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Irrigated Crop Rotations

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Canada

What's the three most important things about buying a house?

1. Location
2. Location
3. Location

What's the three most important things about growing a crop?

1. Rotation
2. Rotation
3. Rotation

Pros of crop rotation

1. **Diversification**
   Monoculture: 'eggs in one basket'
2. **Pest, disease and weed control**
3. **Reduces erosion**
4. **Improves soil conditions, fertility**

Cons of crop rotation

1. **More knowledge/skill required**
2. **More equipment needed**
3. **May reduce profits!**

Definitions

Crop rotation: cycles within fixed format: e.g. 2 cycles of a 3-yr rotation:

[Potato-bean-wheat]-[potato-bean-wheat] = 6 yrs

Crop sequence: the arrangement within a rotation:

Potato-bean:

- potato harvest (Sept) to bean planting (May) – 8 mo
- plant cover crop

Bean-potato:

- bean harvest (Sept.) to potato planting (April) – 7 mo
- cover crop?

Sugar beet-wheat

- beet harvest (Oct.) to wheat planting (April) – 6 mo
- too late for cover crop

Wheat-sugar beet

- wheat harvest (Sept) to beet planting (April) – 7 mo
- cover crop?

Other related concepts

- **Monoculture/monocropping: same crop every year**
- **Intercropping: two or more crops**
  - **Mixed: seeded at same time**
  - **Relay: seeded at different times**
  - **Strip: seeded in wide strips (seeder width)**
- **Break crop: UK, Australia**
  - **Usually refers to a one year break with a legume after >5 yr of cereals, then back to cereals**

Crop rotations:

There are no rules! (Avoid monoculture)

But many considerations…

Soil type, weather, markets, labour, weeds, pests, diseases, nutrients, herbicides etc….

Synergistic, e.g. dry pea before corn

Antagonistic, e.g. hybrid canola after fall rye, allelopathy

Crop choices

Specialty Crops

Cereals/forages

Oilseeds

Pulses

Root crops

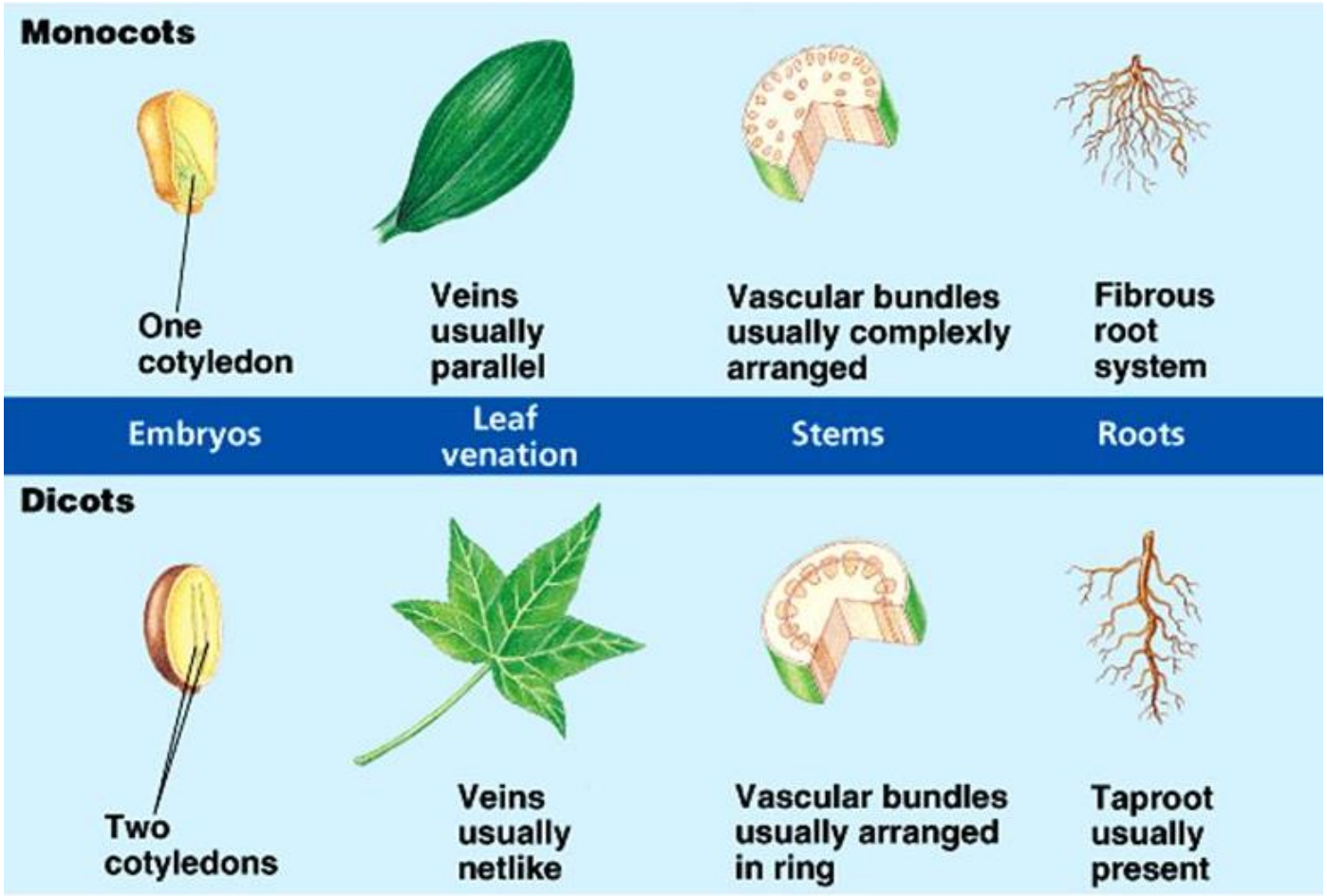
High carbon returns to soil
Some perennials

Non-mycorrhizal

N credits

Soil disturbance

Rotate monocots and dicots



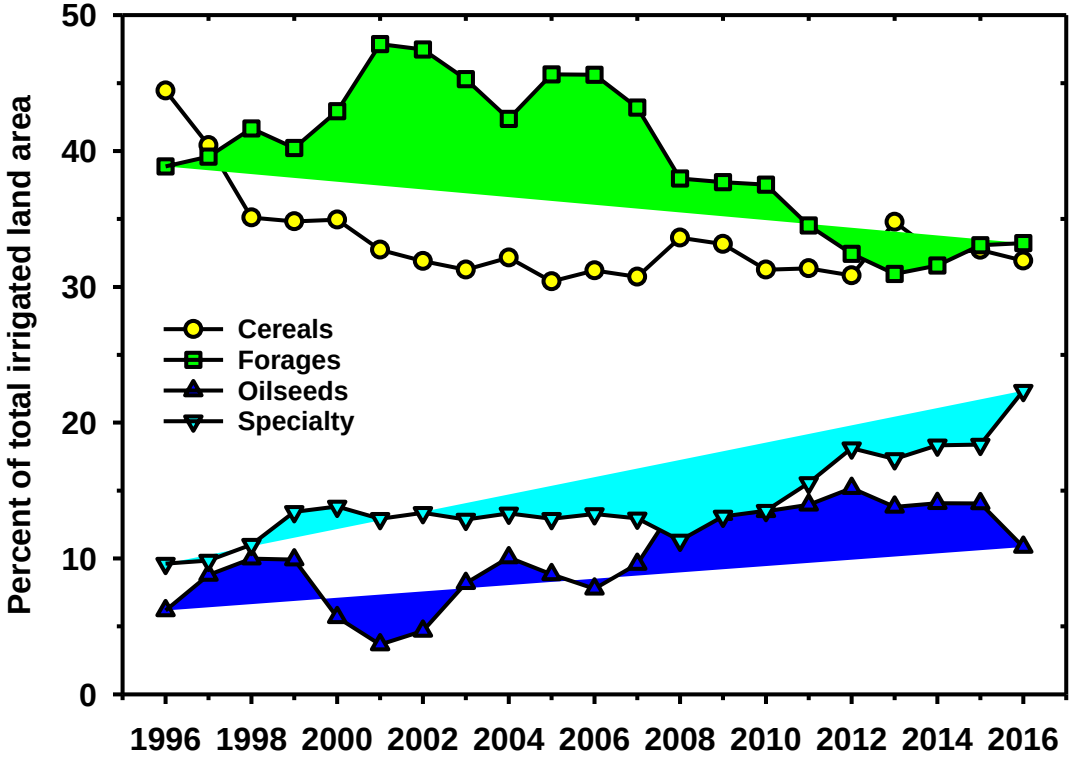
Cereals
Forages
Corn

Oilseeds
Legumes
Potato
Sugar beet

Crops crops in the mix for irrigated rotations

Cereals	Forages	Oilseeds	Specialty
Barley	Alfalfa – 2 cuts	Canola	Alfalfa Seed
CPS Wheat	Alfalfa - 3 cuts	Flax	Canary Seed
Durum Wheat	Alfalfa Hay	Mustard	Canola Seed
Grain Corn	Alfalfa Silage	Safflower	Carrot
Hard Spring Wheat	Barley Silage		Catnip
Malt Barley	Barley Silage (underseeded)		Chickpea
Oat	Brome Hay		Dill
Rye	Corn Silage		Dry Bean
Soft Wheat	Custom Variety Forage/Misc.		Dry Pea
Triticale	Grass Hay		Faba Bean
Winter Wheat	Green Feed		Fresh Corn (sweet)
	Milk Vetch		Fresh Pea
	Millet		Grass Seed
	Native Pasture		Hemp
	Oats Silage		Lawn Turf
	Sorghum/Sudan Grass		Lentil
	Tame Pasture		Market Gardens
	Timothy Hay		Mint
	Tritcale Silage		Nursery
			Onions
			Potato
			Pumpkin
			Radish
			Safflower
			Seed Potato
			Small Fruit
			Soybean
			Sugar Beet
			Sunflower

Cropping trends, Irrigation Districts (1996-2016)



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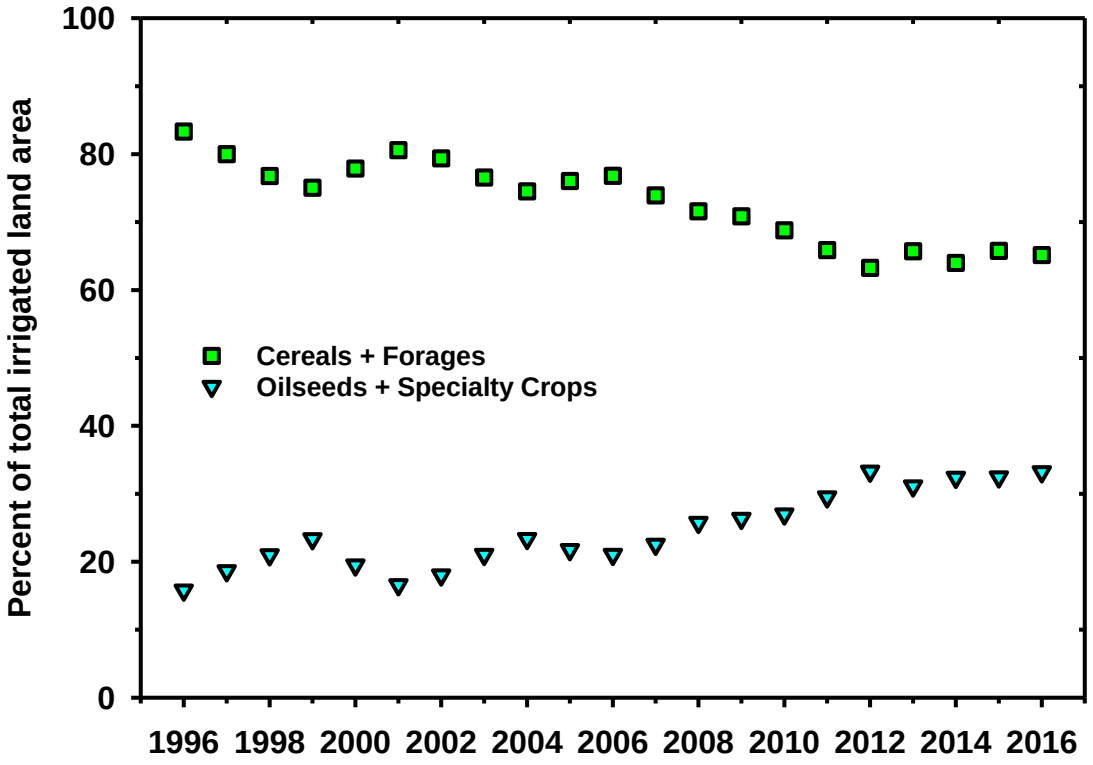

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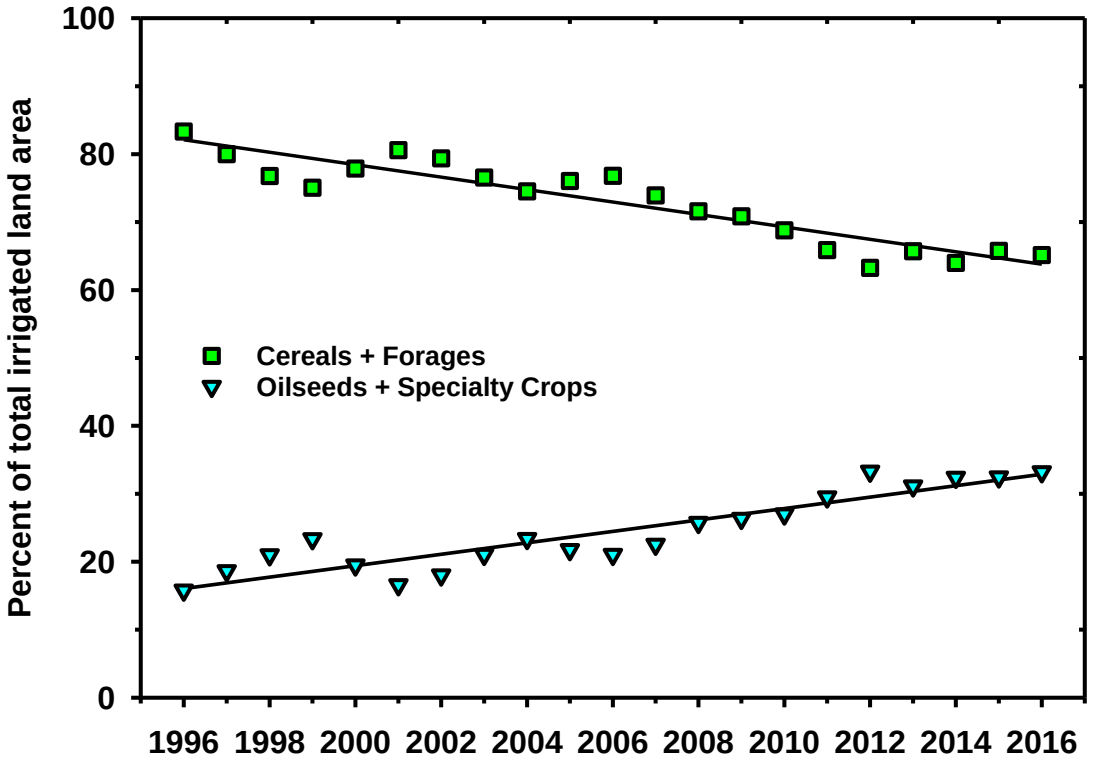

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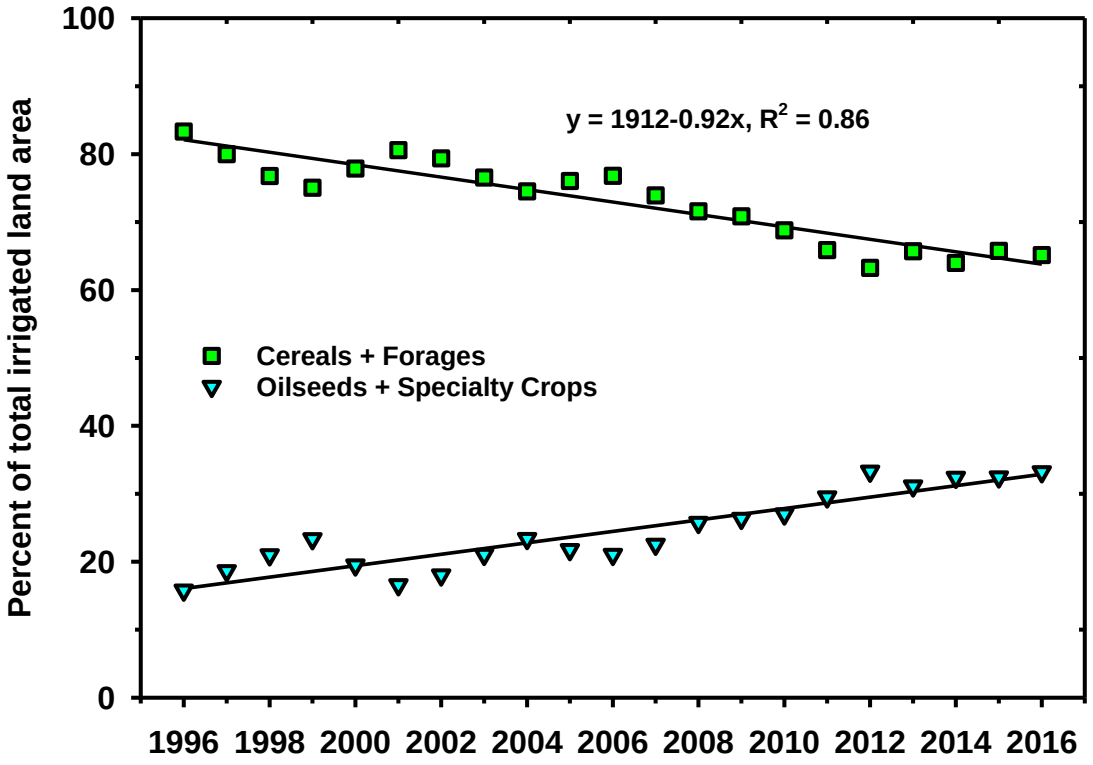

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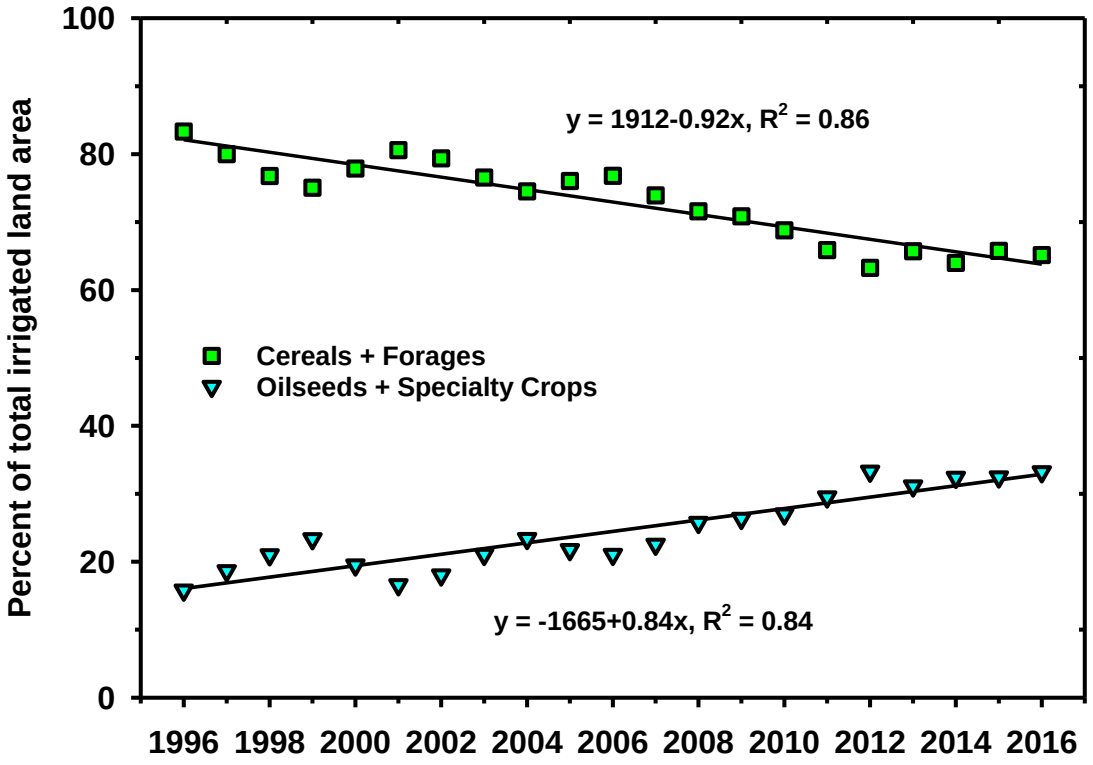

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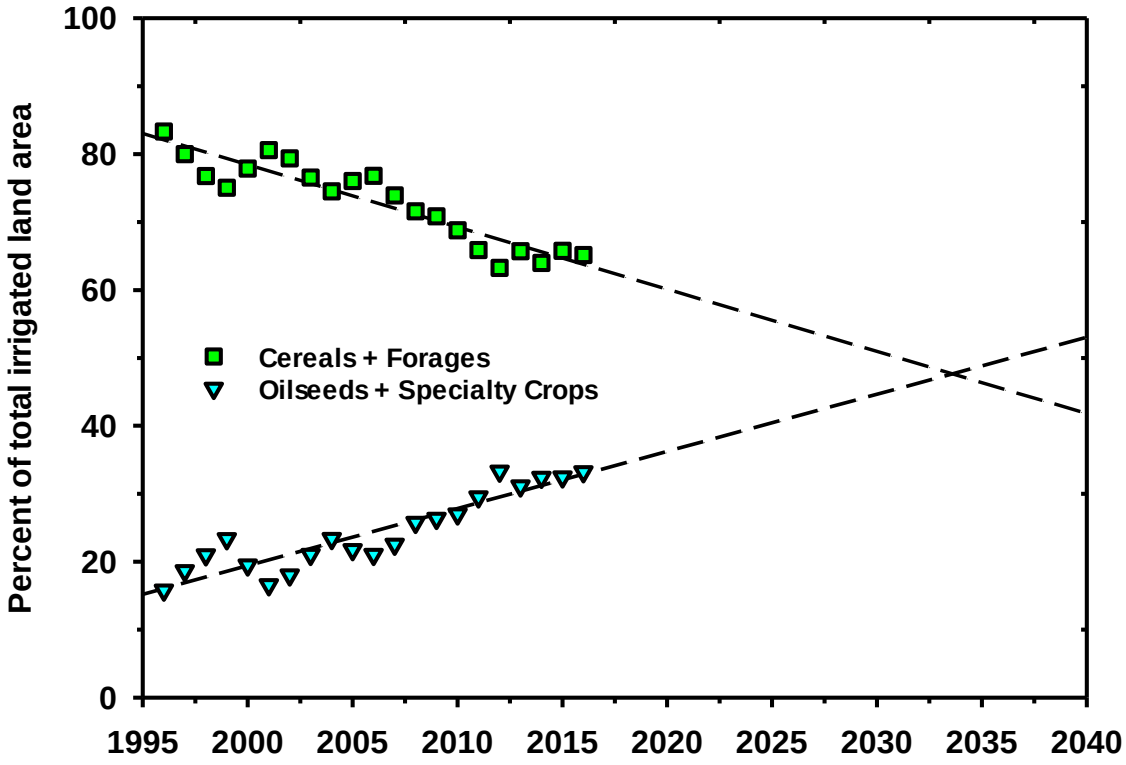

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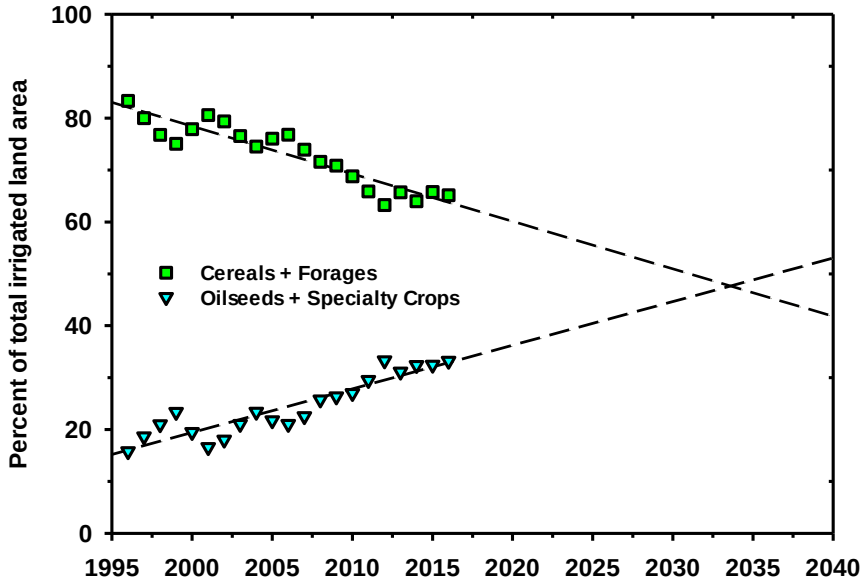


Annual carbon inputs to soil vary with crop

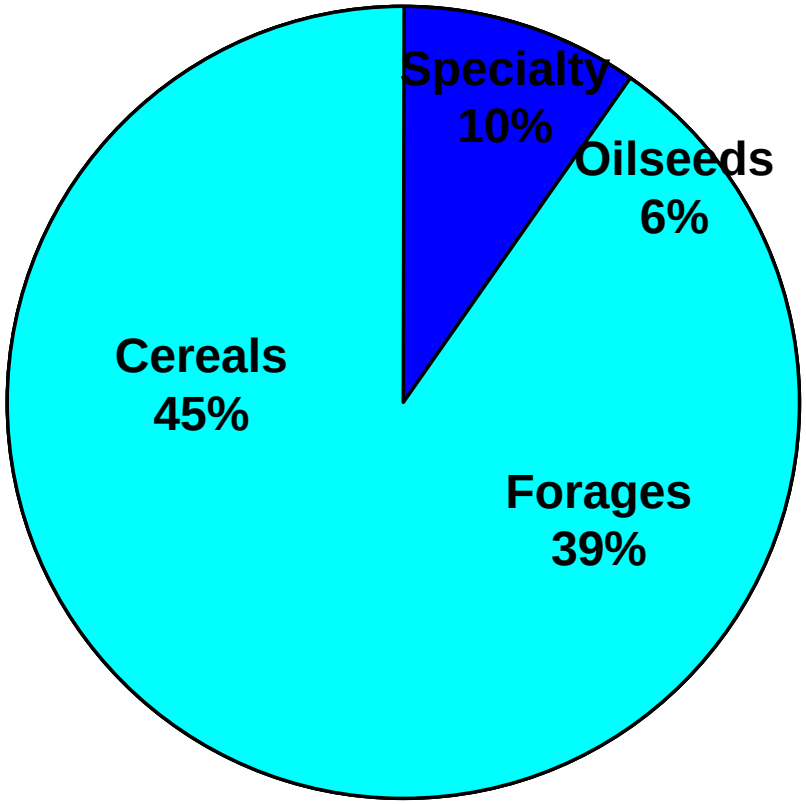
Crop	Carbon input, tonnes/ha
Soft wheat	4.6
Timothy	4.5
Potato	2.3
Sugar beet	1.7
Dry bean	1.1

If cereal and forage area continues to decline:

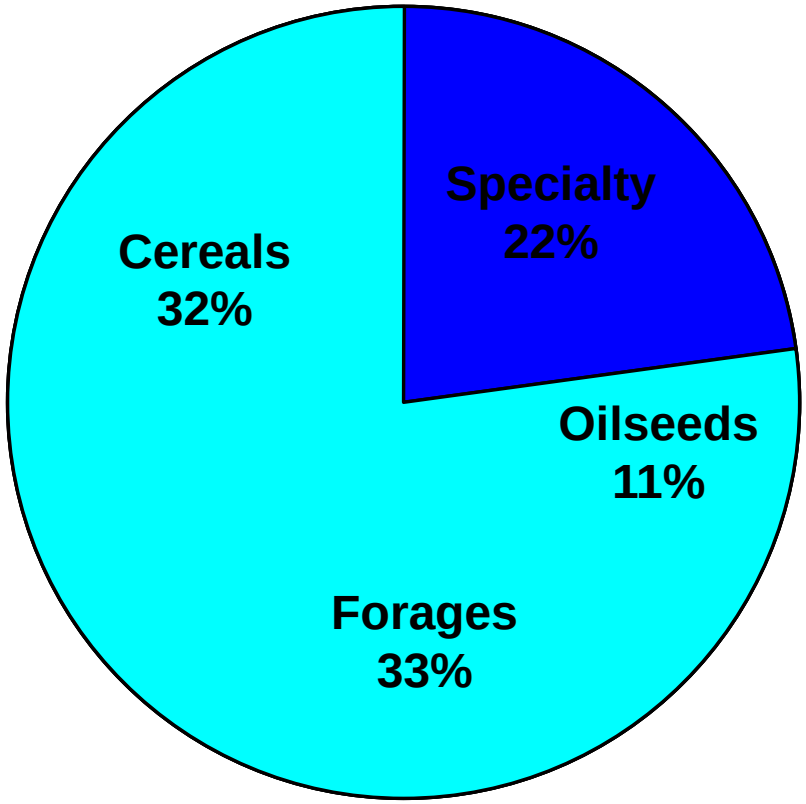
1. Soil organic carbon levels will decline
2. Implications for maintenance of soil health
3. Other ways to replenish carbon, e.g. compost, cover crops, green manures

Crop trends on irrigated land: 1996-2016

1996



2016



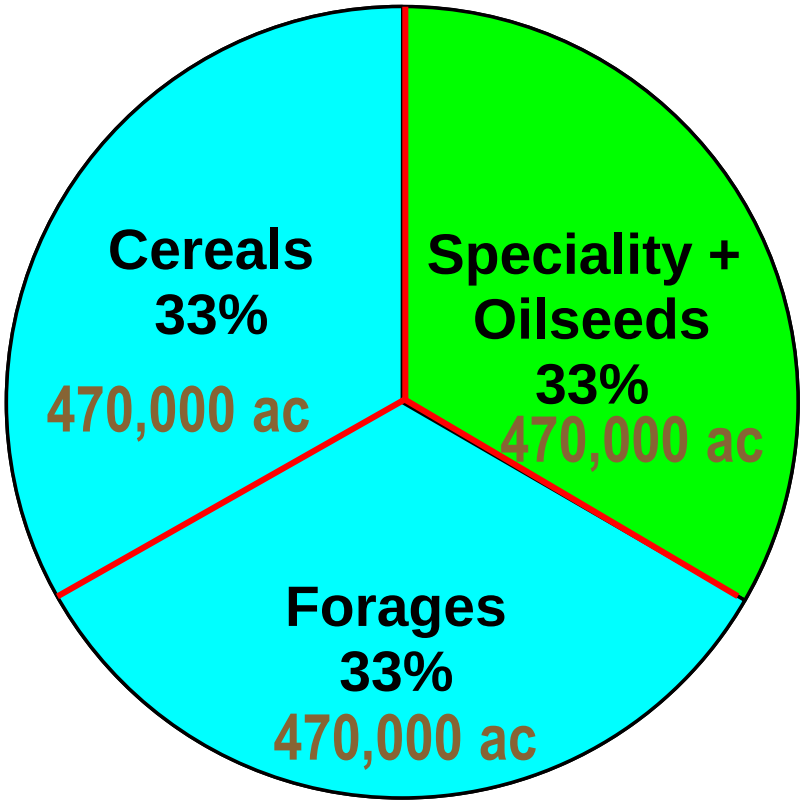
0.33 + 0.33 + 0.33

Crop trends on irrigated land: 2016-17

Time (When): Year crops are grown

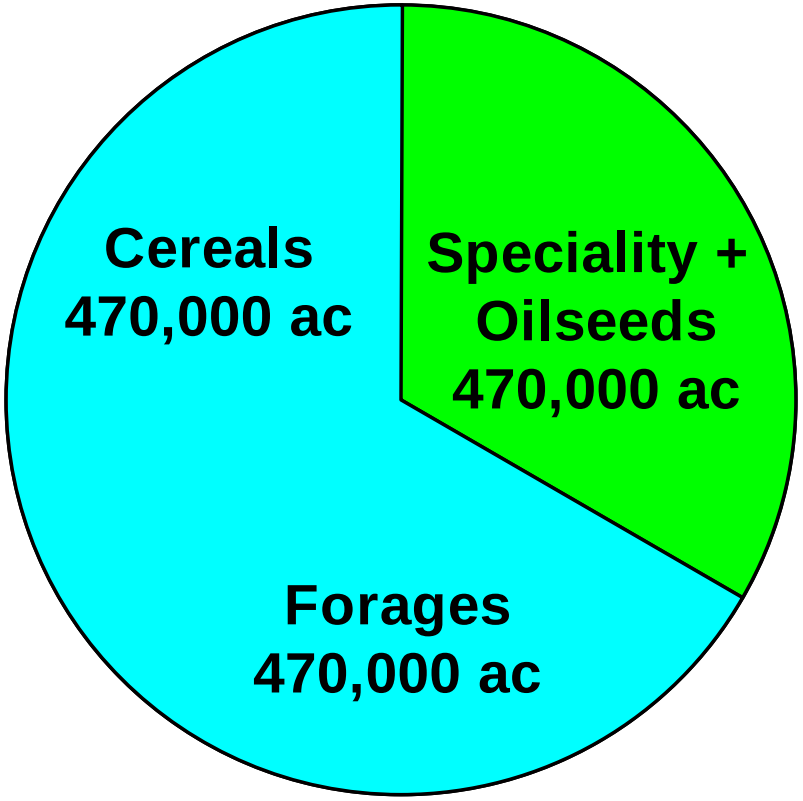
Space (Where): Land crop is grown on: split 1.4 million acres in three

2016



Residue crop

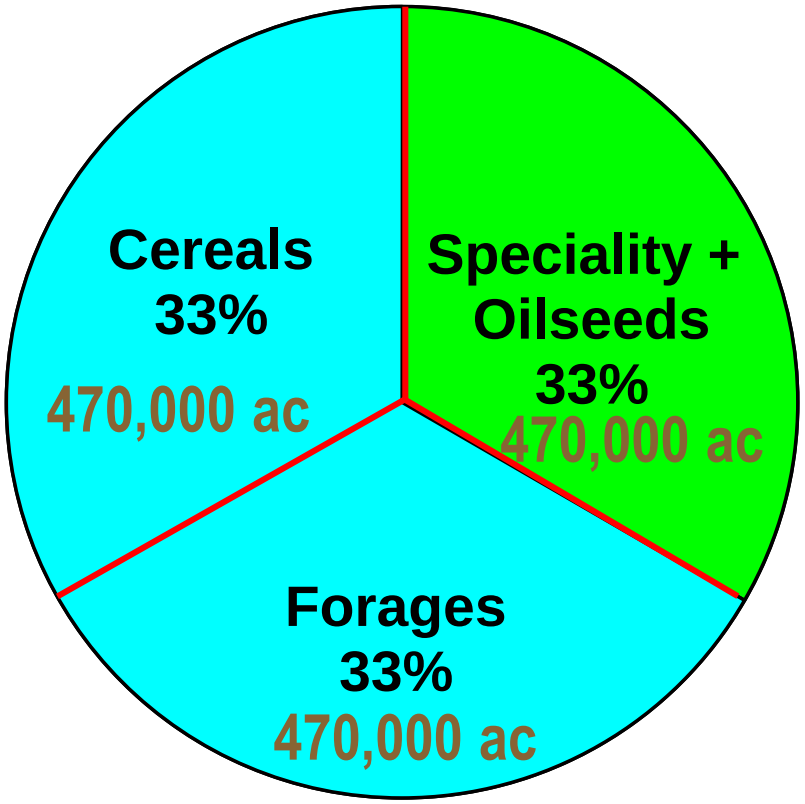
2017-A



Expected crop

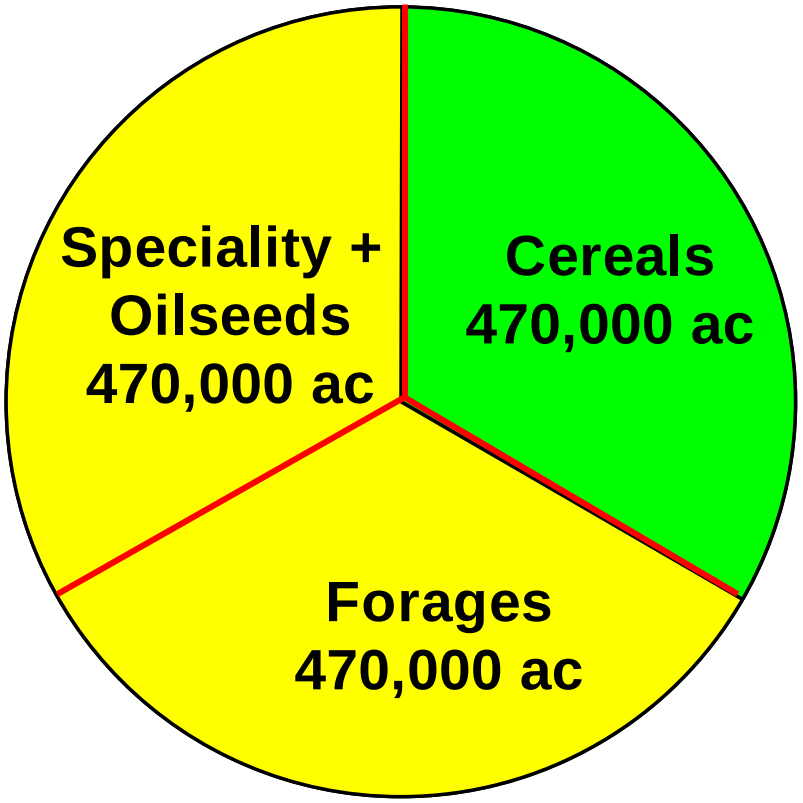
Crop trends on irrigated land: 2016-17

2016



Residue crop

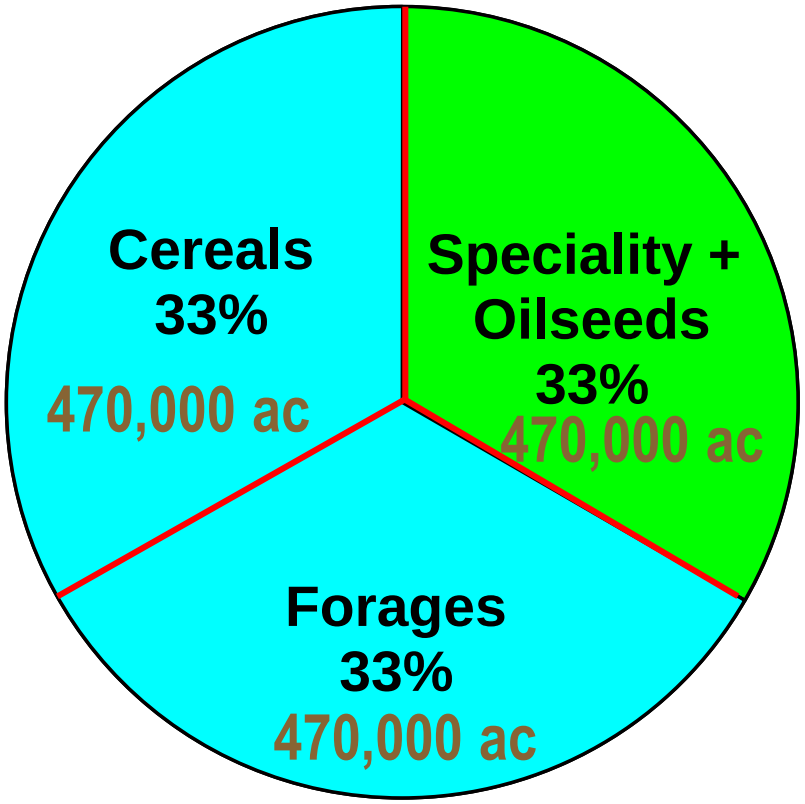
2017-B



Expected crop

Crop trends on irrigated land: 2016-17

2016



Residue crop

2017-C

Spec + Oilseed 0.25

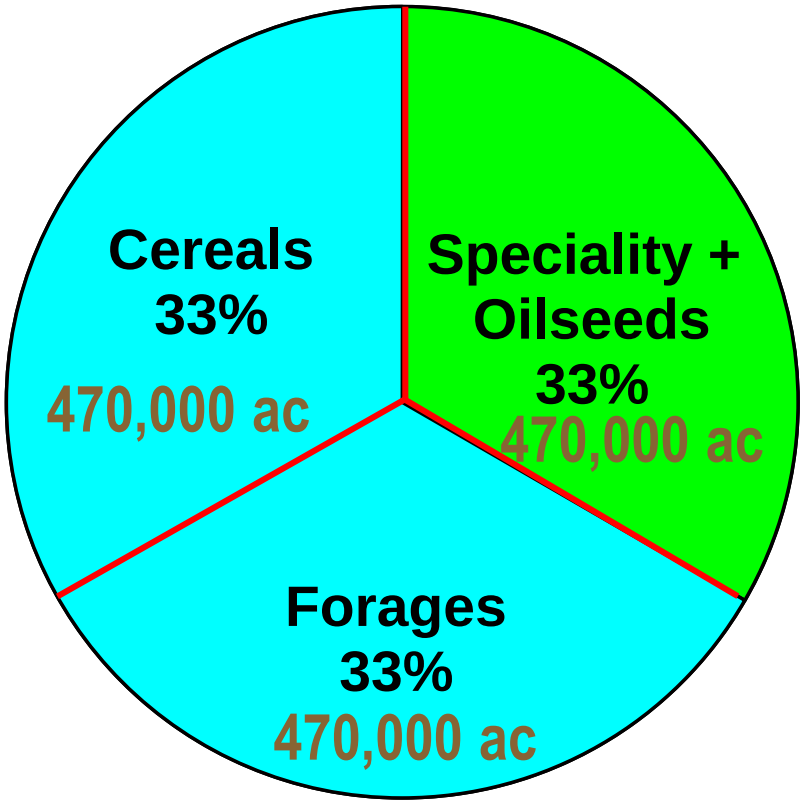
Forages 0.5

Cereals 0.25

Expected crop

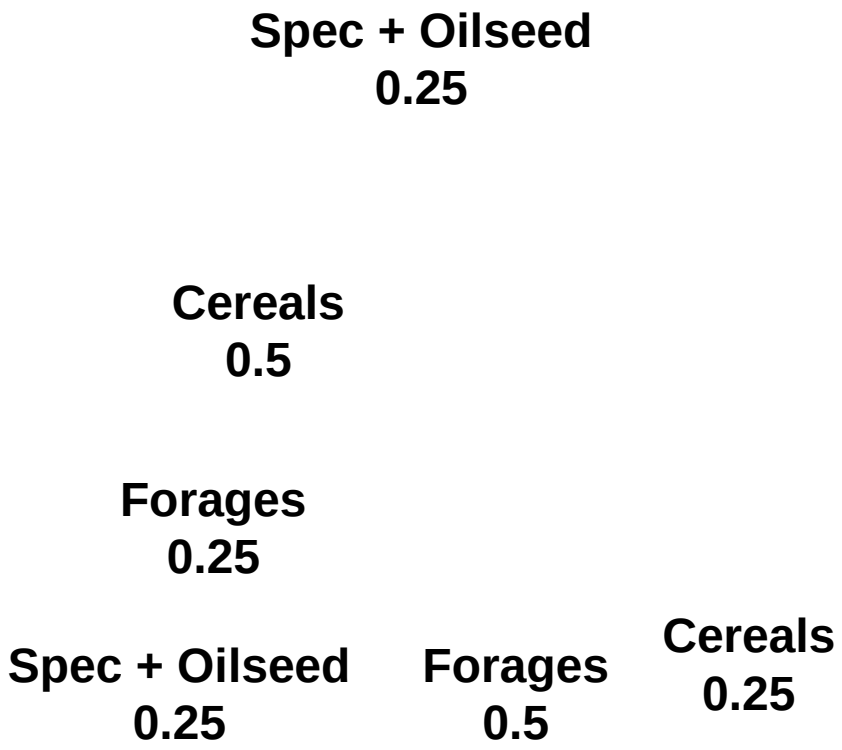
Crop trends on irrigated land: 2016-17

2016



Residue crop

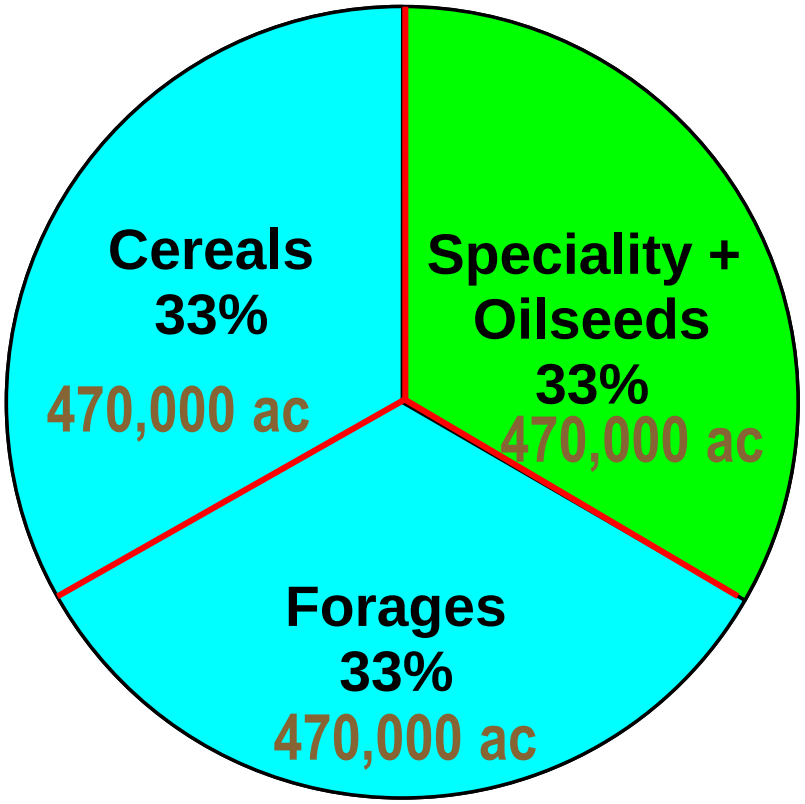
2017-C



Expected crop

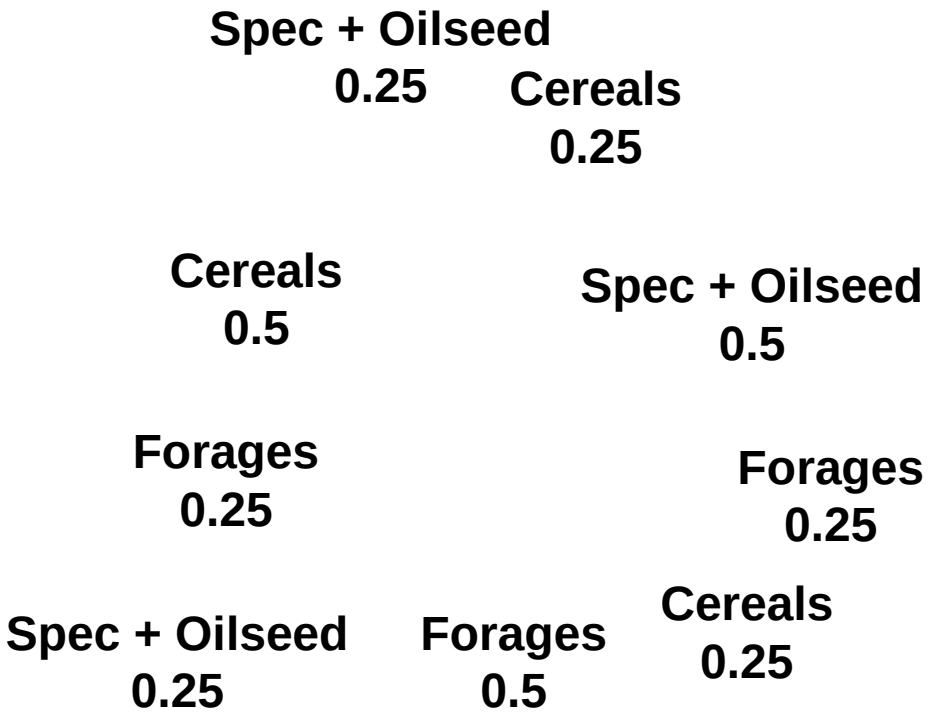
Crop trends on irrigated land: 2016-17

2016



Residue crop

2017-C



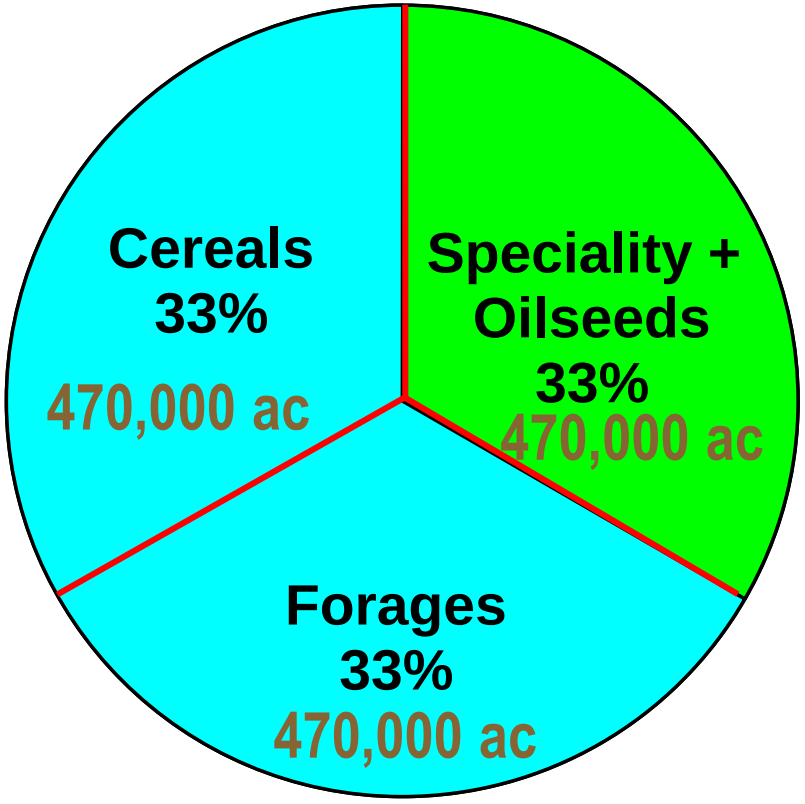
Expected crop

Crop trends on irrigated land: 2016-17

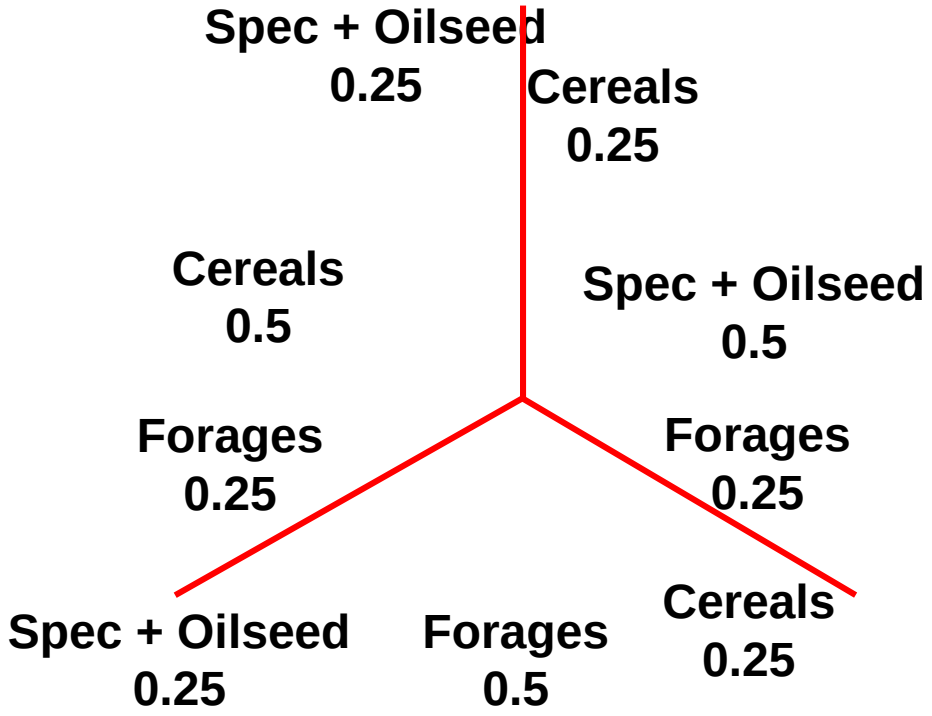
2016

2017-C

Still have same acres of each category but good distribution of rotations across residue crop land base



Residue crop



Expected crop

Wind Erosion

- Wind erosion – not sustainable
- Wind erosion risk: Irrigated > Dryland
- Major irrigated crops in southern Alberta (potato, sugar beet, dry bean) produce low amounts of crop residue
- Residue cover is the #1 one line of defense against wind erosion

Rotation and crop residue cover

<30% residue cover considered a threshold for wind erosion risk

Effect of adding fall rye cover crop

Previous crop	Cover, %
Potato + fall rye (Sep 25-May 11)	58
Potato + fall rye (Sep 25-Apr 25)	30
Dry bean + fall rye (Sep 25-Apr 25)	28

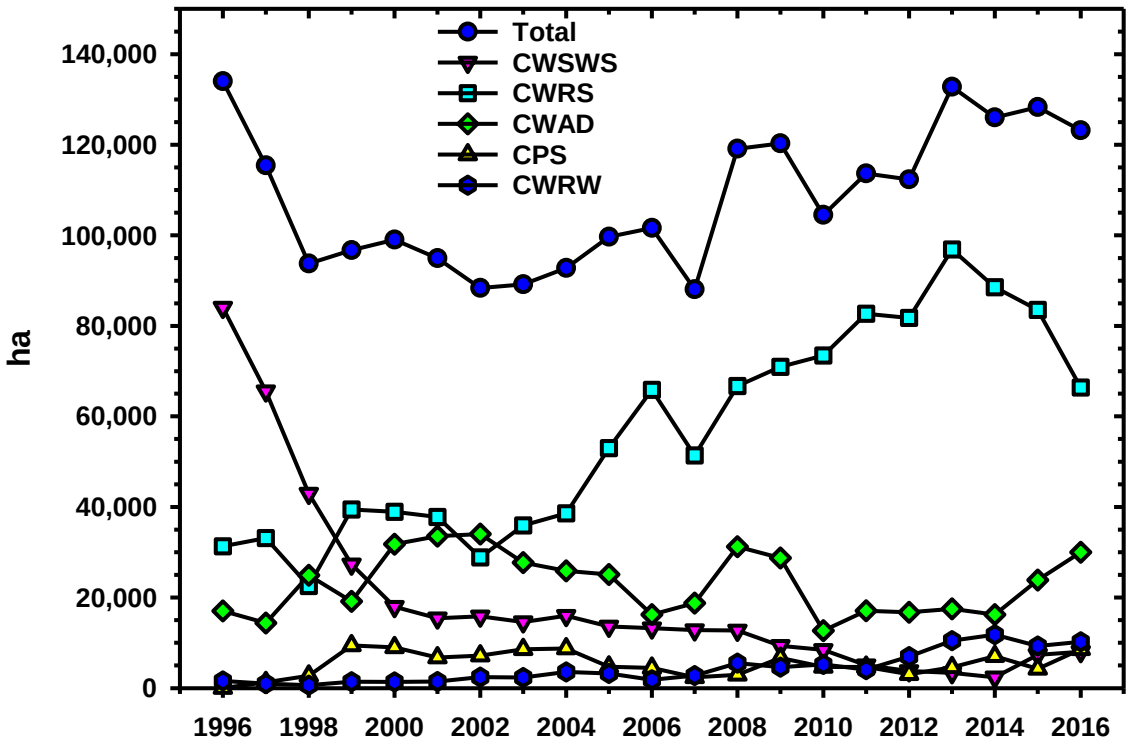
Vauxhall irrigated rotation: effect of previous crop on average residue cover in spring (2002-11)

Previous crop	Cover, %
1st yr timothy	100a*
Oat/timothy	76a
Wheat	34b
2nd yr timothy	12c
Dry bean, narrow row	10c
Sugar beet	7d
Potato	7d
Dry bean, wide row	4e

*Means with different letters are significantly different from each other ($P < 0.05$).

Area of wheat by class within Irrigation Districts (1996-2016)

22% of Irrigation Districts land base area grew wheat in 2016



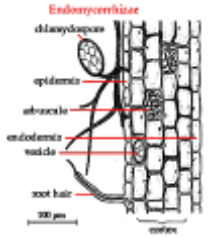
CWSWS, Canada western soft white spring; CWRS, Canada western red spring;
CWAD, Canada western amber durum; CPS, Canada prairie spring; CWRW, Canada western red winter

Adapted from data provided by Basin Management Section, Irrigation & Farm Water Branch, Alberta Agriculture & Forestry, Lethbridge, AB.

Soil Health – Increased Role of Soil Biological Processes in Crop Rotations

- Nitrogen fixation (rhizobia)

- Nutrient uptake (mycorrhiza)



- Crop cycling = Nutrient cycling
  - e.g. mites decomposing crop residues
  - multi-year legacy effect (1st, 2nd and 3rd yr after a legume)

- Biological pest control (*Bacillus thuringiensis* (Bt), etc.).

- Formation and maintenance of soil structure (fungi, etc.).

Soil Health/Soil Quality

- Whatever the term used - increasing awareness of the importance of reversing soil degradation.

- Nutrient/pest management: combine biology with chemistry (integrated nutrient or pest management), not chemistry alone.

- All major agro-chemical companies now - doing research on biological products:-
  - http://www.monsanto.com/products/pages/microbials.aspx
  - https://agriculture.basf.com/en.html
  - http://www.dupont.com/corporate-functions/our-approach/strategic-priorities/bio-based-industrials.html

Summary

- Don't forget about cereals and forages in irrigated rotations: good for returning carbon to soil and providing cover
- 'Soil-building' vs. 'soil depleting'
- Consider replenishing soil organic matter with composted manure if you can
- When talking about rotations, there are time and space components
  - Time: year when each crop is grown
  - Space: field where each crop is grown which then brings in preceding crop, current crop, following crop. Build up a rotation data base, e.g.
    - Field 1: Specialty-cereal-cereal
    - Field 2: Cereal-specialty-cereal
    - Field 3: Forage-forage-forage
  - Links to soil health?

Acknowledgements

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- Alberta Agriculture & Forestry, Basin Management Section, Irrigation & Farm Water Branch

ROGERS Sugar

Lantic Inc.

PGA POTATO GROWERS OF ALBERTA

Alberta Pulse Growers

AARI Alberta Agricultural Research Institute

Alberta Sugar Beet Growers

SASKATCHEWAN pulse Growers

Alberta Freedom To Create. Spirit To Achieve. Government of Alberta

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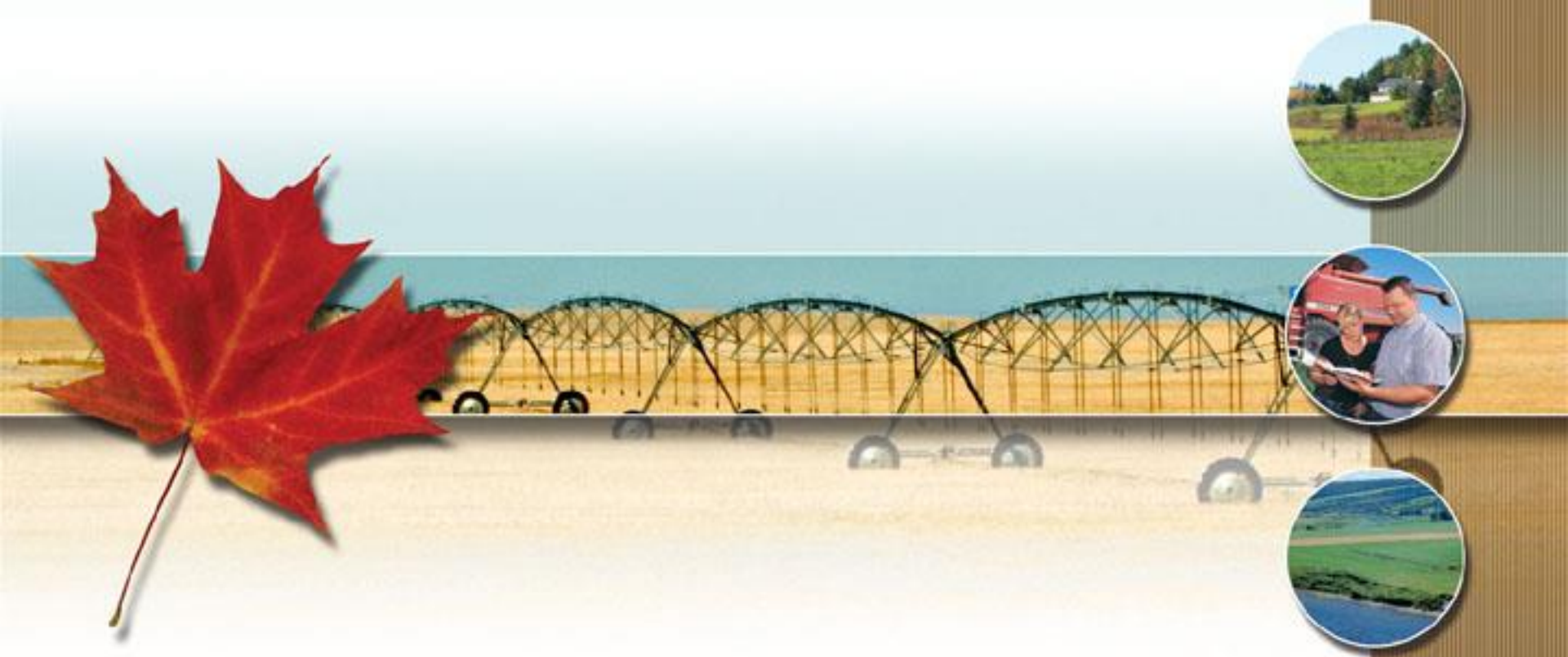

Canada

- Statistics for irrigated land give us information on seeded areas of each crop over time
- When talking about rotations, there are time and space components
  - Time: year when each crop is grown
  - Space: field where each crop is grown which then brings in preceding crop
- To truly figure out rotation trends would be good to know:
  - Q. How many acres of potato did you grow? A. 320 ac.
  - What were the preceding crops, e.g.
    - 160 ac. after soft wheat
    - 160 ac. after dry bean