# Environmentally Responsible Fertilizer Practices

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Make today matter

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# Layout of talk

- Environmental responsibility
- Sustainability and input resource use efficiency
- Some case studies
- Strategies to improve environmentally responsible fertilizer practices
- Conclusions

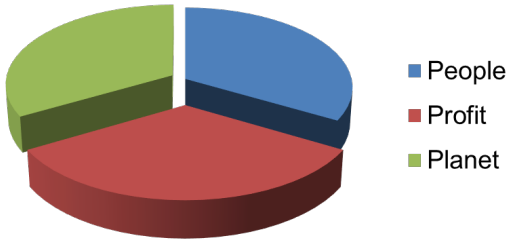
# Introduction

- Environmental responsibility?
- The ethical duty of individuals, organizations, and governments to act in ways that protect the environment and promote sustainable resource use
- Environmentally responsible fertilizer practices?
- Focus on minimizing wastage and pollution and promoting sustainable agriculture

# Introduction

- Definition of sustainability?
- “meeting the needs of the present without compromising the ability of future generations...” (www.un.org)


- 2030 UN Agenda for sustainable development
- 17 SDG’s
- Agriculture: SDG 12
- The 3 pillars of sustainability - PPP (three-P-principle)

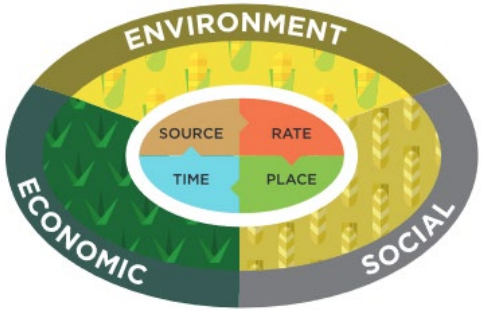


# Planet aspects of sustainability

- Preservation of natural resources for future generations
  - biodiversity preservation
  - reducing losses and
  - pollution of environment and water resources
- Improved efficiency – producing more crop with less inputs, e.g.
  - land
  - energy
  - chemicals
  - water
  - nutrients

# Environmentally responsible fertilizer practices

- Aim to optimize crop production while minimizing negative impacts on the environment
- The 4R's of fertilizer management
  - right source,
  - right rate,
  - right timing,
  - right placement
- Will ensure environmentally responsible fertilization




www.canr.msu.edu

# Potato case studies

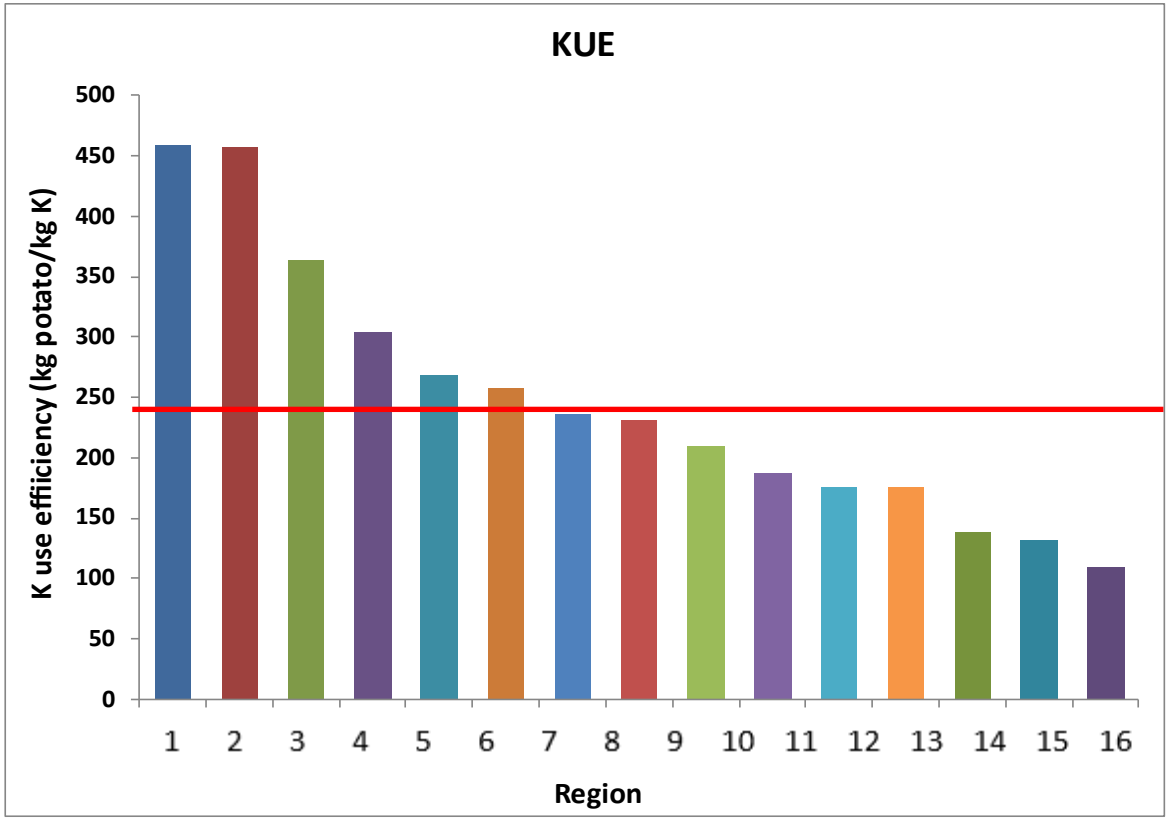
- Potato is highly productive food crop
- One of the most water efficient food crops
- But sensitive to water stress – depends on irrigation
- Requires high input levels: water, nutrients, crop protection chemicals
- Often accused of over fertilization

# Sustainability of SA potato industry?

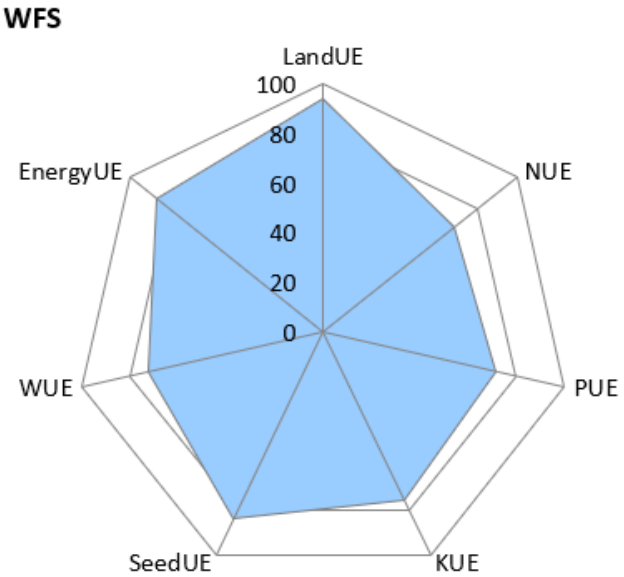
- Survey to assess input resource use efficiencies (Steyn et al. 2016)
- Interviewed ±100 farmers = 15% of growers
- Practices, inputs: water, nutrients, cultivations, labour, seed, chemicals, energy, transport



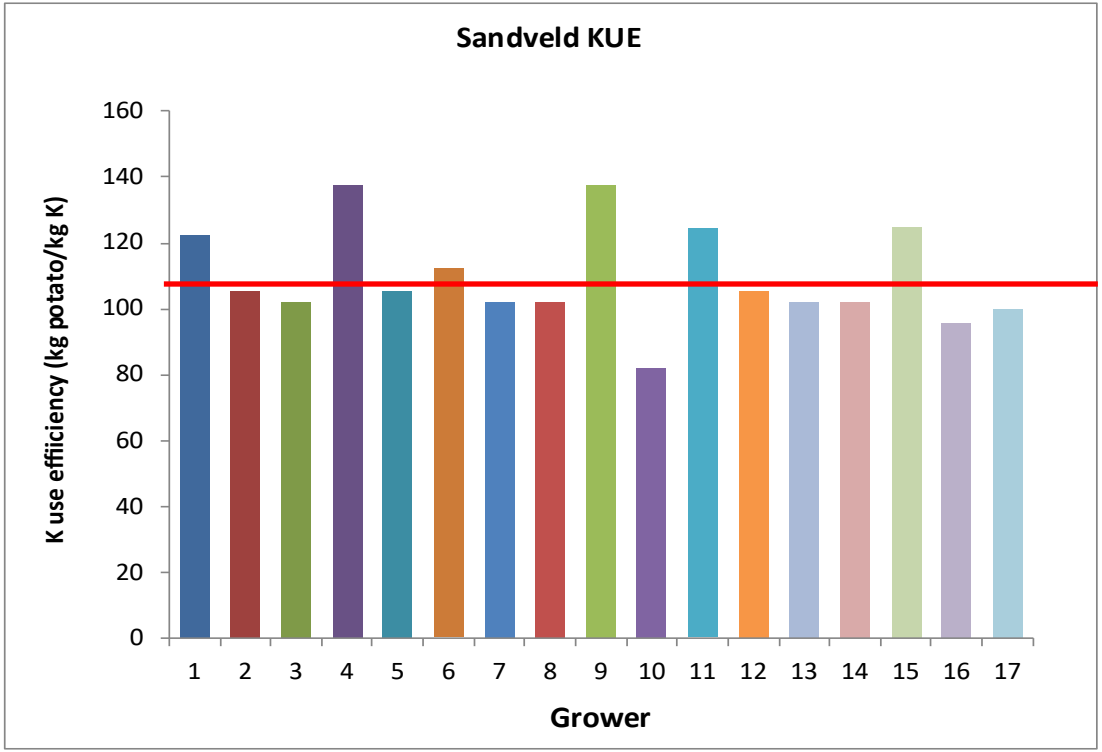

# Nutrient use efficiency



# Resource use efficiencies

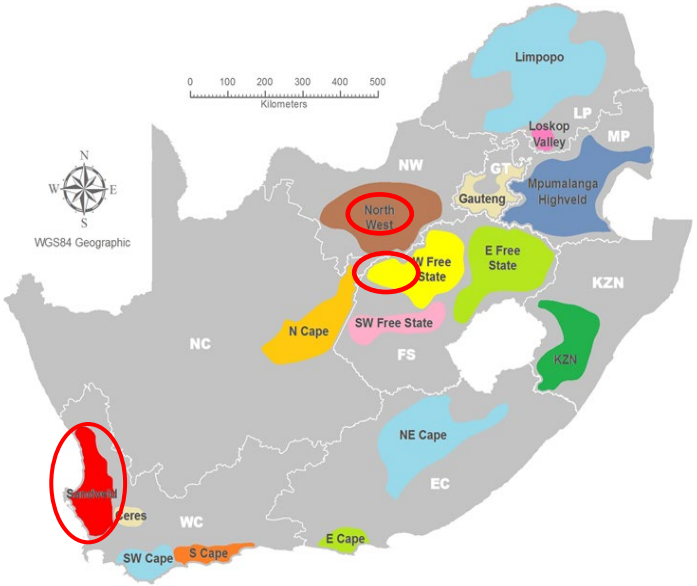


# Nutrient use efficiency



# Unpacking ecological sustainability of potato production

- Field study in the North West, Sandveld, Western Free State – sandy soils
- Aim: to do detailed measurements of water and nutrient input levels and losses
- Monitored centre pivot 25 fields
- Equipment installed to measure
  - irrigation
  - drainage
  - soil water content / water use
  - nutrient dynamics
- Water and nutrient balances, yields, efficiencies



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# Irrigation amounts

Electromagnetic flow meter

Pressure transducer & logger

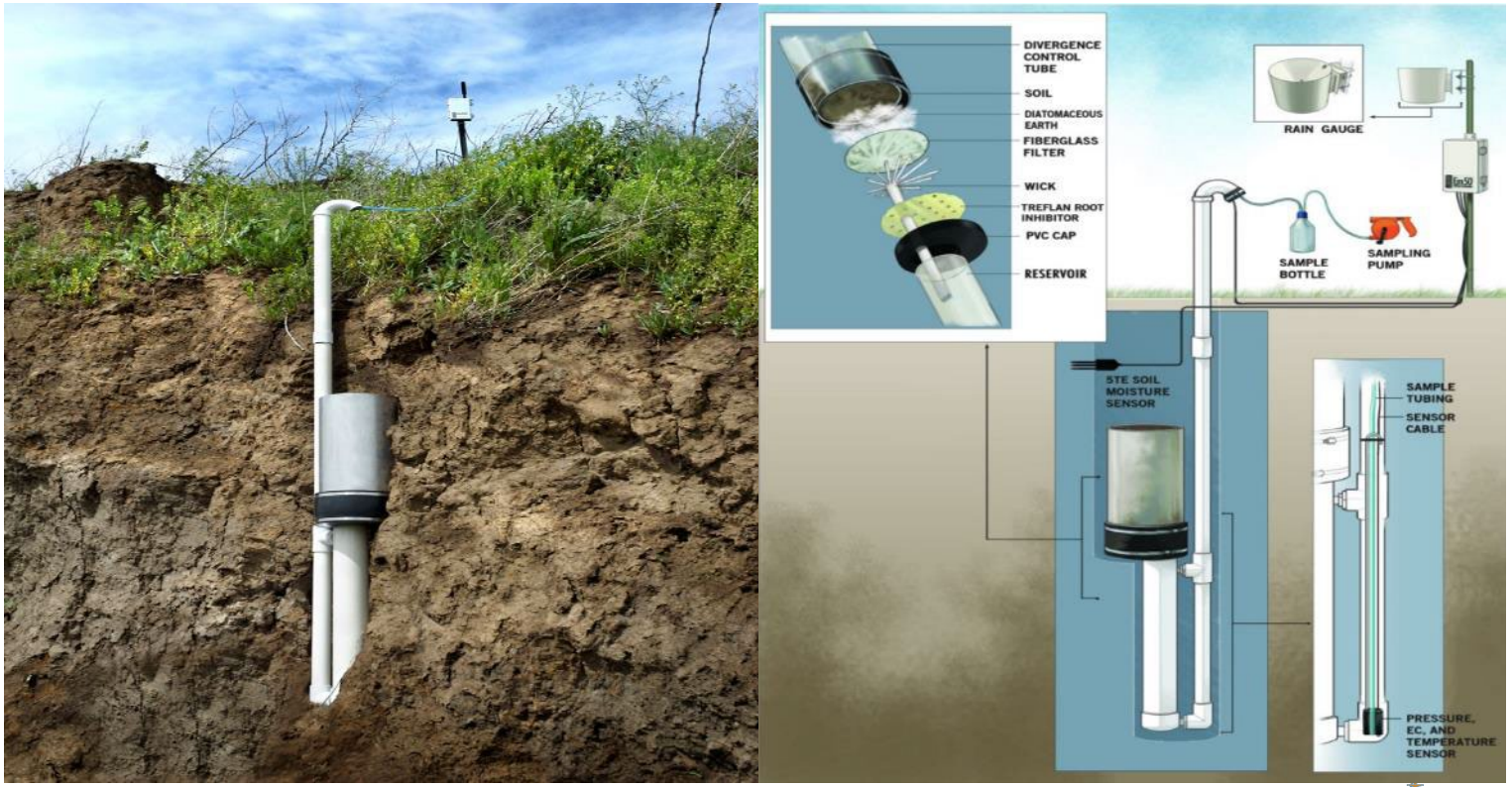
# Rainfall & Water use

Rain gauges

Capacitance probes

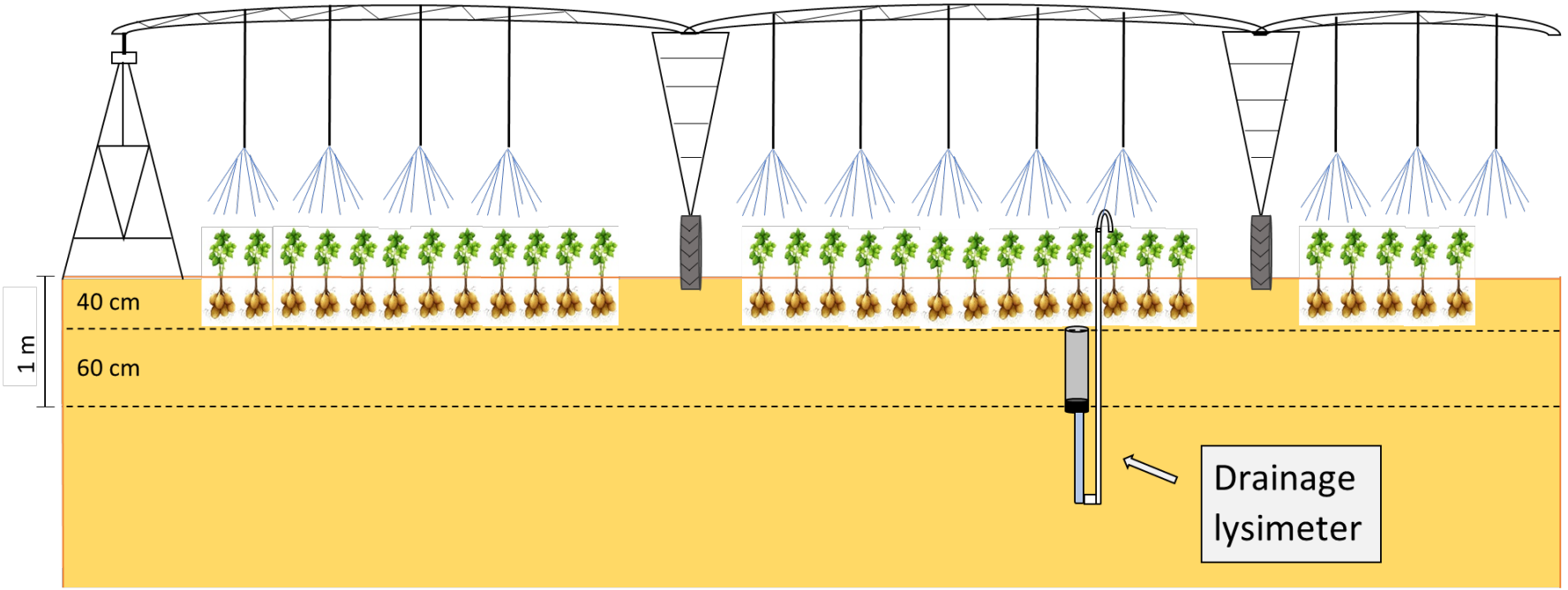
Eddy covariance

# Drainage and nutrient leaching



# Drainage lysimeter installation

# Drainage

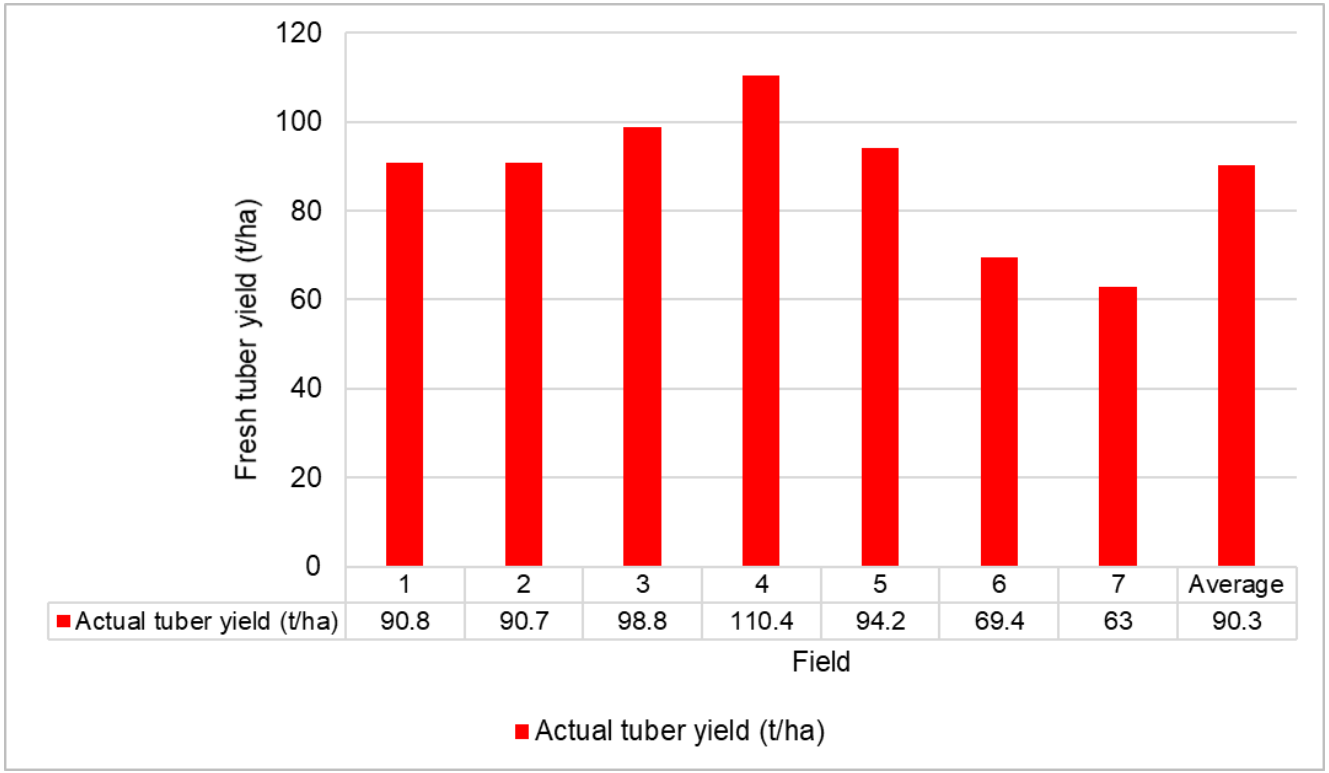


# Drainage lysimeter station

# Irrigation system evaluations

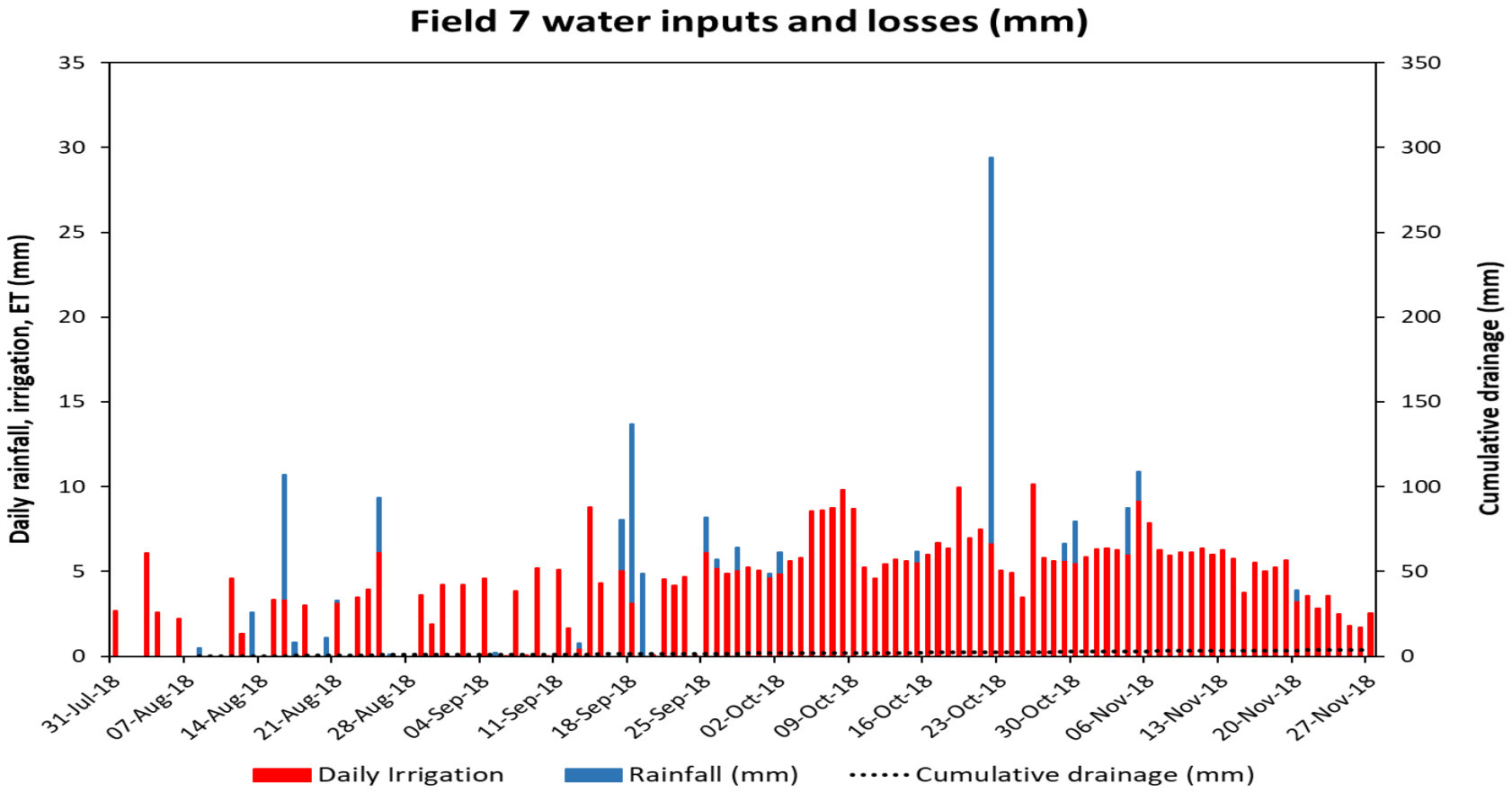

## Ultrasonic water flow meter

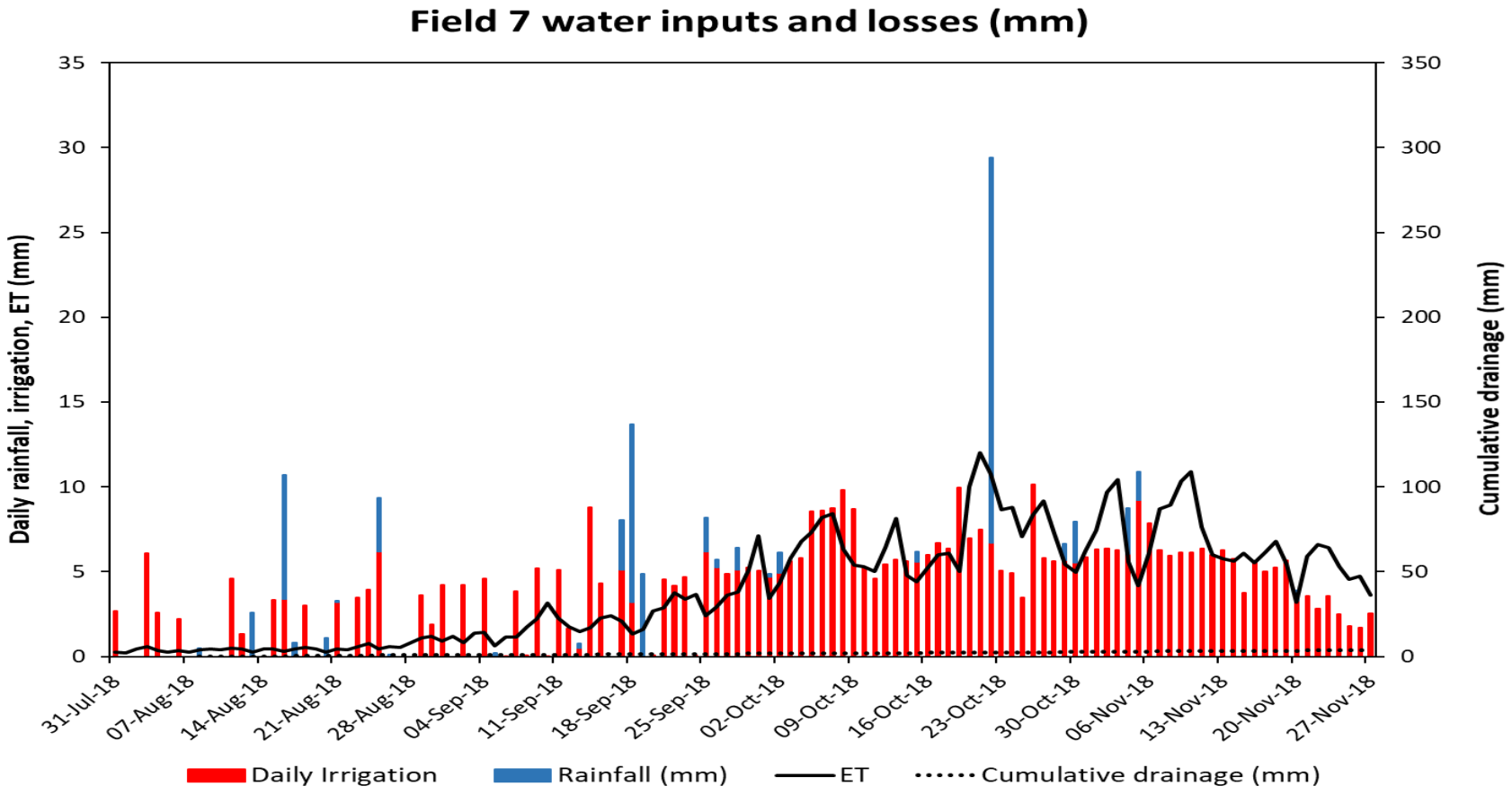
# Tuber yields



# Water inputs and losses

| | Water inputs |
|---|---|
| Field | Rainfall (mm) |
| 1 | 326 |
| 2 | 317 |
| 3 | 429 |
| 4 | 349 |
| 5 | 355 |
| 6 | 350 |
| 7 | 292 |
| Avg | 345 |


Field 7 water inputs and losses (mm)
Daily rainfall, irrigation, ET (mm)
Cumulative drainage (mm)
35
30
25
20
15
10
5
0
350
300
250
200
150
100
50
0
31-Jul-18
07-Aug-18
14-Aug-18
21-Aug-18
28-Aug-18
04-Sep-18
11-Sep-18
18-Sep-18
25-Sep-18
02-Oct-18
09-Oct-18
16-Oct-18
23-Oct-18
30-Oct-18
06-Nov-18
13-Nov-18
20-Nov-18
27-Nov-18
Daily Irrigation
Rainfall (mm)
Cumulative drainage (mm)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30
25
20
15
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5
0
350
300
250
200
150
100
50
0
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02-Oct-18
09-Oct-18
16-Oct-18
23-Oct-18
30-Oct-18
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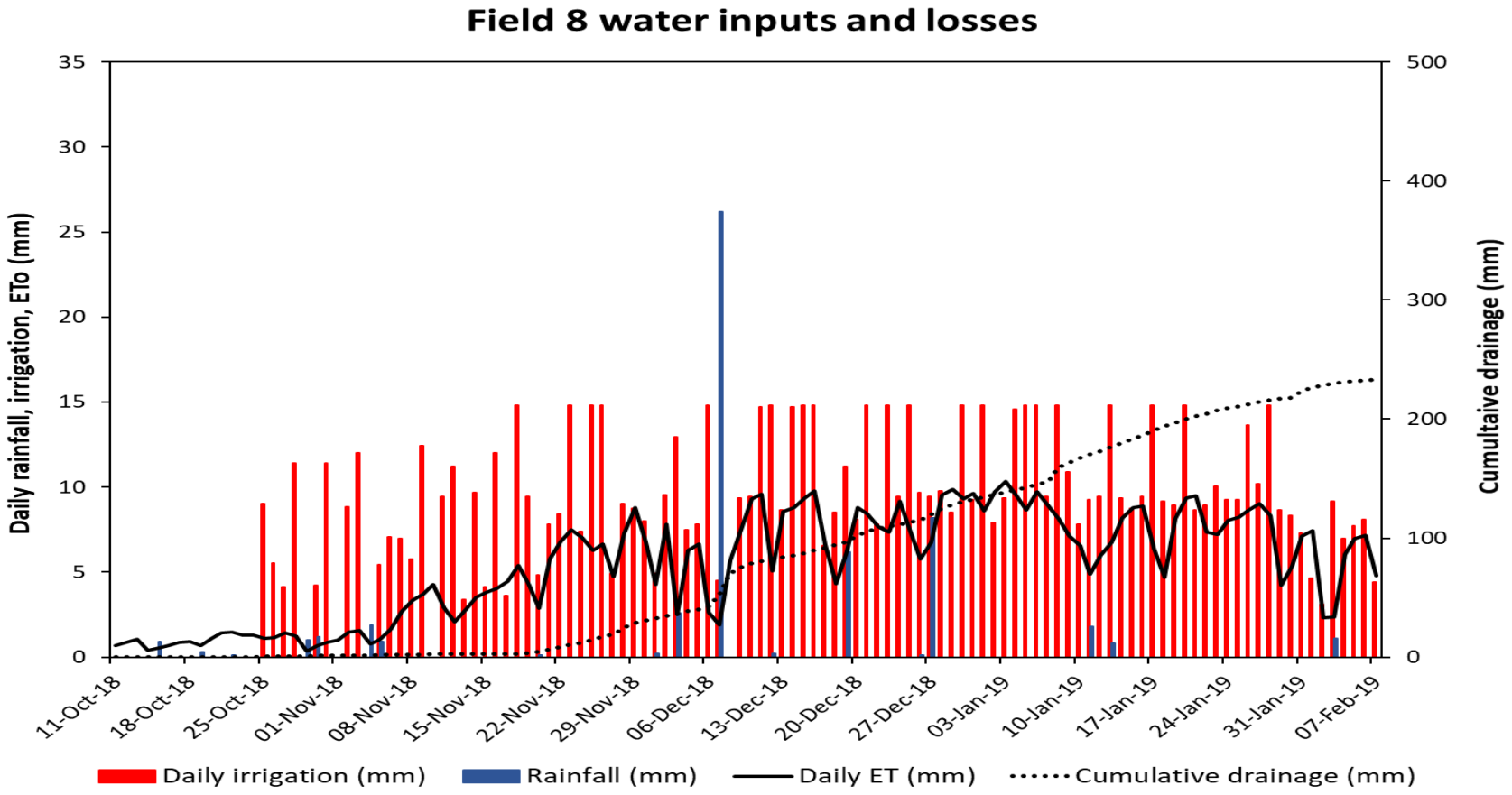
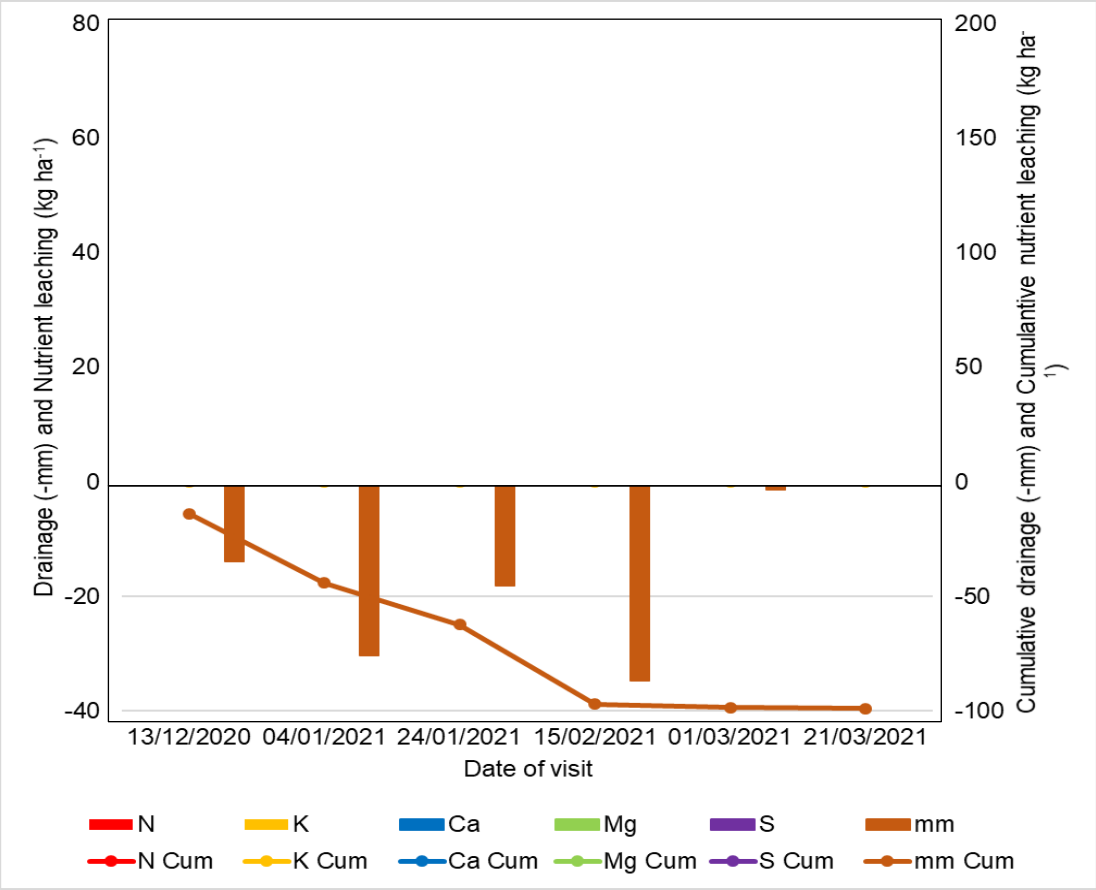
13-Nov-18
20-Nov-18
27-Nov-18
Daily Irrigation
Rainfall (mm)
ET
Cumulative drainage (mm)


Field 8 water inputs and losses
Daily rainfall, irrigation, ETo (mm)
Cumultaive drainage (mm)
35
30
25
20
15
10
5
0
500
400
300
200
100
0
11-Oct-18
18-Oct-18
25-Oct-18
01-Nov-18
08-Nov-18
15-Nov-18
22-Nov-18
29-Nov-18
06-Dec-18
13-Dec-18
20-Dec-18
27-Dec-18
03-Jan-19
10-Jan-19
17-Jan-19
24-Jan-19
31-Jan-19
07-Feb-19
Daily irrigation (mm)
Rainfall (mm)
Daily ET (mm)
Cumulative drainage (mm)

# Nutrients leached – Field 3



# Nutrients balances – Nitrogen (N)

| Field | Total nutrient input (A) | Nutrient exports (B) |
|---|---|---|
| 1 | 344.7 | |
| 2 | 293.2 | |
| 3 | 339.0 | |
| 4 | 318.9 | |
| 5 | 313.3 | |
| 6 | 321.8 | |
| 7 | 320.5 | |
| **Average** | **321.6** | |

# Nitrogen (NUE)

| Field | Total nutrient input (kg/ha N) |
|---|---|
| 1 | 344.7 |
| 2 | 293.2 |
| 3 | 339.0 |
| 4 | 318.9 |
| 5 | 313.3 |
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| **Average** | **321.6** |

# Nutrient uptake efficiency

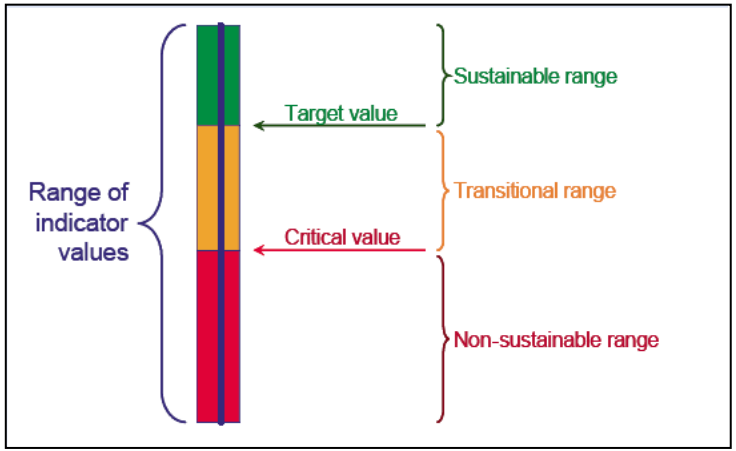
| Field | Nutrient uptake efficiency (kg nutrient removed / kg nutrient applied) |
|---|---|
| | N |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| **WFS Avg** | |
| **Avg (SV, NW)** | |

# Most important observations

- Range in WUE and NutUE between fields – external factors, management
- Low WUEs often due to low yields, high rainfall, over irrigation
- Drainage - mostly after rainfall events (and occasionally over irrigation)
- Nutrient leaching - with drainage – mainly Ca > S > N > Mg > K
- NUEs generally good, but…
- Poor correlation between nutrient rate, yield and NUE
- Substantial amounts of most nutrients left in soil after potato harvest (especially N, P) – utilize by following crops

# Strategies to improve input resource use efficiency

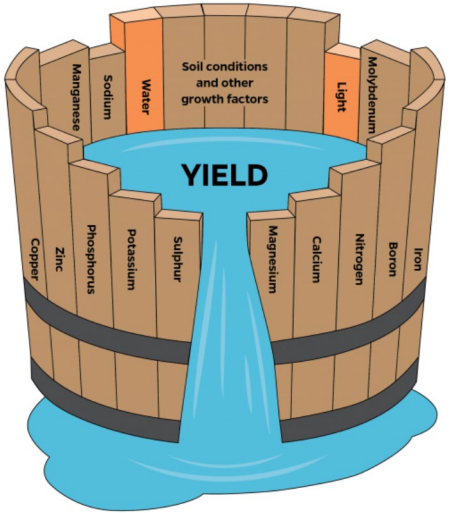
- Identify non-sustainable practices

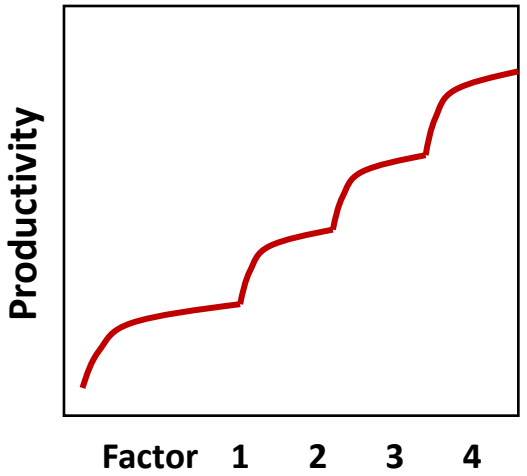



- Apply management strategies to improve efficiency
- Reduce risk of unproductive losses

# Strategies to improve input resource use efficiency

- Liebig's 'law of the minimum'

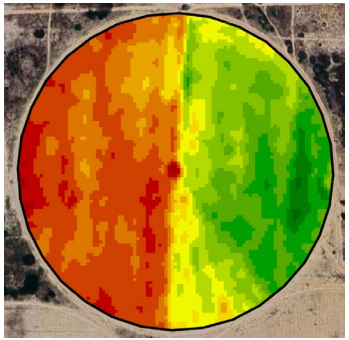


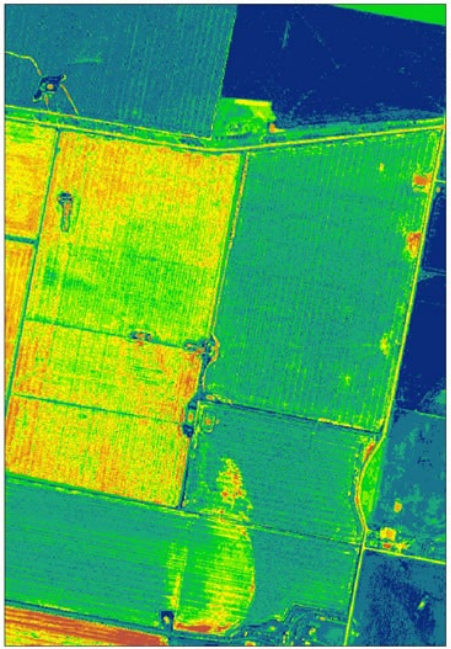



# Strategies to improve environmentally sustainable fertilizer practices

- Alter practices to improve nutrient use efficiency
- Focus on sustainable intensification – Less is often more!
- Reduce losses and pollution of the environment
- Optimize fertilizer programmes to reduce leaching risk – especially on sandy soils
- Consider techniques like slow-release fertilizers
- Improve nutrient retention with e.g. compost, cover crops, biochar, hydrogels
- Apply precision agriculture – soil mapping, remote sensing, variable rate application
- Use decision support systems (DSS) to optimize water and nutrient management practices

# Examples of DSS




# Thank you

# Acknowledgements


- Potatoes SA
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- Participating producers
- Students
- Yara Africa Fertilizer