Department of Primary Industries

Frost management in olives

Photo - https://www.oliveoilsource.com/page/frost-prevention

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Olive Conference, Albury 2019

Presentation outline

1. How frosts occur and damage thresholds
2. Frost mitigation
    a) Cultural practices
    b) Water
    c) Fan
    d) Heaters
3. Planning and monitoring
    1. Site and varieties
    2. Orchard frost mapping
    3. Digital monitoring & quick harvest
4. Economic analysis
5. Resources

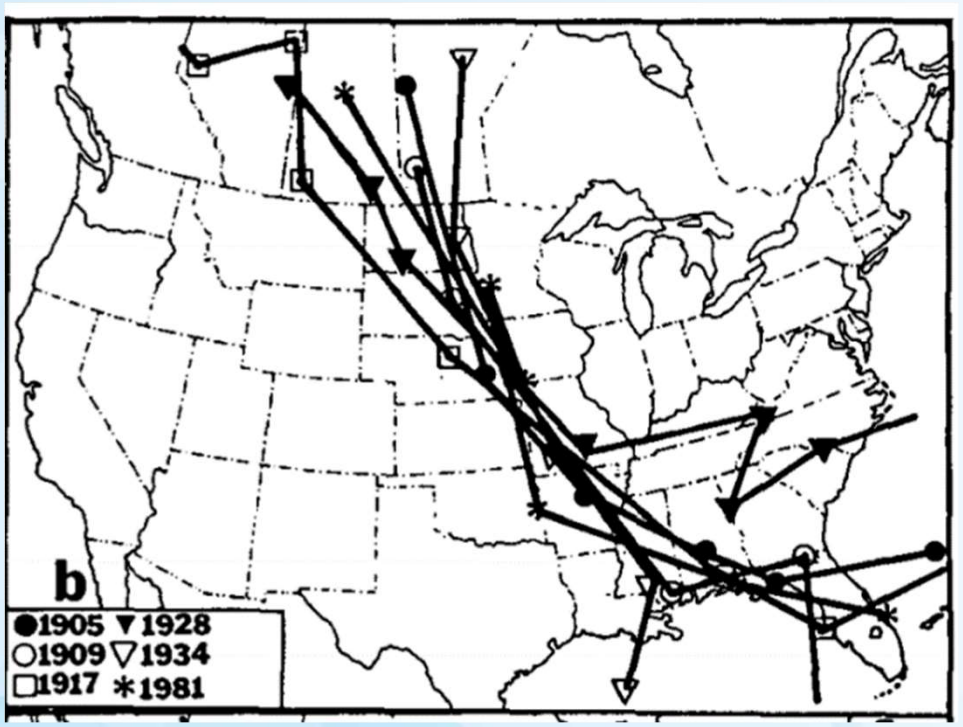
How frosts occur

Advection & radiation frosts

Advection frosts – “Freeze”

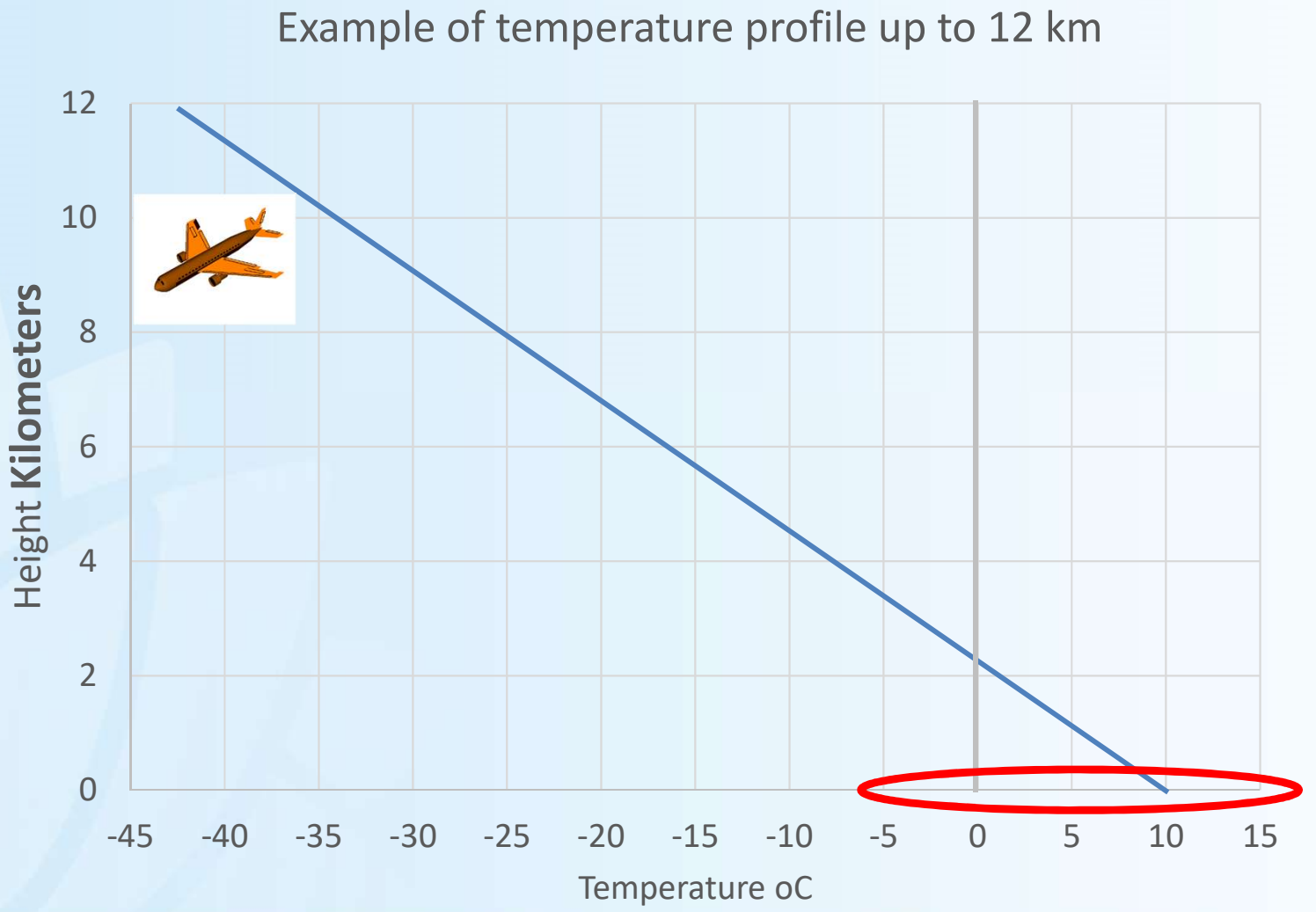
Cold air moving into a region

Commonly “Florida Freezes” associated with cold air moving over land

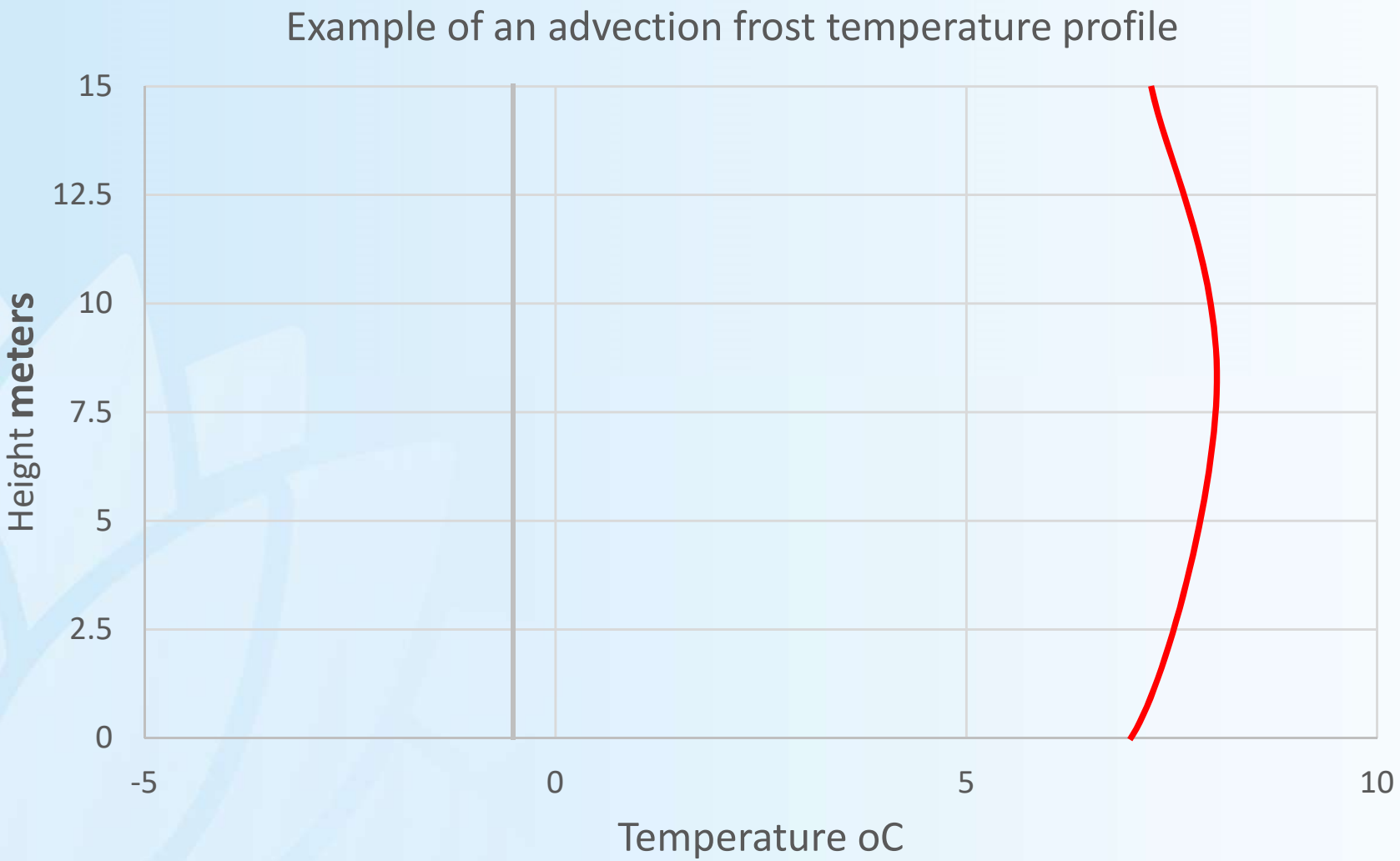


Rogers J., & Rohli R. 1991, Florida Freezes and Polar Anticyclones in the great Plains. 1991 American Meteorological Society p 1103

Temperature and height

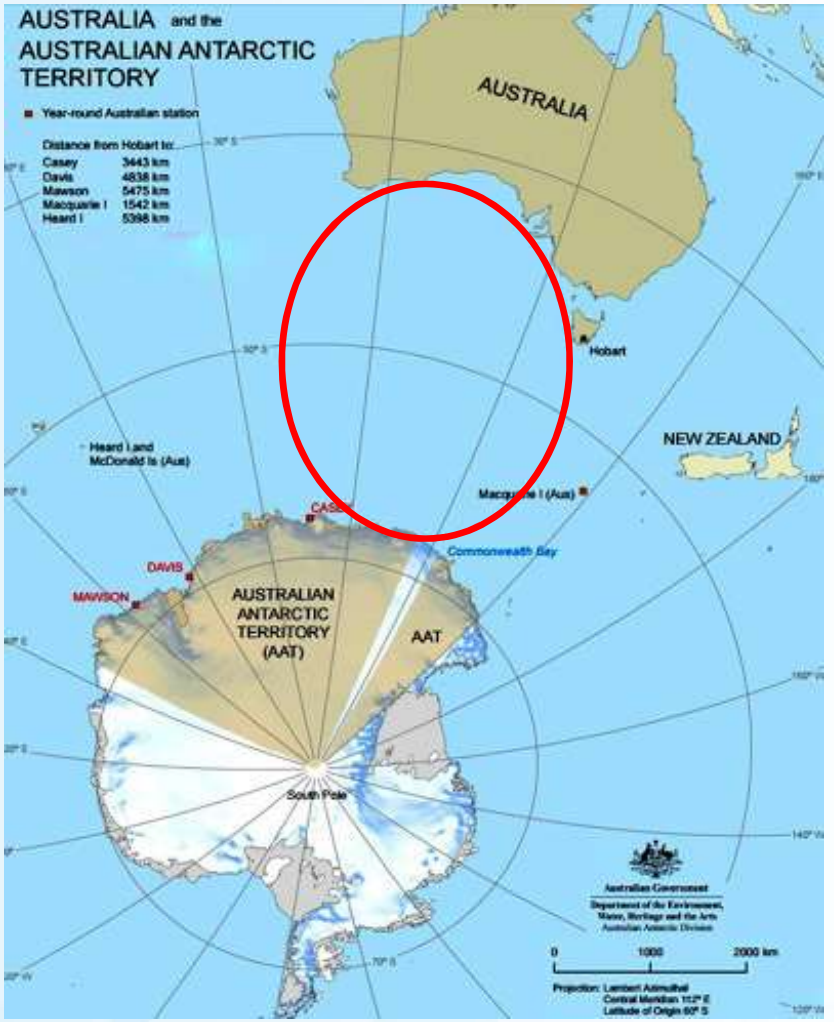


Advection frost temperature profile

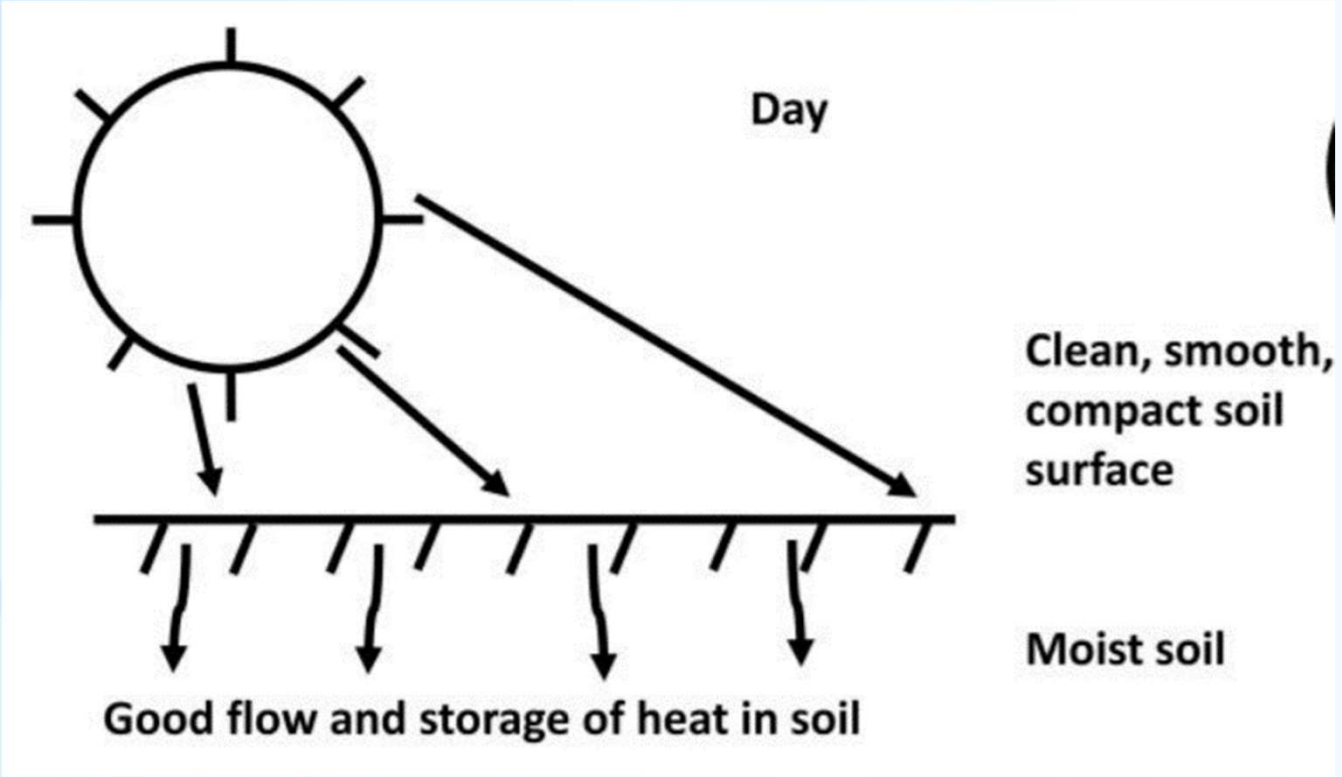


Why Freezes are less common in Australia?

Antarctic ocean helps to buffer temperatures

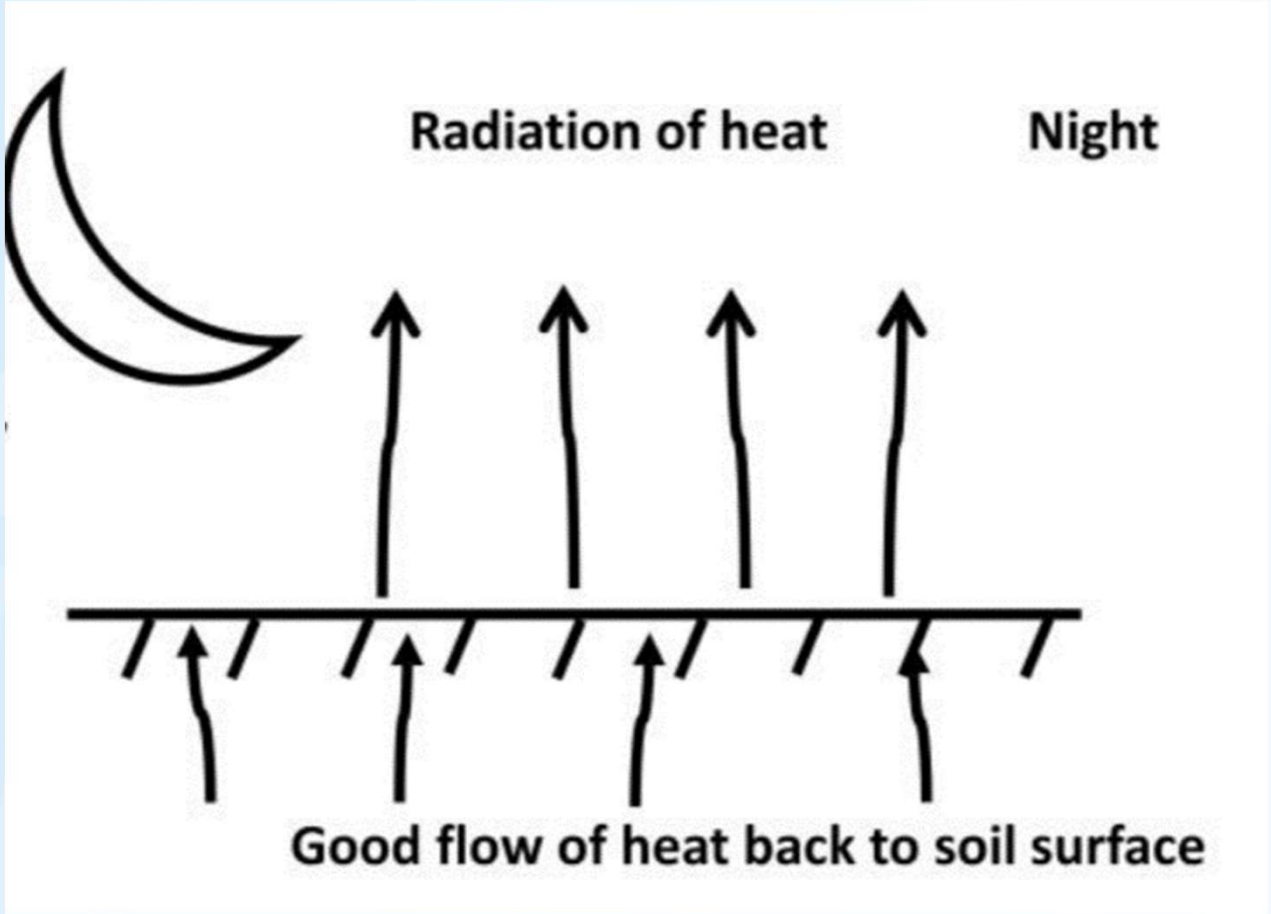


Radiation frost – ground heats up in the day



Frost management in vineyards. The Australian Wine Institute, October 2017

Radiation frost – ground heat loss

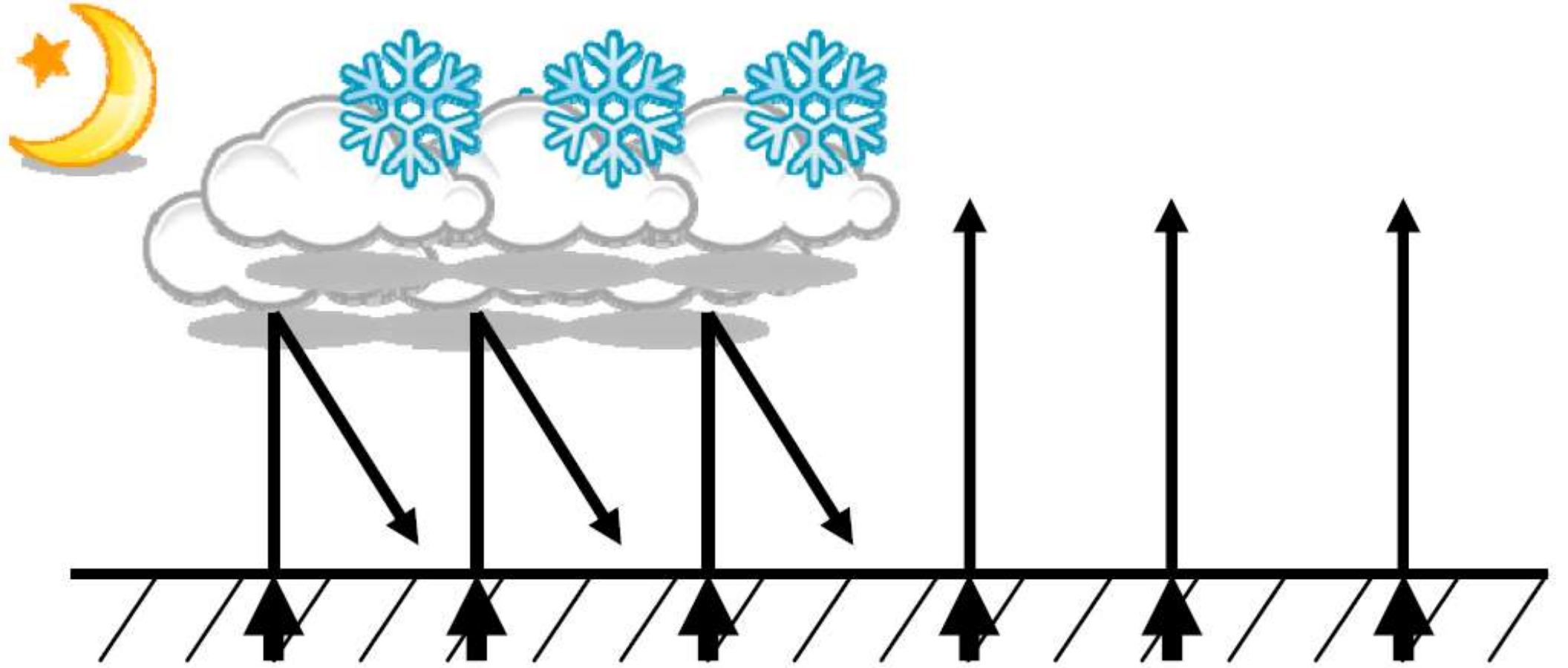


Frost management in vineyards. The Australian Wine Institute, October 2017

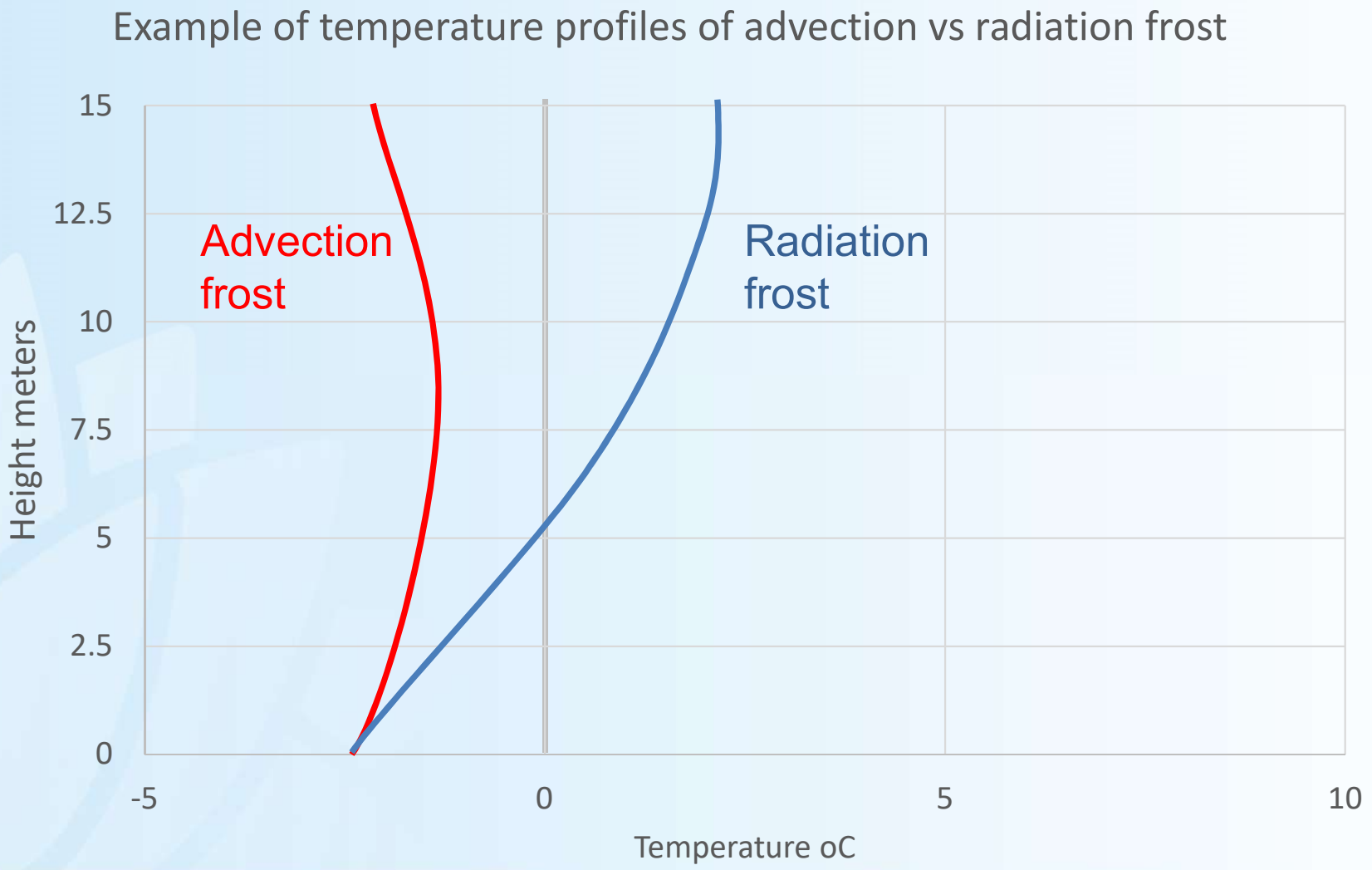
Inversion frost – Land looses heat at night

Heat loss at night through radiation

We can see some of this radiation with night vision goggles



Inversion frost



Dew Point

Temperature that air humidity = 100%

- start to form droplets on object (e.g. dew on grass)

The higher the dew point = more moisture in the air

Dew Point

- Heat is released when dew/fog is formed
- Water vapour in the air absorbs infrared radiation and can slow the rate of temperature fall.
- Fog can provide frost protection
- Low dew point (e.g. -4°C) is associated with rapid reduction in temperature.

- Nutshell: Dew point helps to buffer frost

Olive frost thresholds

Frost damage is a time and temperature relationship

- Fruit/shoots need time to decrease in temperature to reach freezing point

- Olive fruit damaged at below -1.7ºC.
- Young olive trees and branches can be killed below -5.5ºC and
- Mature trees can be killed at temperatures below -9.5ºC

https://www.oliveoilsource.com/page/frost-prevention

Main damage risk

Late maturing fruit (June – Murray Valley)

Photo: Vera Sergeeva, *University of Western Sydney*

Spring shoots (Mid Aug - Sept)

Cultural Practices

Cultivation, moist soil & mowing

Healthy trees gets less affected – nutrition, irrigation etc.

Mowing

- mowing a high sod adds 1°C

Moist & bare soil

- Moist soil can store sunlight heat better than dry soil
- Bare soil : sun to need to reach soil
- Bare soil and moistening soil adds another 1°C

Realistically in Sunraysia by maintaining a moist soil with low sparse sod (better bare soil)

1°C increase.

Anti- frost bacteria sprays

Theory of how it works

- Pure water freezes at -39°C
- Ice forms on particles that disturb the water and grows
  - Particles = plant molecules, dust & microbes
  - Microbes = Ice nucleating active (INA) bacteria
- Suggested plants can go down to -5°C without freezing, but due to INA plants freeze at -1.7°C

Anti- frost bacteria sprays

- Idea – Spray trees with bacterial strains that are not active (not INA) to “overcrowd” the INA bacteria
- Conflicting options of practical value
- “Google” search difficult to find reliable field trial research reports
- More research needed (good science)
  - Sprayed and non sprayed areas
  - Arrange a frost for the trial site!
  - Collect data and document results

Water – under tree

1. Temperature of water adds heat
2. Freezing of water on soil surface gives off heat

Grower experience

- David Stevens: change spray heads to 1.2 mm/h & change over sprinklers take 8 h/ha
- Bart Brighentti: big areas work best, boundary rows affected, 1-2 ºC increase

Water – over tree

1. Same as under tree
2. + <u>WET</u> ice around fruit prevents fruit temperature below 0 ºC

Grower experience

- 1.5 to 1.8 mm/h
- Excellent protection
- New install ~ $8000 piping, $1000 controller, $3000 install ~ **$12,000/ha total**

Water: problems

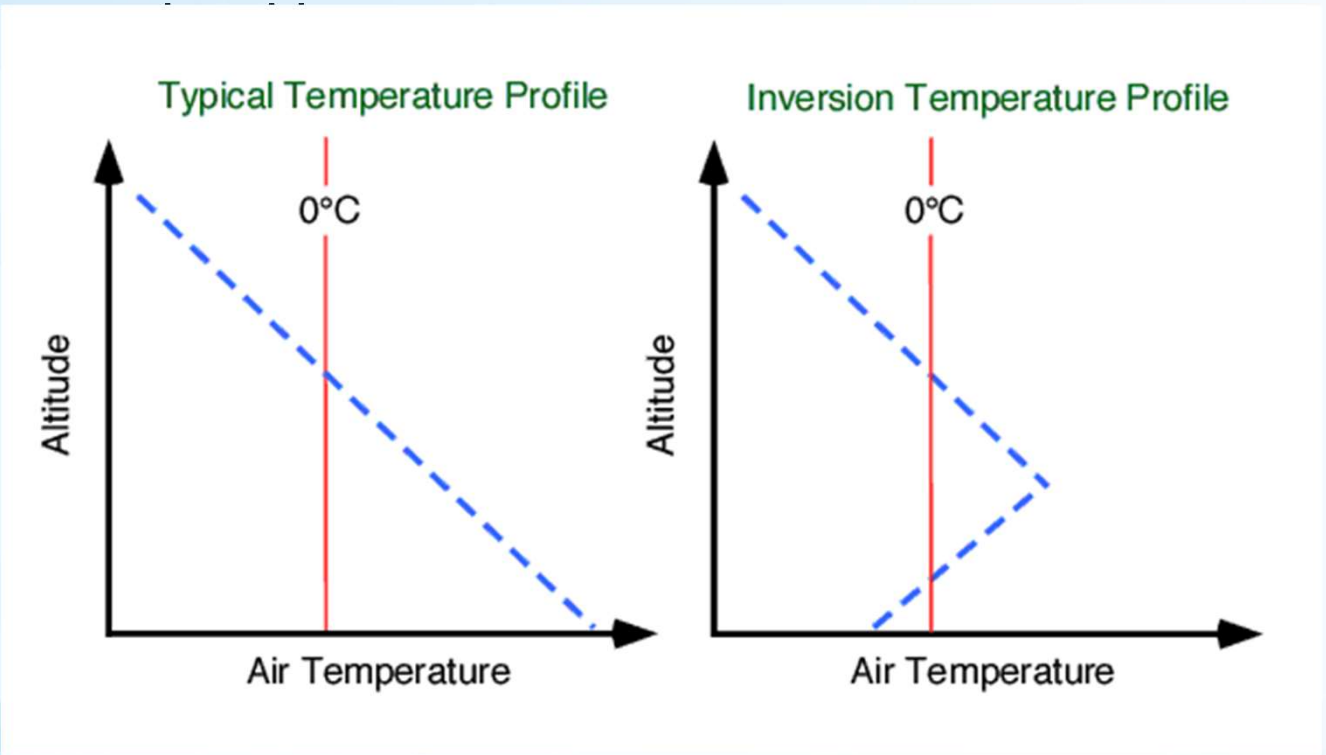
- Waterlogging

- Olive knot disease

Fans

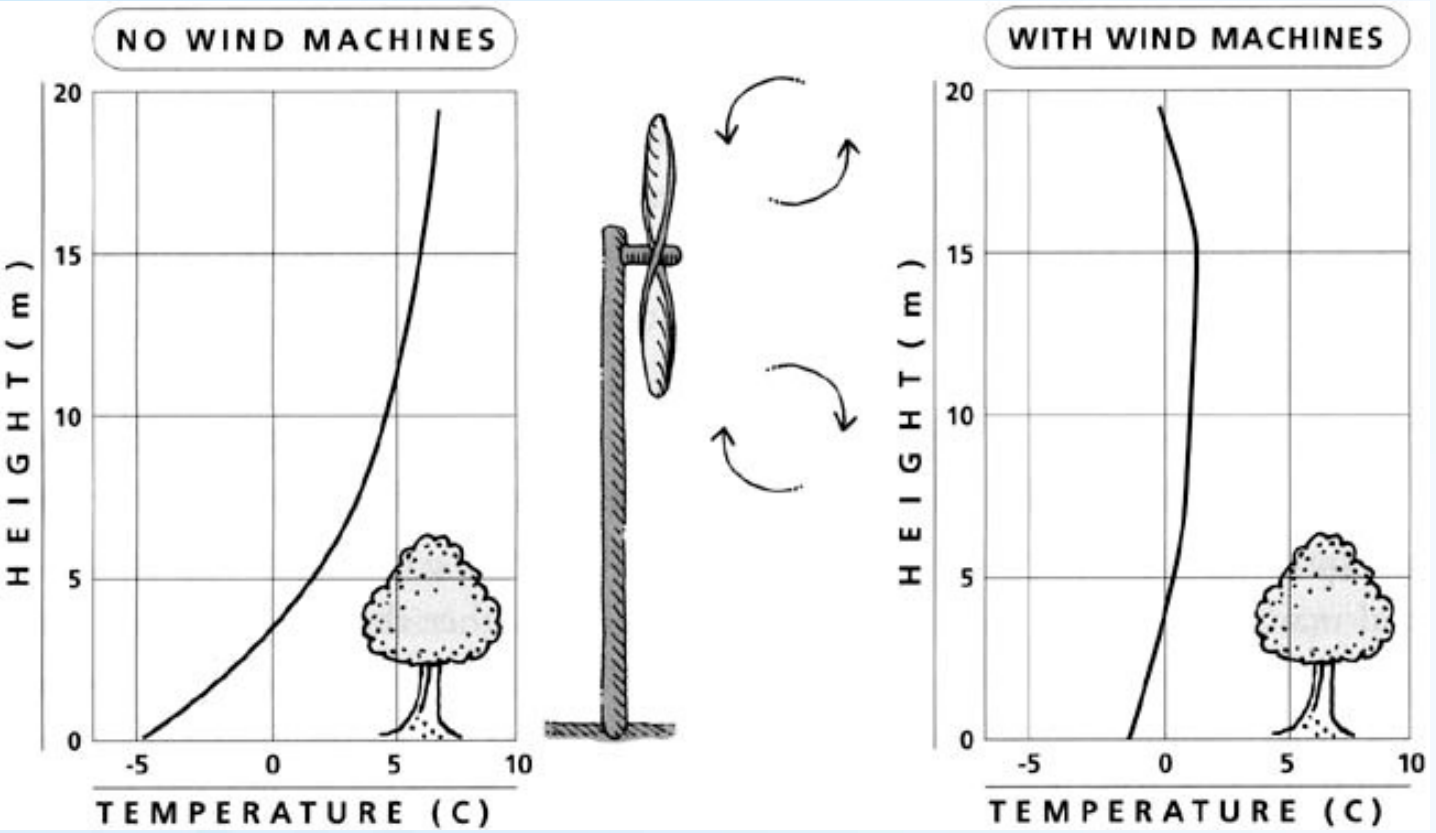
NEED AN INVERSION

- Inversion varies 2-7ºC, normally 3-4ºC
  - Inversion 5 to 50 m, mostly around 15 m
  - Pushing warmer air down often results 2-3ºC



http://www.physicalgeography.net/fundamentals/8f.html

Fan temperature profile



http://www.fao.org - **CHAPTER 7 - ACTIVE PROTECTION METHODS**

Permanent fans

- Cost: $62th to 68th
- Change position on farm: $4500
- Coverage: 8 to 3 ha
  - Coverage reduces as frost becomes more severe
- Grower experience
  - Tony Sergi: 4 yr experience lemons, cover 6 ha for -4oC frost and 2.5 ha to -6oC. Fuel = 20L/hr, service = $900/yr plus $1000 for a repair
  - Bart Brighentti: provides 4oC on average. Saved crop -6oC frost (costs as above)

Permanent fans

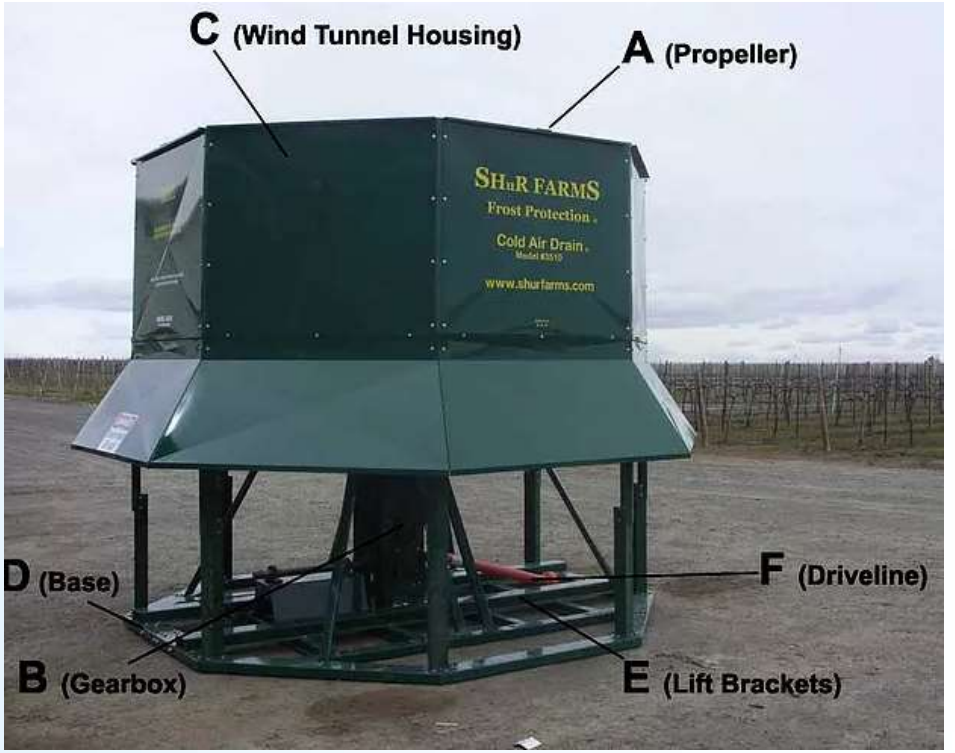
Considerations

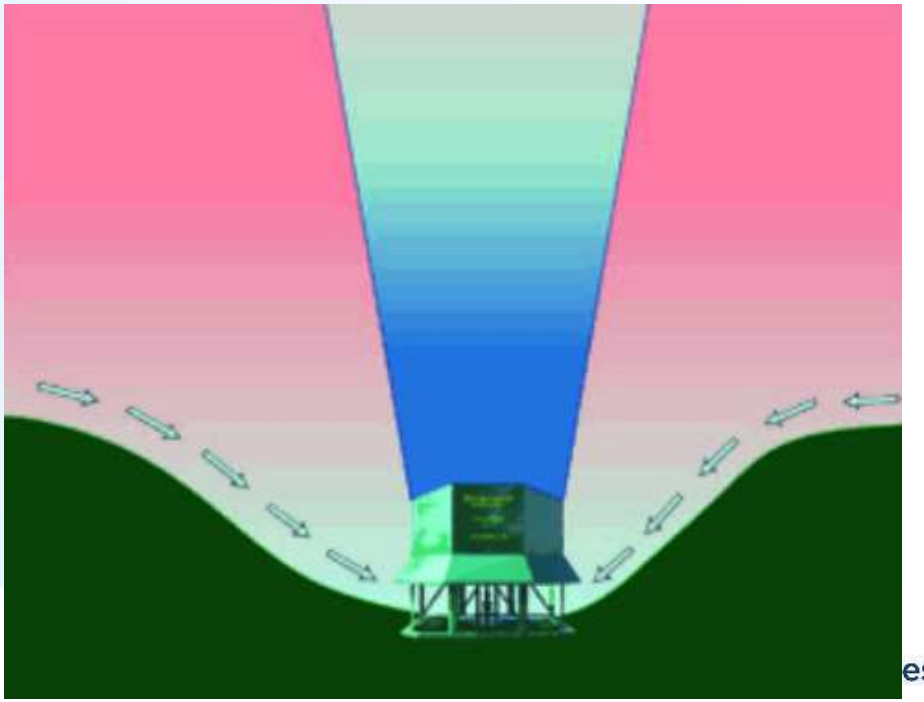
- Height: blade 10.4 m top of prop shaft
  - + impellor
- Noise
  - Local council laws
  - New 5 blade fans reduce noise

Mobile fans: Shur

- Tractor PTO
- Blow air upward
- Need a barrier around orchard
- No experience in Australia
- See website:

http://www.shurfarms.com





Mobile fans: Tow and blow

- 8.2 metres
- On-board 24hp diesel engine
- Claim to provide “up to” 70% of permanent tower coverage
- Cost: $40,000

Grower experience

- Vito Mancini (Griffith): good to move around different times of year, new product and still learning, probably buy some

Mobile fans: Frost Stoppa

- PTO, 60 to 70hp tractor engine running just above idle
- 6.7m high mast
- 1 to 3 hectares
  - Probably lower end for -2 to -4oC frosts
- Cost: $22,300.00 Plus GST

http://www.tateng.com.au

Helicopters

https://www.sydneyhelicopters.com.au/

- Effect depends on weight/thrust
- Smaller helicopter need more time
- Limitations
  - Pilot needs to have a night and low level licence
  - Max flight time 10-8h, might need two pilots?

Grower experience

- Bart Brighentti: Squirrel AS350 did 140 ha farm (Jun 2017), $2400/hr for 8 hr. Worked well. Probably not use on small acres, maintained -2oC during -5oC frost, plan at least 3 days ahead, pilot suggested to make fires to help generate warm air to push down.

Heaters

All heaters work best at correct temperature, too high and heat goes up and does not circulate.

Oil burners

- Technical knowledge in USA
- Fuel (sump oil) and smoke issue?
- Cost $100-$200 – 100 per ha

Hay bales / pruning debris

- Store up for a frosty night

Grower experience

- Bart Brighentti & Frank Battistel: Unsure of effectiveness, concentrate fires more on the frost front as it moves in

Planning & monitoring

Site and varieties

Site

- Identify high frost risk area
  - Low areas or can frost map the farm

Varieties

- Some varieties less frost sensitive
- Early varieties planted on higher risk areas

Frost mapping

Professional frost mapping can help site frost protection machinery

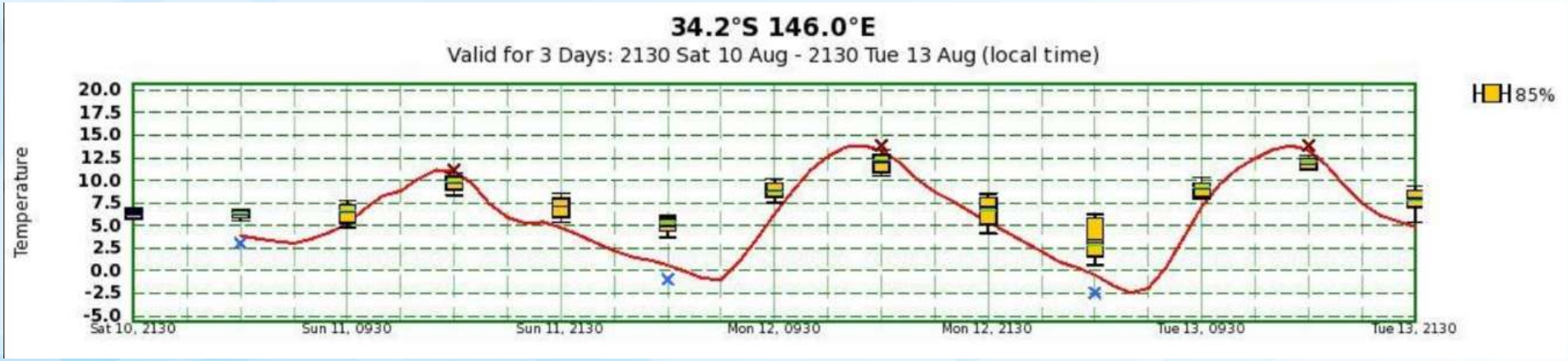
- Suggested by Aussie frost fans

Climate consulting NZ

- https://www.climateconsulting.co.nz/
- Report indicates best fan placement (e.g. tear drop protection shape)
- Cost 20 ha $8000, 50 ha $15,000

Frost prediction tool

- Know if to turn on fans (save fuel and time)
- Weather websites provide general indication
- Bureau of Meteorology provides a more accurate prediction subscription service
  - Detailed graphs and telephone discussions

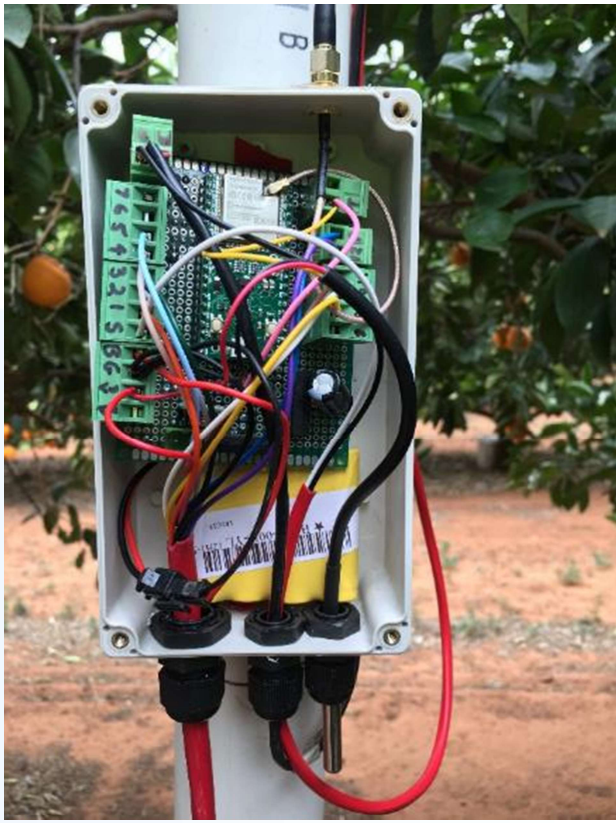


Frost monitoring

- Damaged fruit oil OK for 2-3 days
  - Need to quickly identify blocks and harvest
  - Fruit turns brown after a day
- Digital monitoring (which block was frosted?)
  - Temperature sensors
  - Numerous companies provide climate and soil moisture monitoring equipment and services
  - Well developed interfaces for PC and mobile

Frost monitoring

- NSW DPI is developing basic climate and frost monitoring tool
- Data viewed in the internet (google sheets)
- Aim:
  - DIY instruction provided & wireless model built from eBay/local components ~ $300/unit
  - Electronics technician or hobbyist can build for extra $350

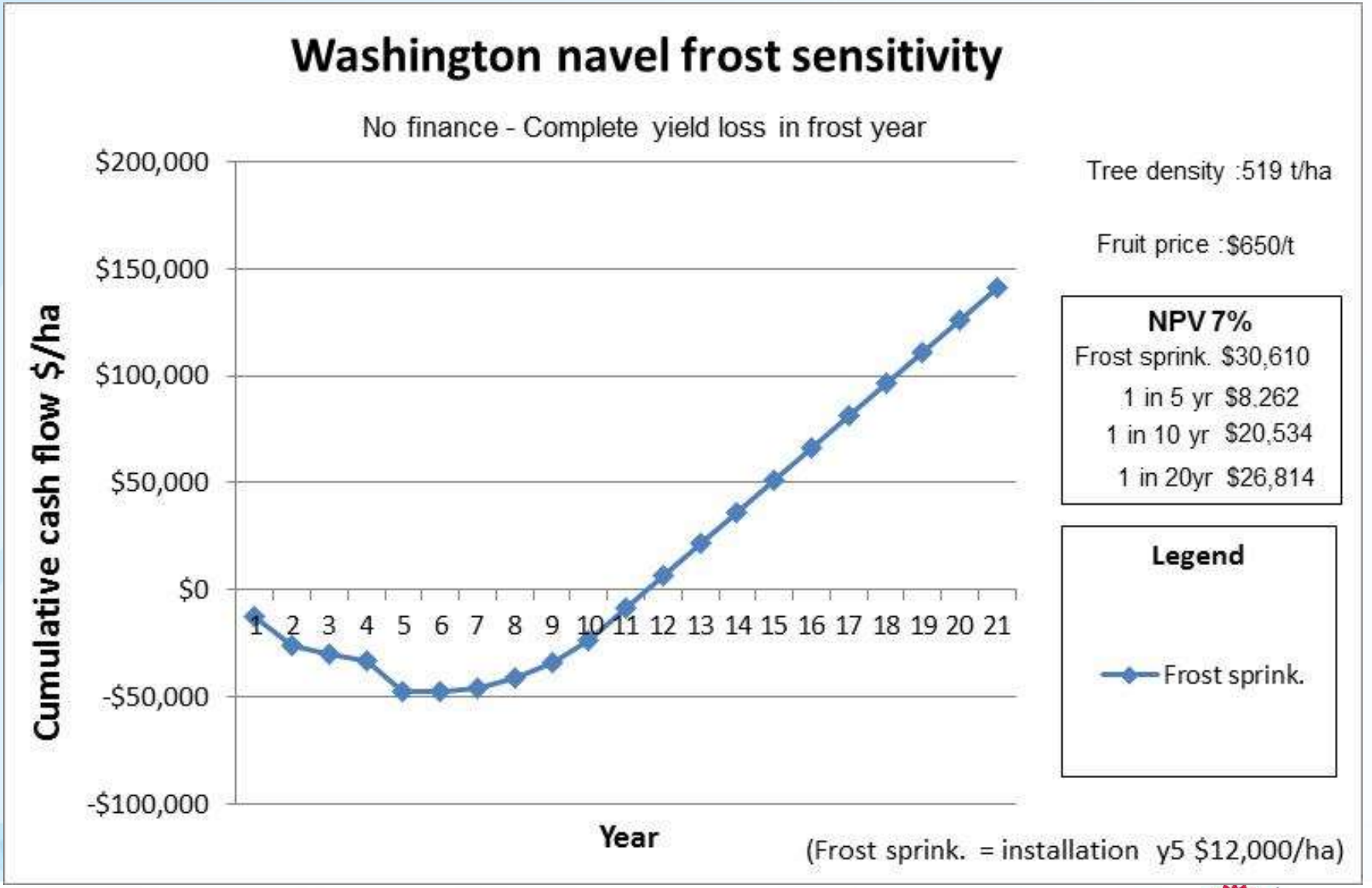


Economics

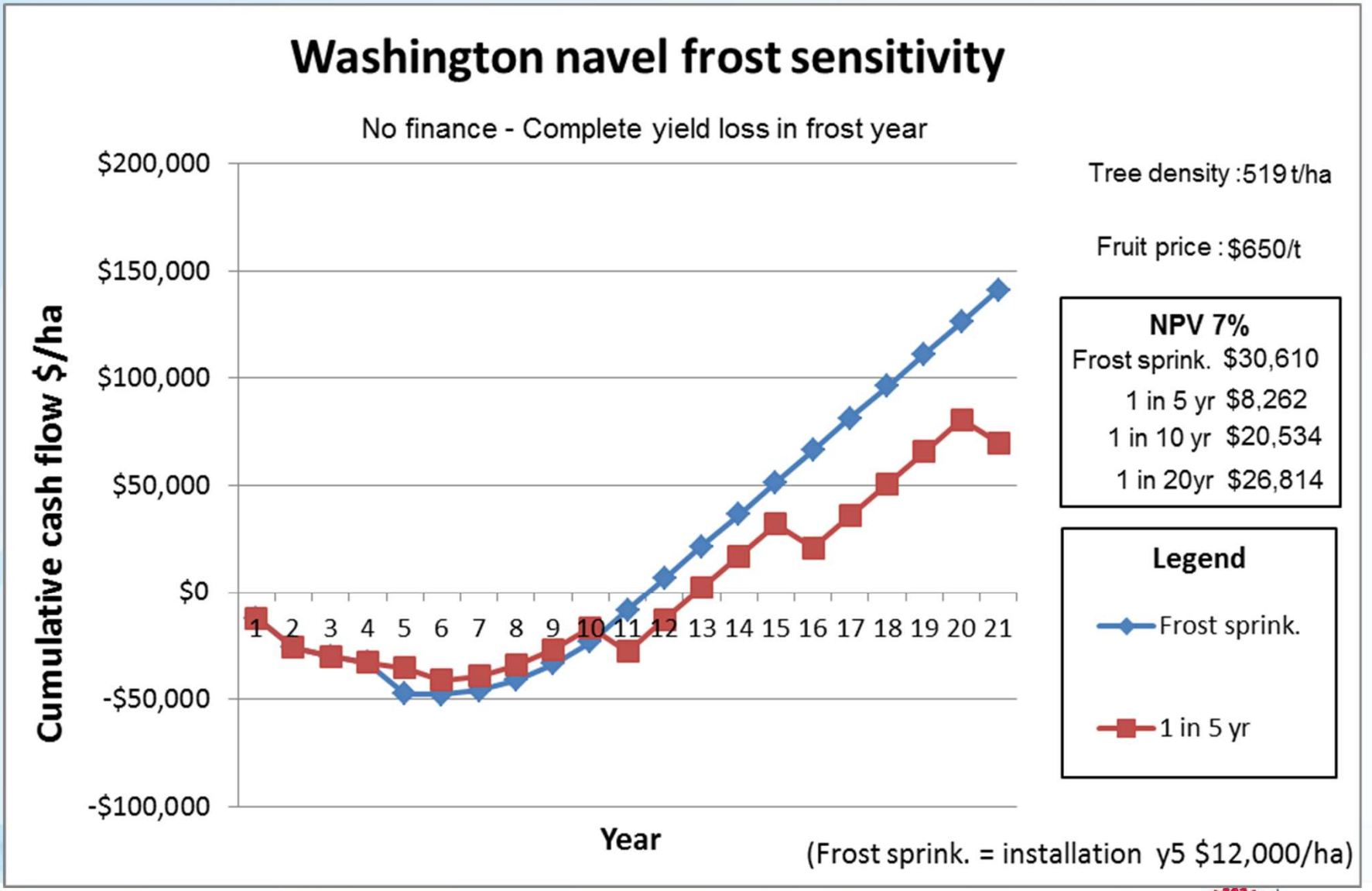
Do your sums!

Following citrus example of how to assess

Citrus economic analysis: total crop loss



Economic analysis: total crop loss



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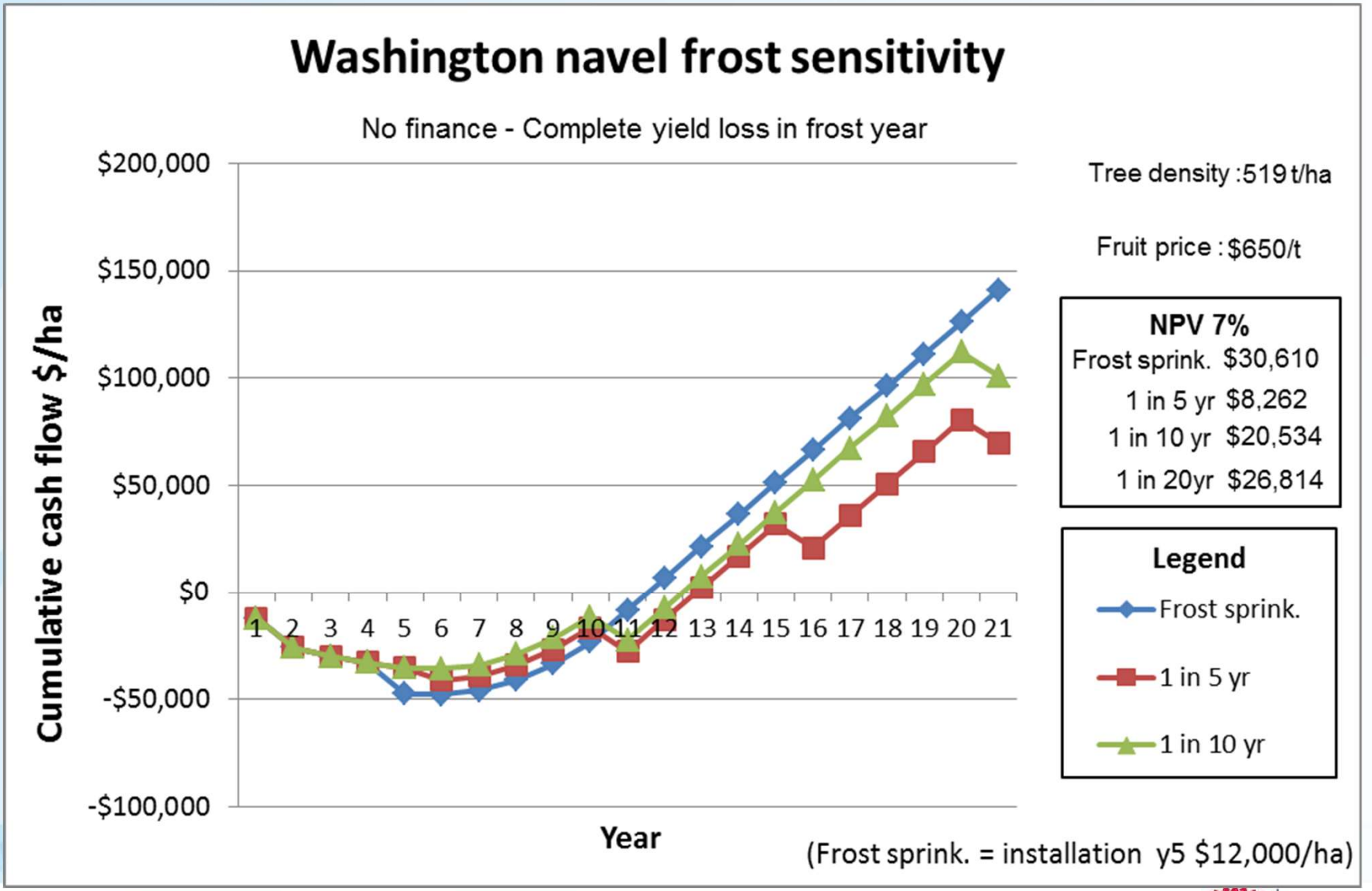
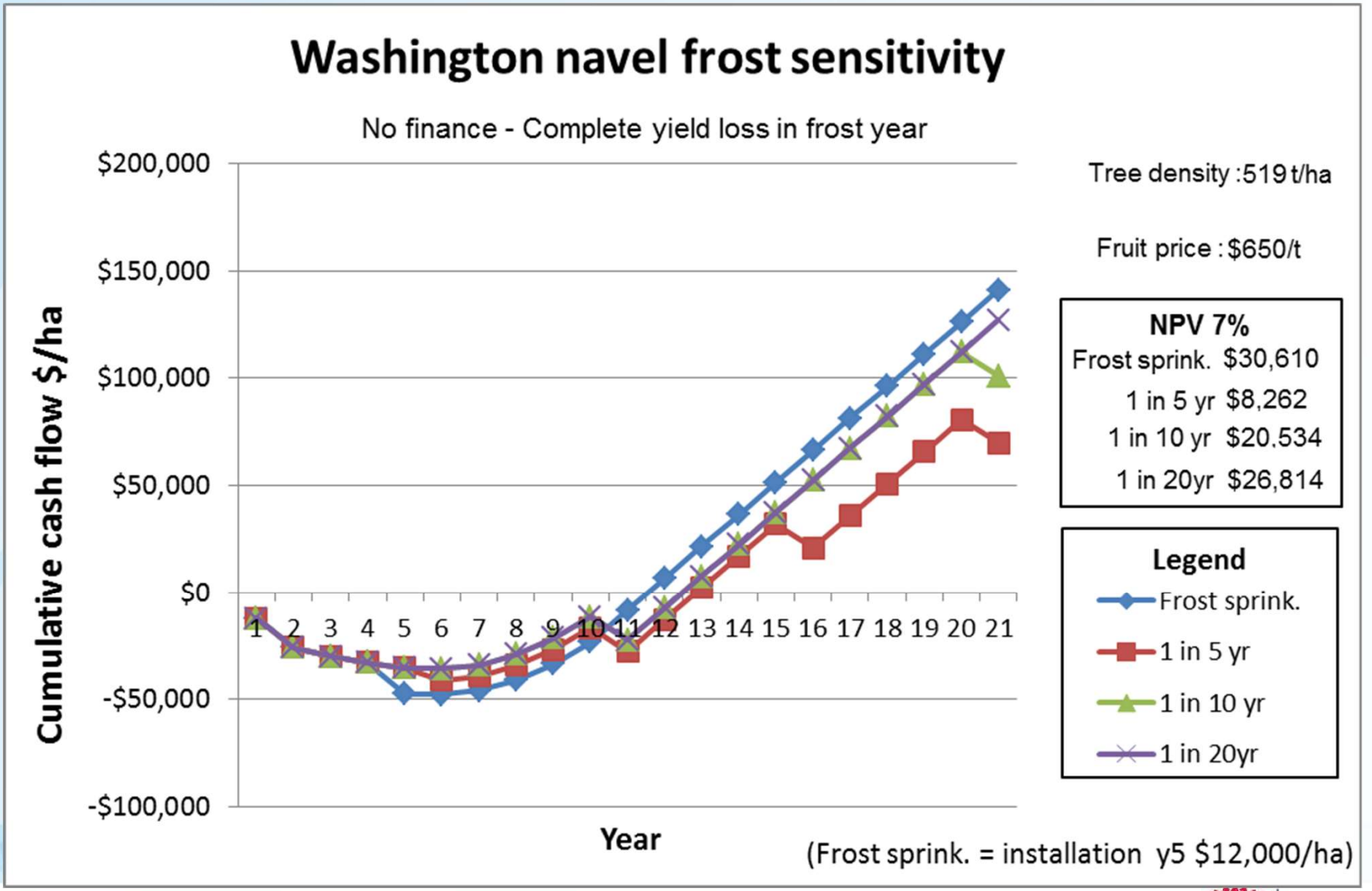
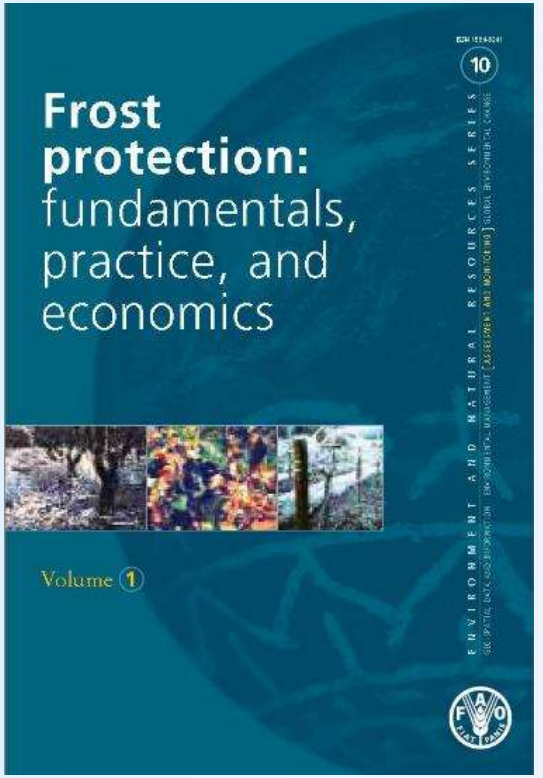


Economic analysis: total crop loss



Frost resources

Frost Protection: fundamentals, practice, and economics Vol 1; FAO



Available by searching internet

Summary

1. Advection vs radiation
2. Frost mitigation – tree health, moist bare soil & fans
3. Planning and monitoring - Site and varieties, mapping
4. Digital monitoring & quick harvest
5. Economic analysis – do your sums

Acknowledgements

Citrus Australia Murray Valley Advisory Committee & grower input

- Niel Eagle
- Bart Brighentti
- Daniel Lazar
- Werner Ulrich
- David Stevens
- Frank Battistel
- Tony Sergi
- Tyson Milne

Investigation continuing:
Please talk with me
about your experiences