommended seeding rate is **1kg/ha of pure live seed**.

Germinable seed sown (kg/ha) =

planting rate (kg) X germination (%) X purity (%)

Coated or uncoated seed?

Coated seed has different seed to coat ratios, 3 to 1 (250 g of seeds /kg) is the lowest ratio and it goes up to 8 to 1 (120 g of seed /kg).

Depending on the ratio the planting rate will have to be at least 4 times that of bare seed to plant the same amount of seed

Request a seed quality certificate (retain or test seed)

Early growth

Aim for large plants before frost or dry season and maximise seed set.

1. **Weeds**
   - Can have a huge impact, especially if the soil seed bank has not been reduced during a fallow
2. **Grazing**
   - Grazing must be managed until legume plants have flowered and set seed
   - If seedlings are growing well, light grazing can promote flowering
3. **Insects**

Early growth - Weeds

Weeds are likely to be a problem, especially on:

- Old cultivation
- Lighter soils

Fallows reduce the soil seed bank

Jan – Feb plant allows spring and early summer weeds to be controlled by cultivation or chemical

Post emergence herbicide made a big difference in our trials… but the chemicals used are not registered for all legumes.

Check registrations first!

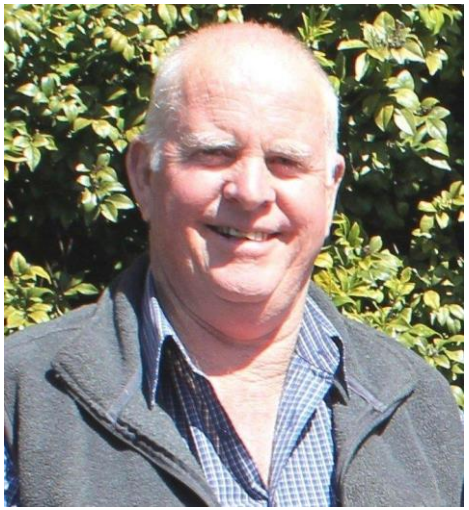
Early growth – Cover crops or smother crops?

Conclusions

- Plant legumes
  - Well adapted, productive varieties available
- Poor establishment is the most common reason for failure
  - Spend more time and effort
  - Planning, fallowing, sowing/emergence, early growth
- Plant nutrition is important for legume production
  - Pick higher P soils first (soil test)
  - If P deficient, fertilise in moderate to high production environments
- MLA funded project finishes mid-2016, new funding required to:
  - Continue establishment trials
  - Develop and deliver training with graziers on establishing legumes

Questions??

Further information:



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