Valuing Genetic Gain in Forages

Dairy Feedbase

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Dairy Australia — Your Levy at Work

Gardiner Foundation

Current FVI

Valuing Forages is not Trivial

- Pastures are an intermediary product or input
- Cultivar grazing comparisons are rare
- They are seldom traded in their own right
    - Hay, silage, standing for agistment
- They are “harvested’ multiple times
- The components that contribute to value are poorly defined for some systems
- They may not be the whole diet

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Valuing Stuff With Variable Specifications

Price: Triton $48k < D-Max $54k < Navara & BT-50 $54.5k < Hilux $56.5k < Colarado $57k < Ranger $62k < Amarok $69k

But does price reflect value?

Are they equivalent?

- Triton doesn't have sat-nav; Amarok doesn't have rear airbags

Performance and Specification data is available

- Market price tells you how consumers value performance, specification and other factors such as prestige/brand

Choosing a Perennial Ryegrass Cultivar

Ceres ONE50 Perennial Ryegrass

Bealey Perennial ryegrass

Base AR37 grasslands endophyte tetraploid perennial ryegrass performance bred®

BOOMER PERENNIAL RYEGRASS

VicSeeds Avalon AR1 Perennial Ryegrass

AUSTRALIAN GROWN AND OWNED

Everlast LE PERENNIAL RYEGRASS

CAMEL PERENNIAL RYEGRASS

PayDay TETRAPLOID PERENNIAL RYEGRASS

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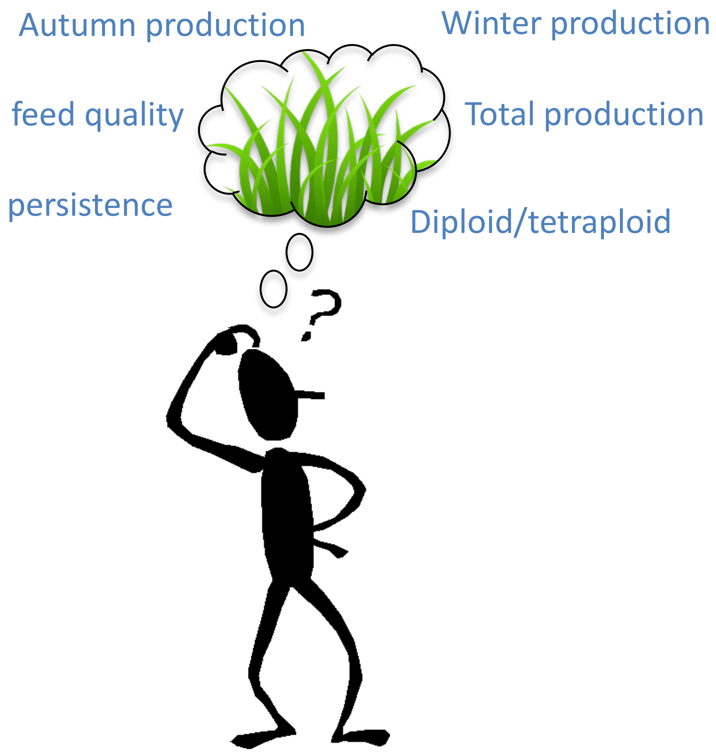
Why do we have a FVI for <u>perennial ryegrass</u>?

- Accounts for 80% of the estimated >$100 million/year Australian dairy farmers spend on pasture renovation
- 60+ cultivars of perennial ryegrass on the market



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Australia's first Forage Value Index

Dairy farmers can now access independently-analysed comparative information on the performance of perennial ryegrass cultivars

Forage Value Index

Dairy Australia
Your Levy at Work

https://www.dairyaustralia.com.au/fvi

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Gippsland - Forage Value Index

Cultivar		FVI Gipps	Autumn	Winter	Early Spring	Late Spring	Summer	Endophyte	Ploidy	Heading Date	Marketer	No. of trials
Base AR37		183	115	115	100	96	110	AR37	Tetraploid	Late	PGG Wrightson Seeds	7
Bealey NEA2		180	112	115	100	96	113	NEA2	Tetraploid	Very Late	Heritage Seeds	8
One50		158	113	116	99	95	110	SE	Diploid	Late	Agricom	4
Matrix - Festulolium		130	107	115	98	96	110	Unknown	Diploid	Late	Cropmark Seeds	3
Fitzroy		127	107	110	104	96	106	SE	Diploid	Early	PGG Wrightson Seeds	5
Halo AR37		125	113	113	95	93	112	AR37	Tetraploid	Late	Agricom	7
Kingston		122	110	113	98	97	107	SE	Diploid	Mid	Agricom	3
Kidman		122	108	113	101	96	106	AR1	Diploid	Early	Heritage Seeds	3

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Overall FVI rating and seasonal tables are available for each region

1. Overall FVI ranking

Gippsland - Forage Value Index

Cultivar		FVI Gipps
Base AR37		183
Bealey NEA2		180
One50		158
Matrix - Festulolium		130
Fitzroy		127
Halo AR37		125
Kingston		122
Kidman		122
Ansa		117
Extreme AR37		111
Banquet II Endo5		109
Endure		100
Arrow AR1		89
One50 AR1		82
Barberia		76
Avalon (+AR1)		72
Ohau AR37		50
Revolution - Festulolium		49
Impact 2 NEA2		46
Helix - Festulolium		10
Victorian		0

2. Seasonal

Gippsland - Autumn Seasonal Performance

Cultivar		Autumn
Base AR37		115
Halo AR37		113
One50		113
Bealey NEA2		112
Extreme AR37		111
Kingston		110
Banquet II Endo5		109
Kidman		108
Ansa		107
Matrix - Festulolium		107
Fitzroy		107
Endure		107
Impact 2 NEA2		105
One50 AR1		105
Ohau AR37		105
Avalon AR1		105
Revolution - Festulolium		103
Arrow AR1		103
Helix - Festulolium		101
Barberia		101
Victorian		100

Gippsland - Winter Seasonal Performance

Cultivar		Winter
One50		116
Base AR37		115
Ansa		115
Bealey NEA2		115
Matrix - Festulolium		115
Extreme AR37		114
Halo AR37		113
Kingston		113
Kidman		113
Endure		111
Banquet II Endo5		111
Fitzroy		110
Avalon AR1		110
Barberia		109
Revolution - Festulolium		109
Arrow AR1		107
Helix - Festulolium		106
One50 AR1		104
Ohau AR37		104
Impact 2 NEA2		103
Victorian		100

How was the FVI developed?

1. Calculating seasonal performance values for each cultivar

Pasture Trial Data
9 x 3yr trials
15-40 cultivars/trial

Australian Seed Federation SOWING SEEDS

mla MEAT & LIVESTOCK AUSTRALIA

Performance Value
difference in DM yield between each cultivar and a 'base' cultivar (Victorian)

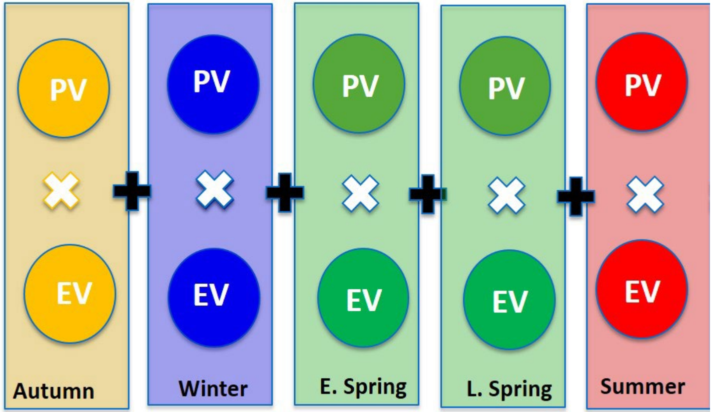
2. Calculating economic values for 5 "seasons" in 4 dairy regions

Farm-level data
- Feedbase
- Herd feed demand and supply (energy basis)

Market prices of feeds
- Dairy Australia hay & grain data

Economic Value
estimated net benefit to a farm system for every 1kg increase in pasture DM

3. Combining performance values and economic values into a FVI rating



Current FVI

Calculation of Performance Values (PV's)

Statistical Modelling: MEMH trials

Realistic prediction of the performance values of cultivars requires appropriate modelling of:

- genotypic variance
- residual variance

By accounting for:

- Temporal correlation between observations on the same plot from consecutive harvests (repeated measurements)
- Spatial correlation between observations in row and column directions at trial sites
- Heterogeneity of residual variance at different trials or in different harvests within a trial
- Appropriate model for residual covariance between harvests

Statistical Modelling

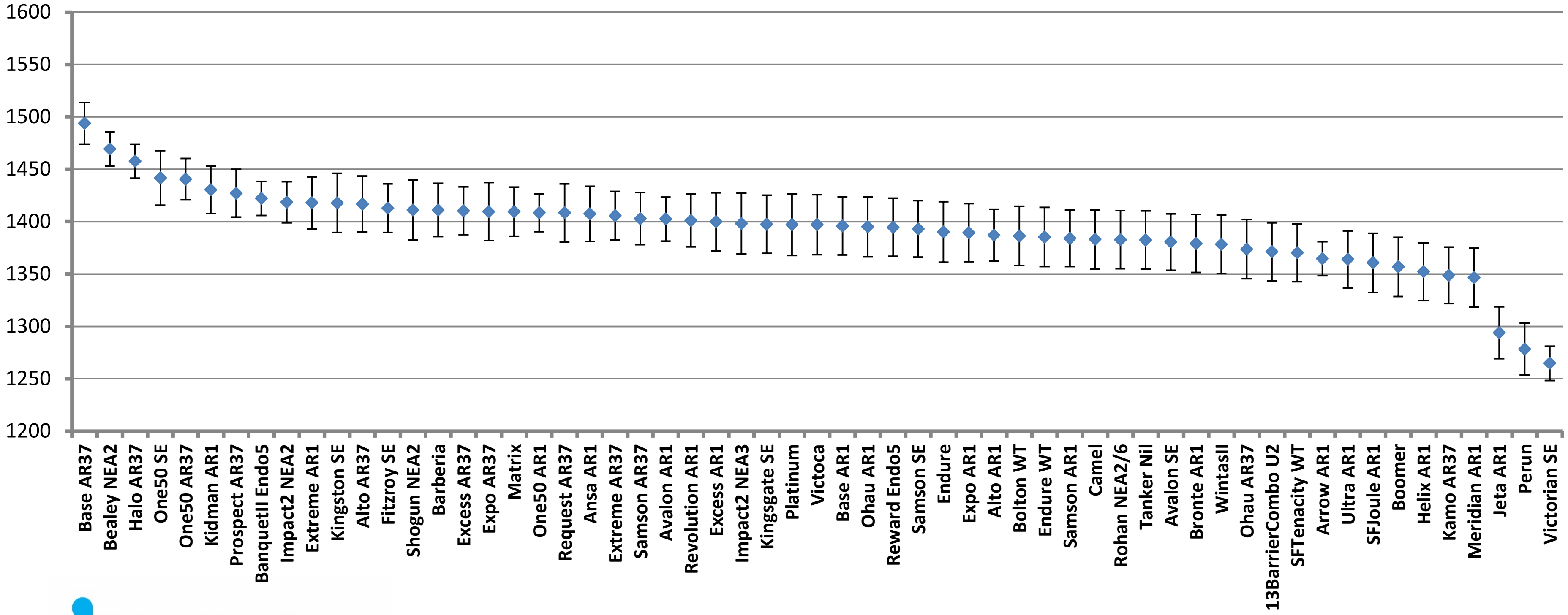
Each harvest was analysed using a linear mixed model

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{Z\gamma} + \boldsymbol{e}$$

Where

- β is the vector of fixed effects
- $\boldsymbol{X}$ is a design matrix for the fixed effects
- γ is the vector of random effects
- $\boldsymbol{Z}$ is the design matrix for the random effects and
- e is the vector of residuals

Results: Winter BLUP means (kg/ha)

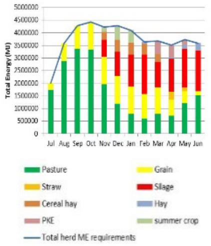


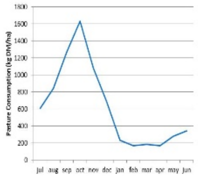
Current FVI

Calculation of Economic Values (EV's)

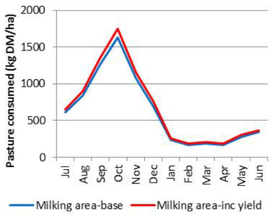
A partial budget approach in a whole farm systems context is used to calculate EV's in the FVI

ECONOMIC VALUE = predicted $ net benefit to a dairy farm system for a single unit change in the trait of interest (e.g. kg pasture DM)





1. Monthly pasture consumption and herd feed demand and supply (ME basis) determined for a case study farm in each region



2. Pasture trial data used to estimate % increases in pasture available and applied to regional pasture curves

3. Use of extra pasture in the farm system valued monthly according to the feed it replaces *or* as conserved forage (accounting for forage conservation costs) if surplus to needs

Economic values

Estimated economic values for dairy regions shows the value of pasture grown varies according to location and time of year

Region	Autumn	Winter	Early Spring	Late Spring	Summer
SW Vic	$0.31	$0.33	$0.20	$0.23	$0.37
Nth Vic	$0.29	$0.34	$0.34	$0.32	$0.26
Gippsland	$0.36	$0.43	$0.37	$0.22	$0.38
Tasmania	$0.33	$0.35	$0.36	$0.11	$0.17

Economic Value = estimated net benefit to a farm system for every 1kg increase in pasture dry matter
Seasons:

- *Autumn = March, April, May*
- *Winter = June, July*
- *E. Spring = August, September*
- *L.Spring = October, November*
- *Summer = December, January, February*

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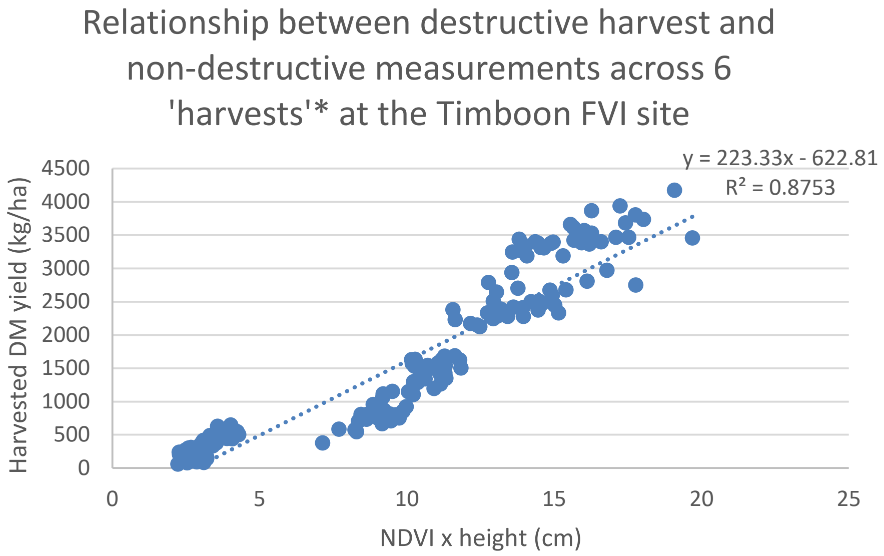
FVI Futures

FVI Futures

Automated data capture

FVI Futures

More efficient data capture through modern sensor technologies



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Incorporation of automated measurement = 16 fold decrease in time of measurement (1h vs 16h)

Aerial Phenotyping: Workflow

Image Acquisition

- Autonomous flight missions
- Multispectral imaging
- Thermal imaging
- RGB imaging

Image Processing

- Orthomosaic
- DSM and DTM
- Reflectance map
- Index map

Image Analysis

- Object and pixel analysis
- Segmentation
- Classification

Summary Statistics

- Plot/Plant based summary
- Export to Excel

Workflow in Pictures

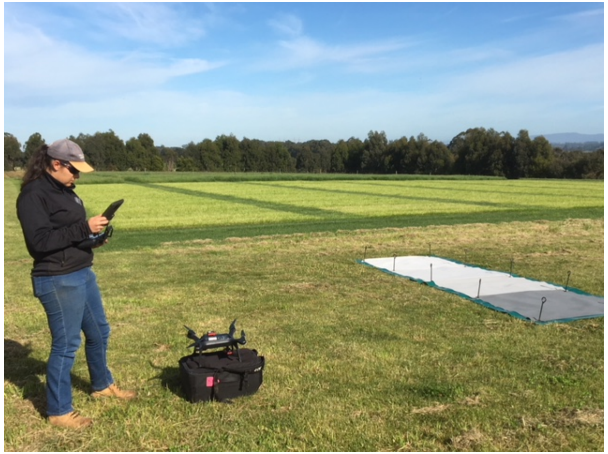
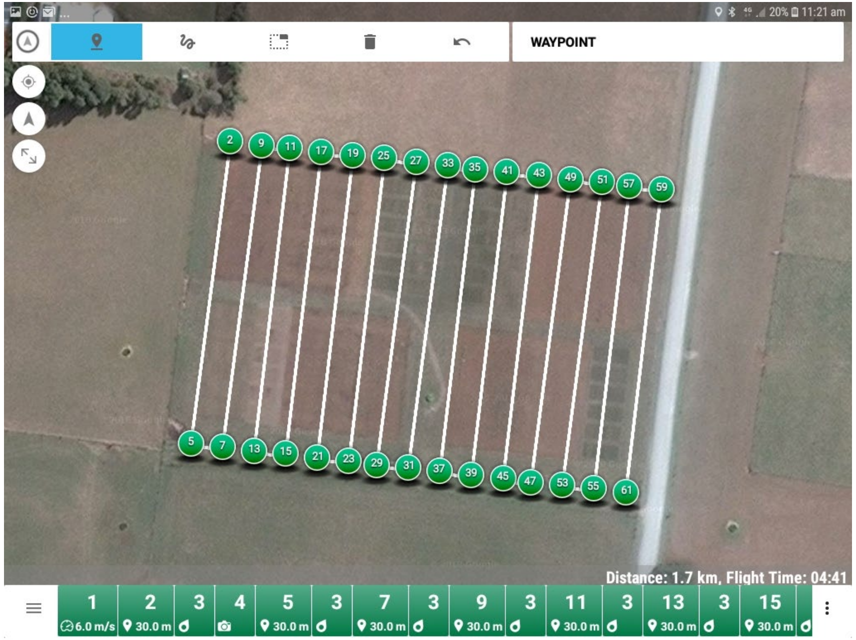


Image Acquisition

- Flight path entered as a template into an application called Tower
- Distance covered 1.7km
- Flight time approx. 5 minutes



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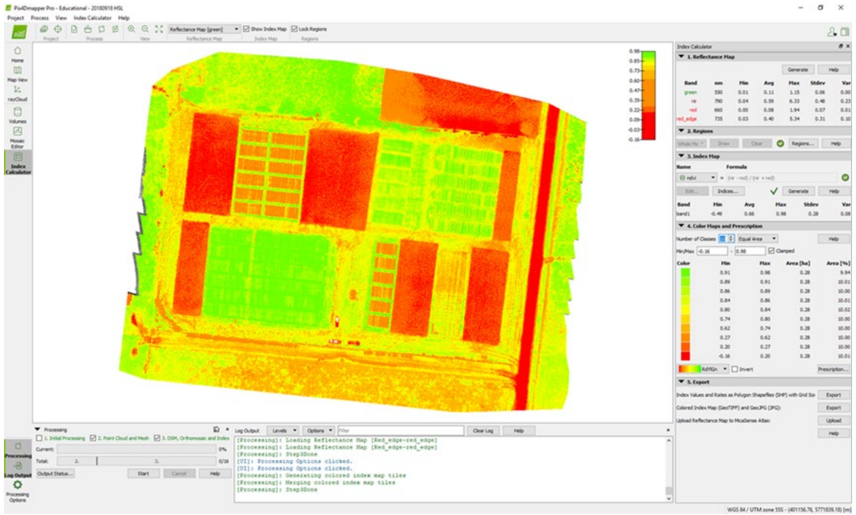
Non-destructive Yield Estimation using NDVI

- NDVI is not a direct measurement of yield
- Highly correlated to vegetative biomass of perennial ryegrass (R^2 = 0.49 to 0.89)
- NDVI is very effective in ranking plants for biomass yield



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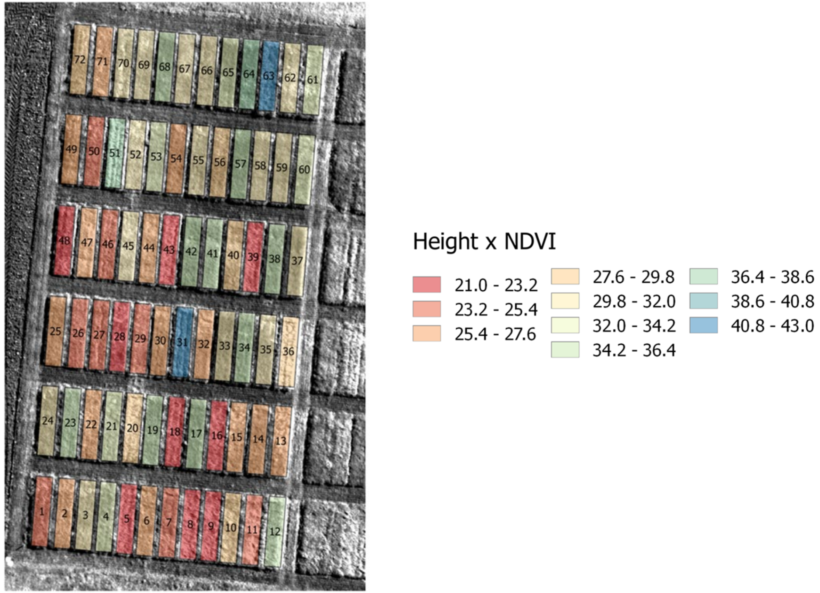
NDVI x Plant Height

- "Yield" map of a perennial ryegrass cultivar trial



FVI Futures

- More efficient data capture through modern sensor technologies
- New traits – persistence and forage quality measure with new technologies

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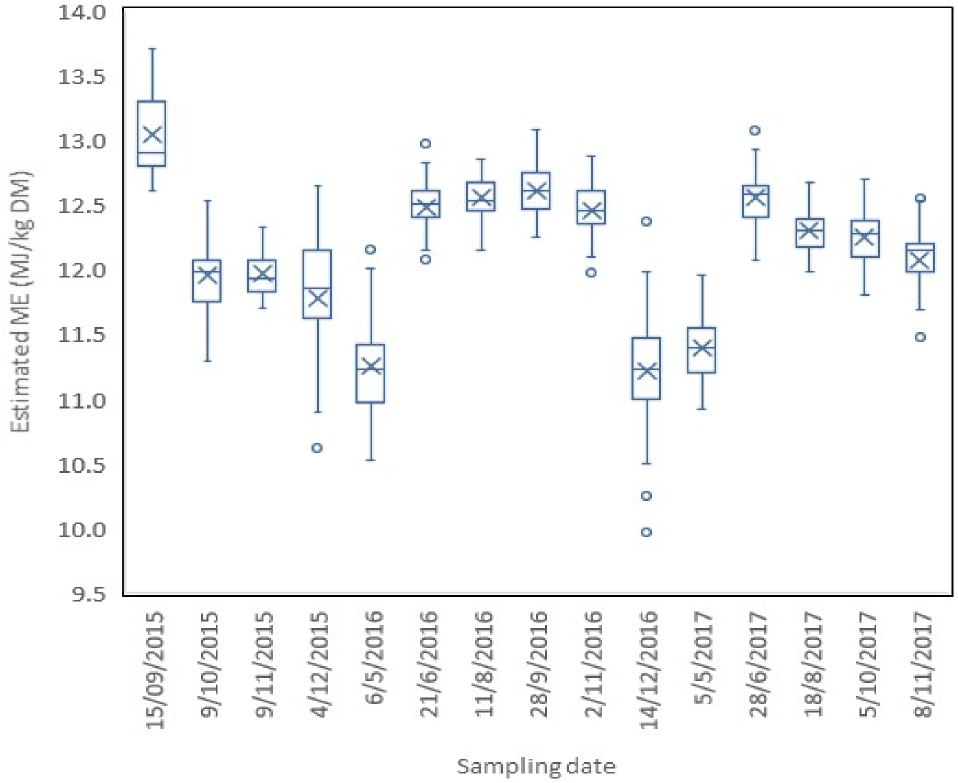
Metabolisable energy will be the first quality measure to be added



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Composite sample strategy can reduce analysis costs by 40%

- Results of composite data model (77 samples/harvest) were similar to the full data model (128 samples/harvest).
- Compared to full data model, the composite data model had:
  - Slightly higher variability due to season and cultivar
  - A slightly lower linear row and column effect and lower column and row variability (due to 3 “missing values” in cultivars that had been bulked).
  - Higher row and column auto correlation.
  - Slightly higher average standard error of difference between any cultivar and ‘Victorian’ with standard endophyte.
- Implementing strategy would reduce sampling costs by 40% (from $5,120 to $3080 per harvest).
- If composite sampling is done properly:
  - it will yield statistically valid inference.
  - Precision of estimates and ‘BLUP’ means will be very similar to the full data model.
- Strategy has been applied to analysis of samples from other 3 FVI trial sites (Ellinbank, Tongala, Elliott).

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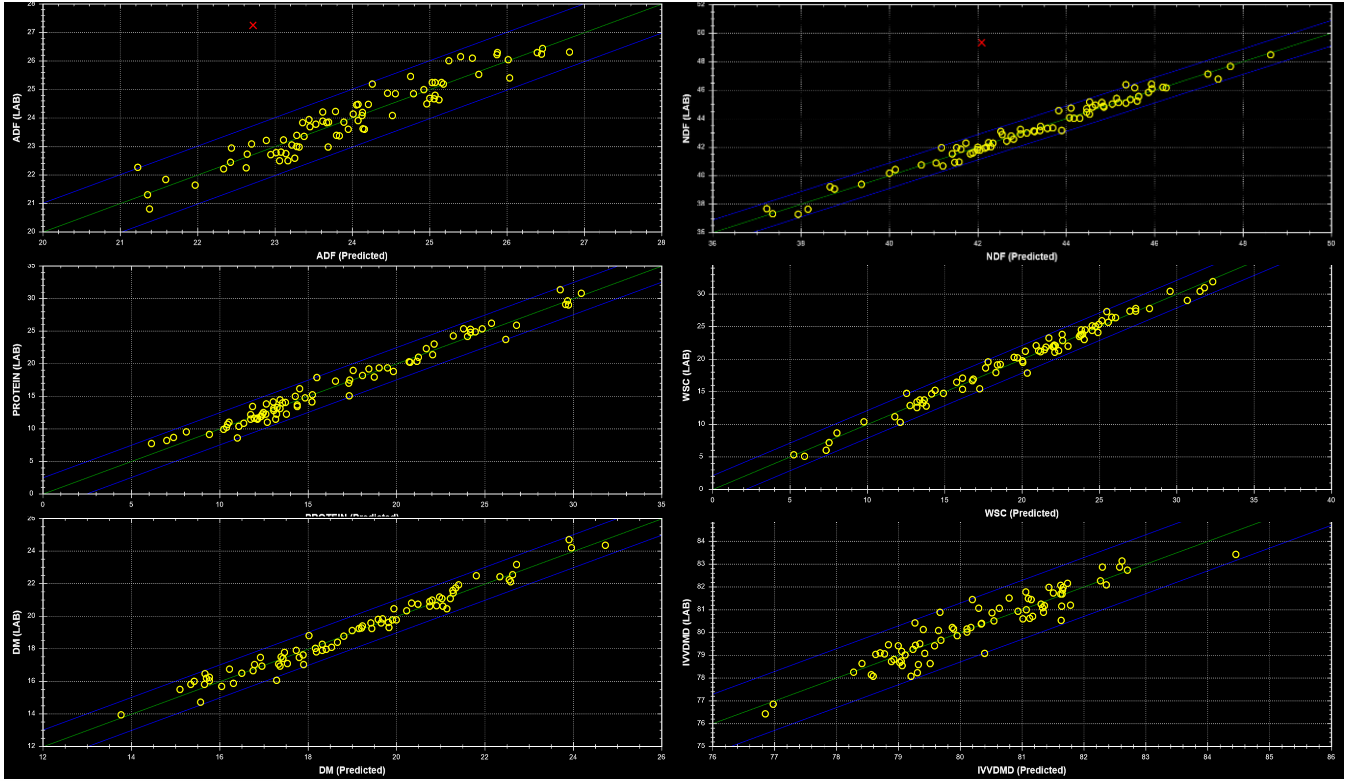
Comparison of strategies (crude protein%)

Effects	Full data model	Composite data model
Overall mean	21.11	21.16
Linear row	-0.17	-0.14
Linear column	0.008	0.004
Seasonal var.	24.54	26.18
Cultivar var.	0.08	0.10
Season x Cultivar var.	0.22	0.14
Row var.	5.28	4.38
Column var.	0.16	0.15
Row cor.	0.18	0.28
Column cor.	0.14	0.22
Avg. s.e.d	0.40	0.44

2. Non-Destructive Measurement of Forage Quality



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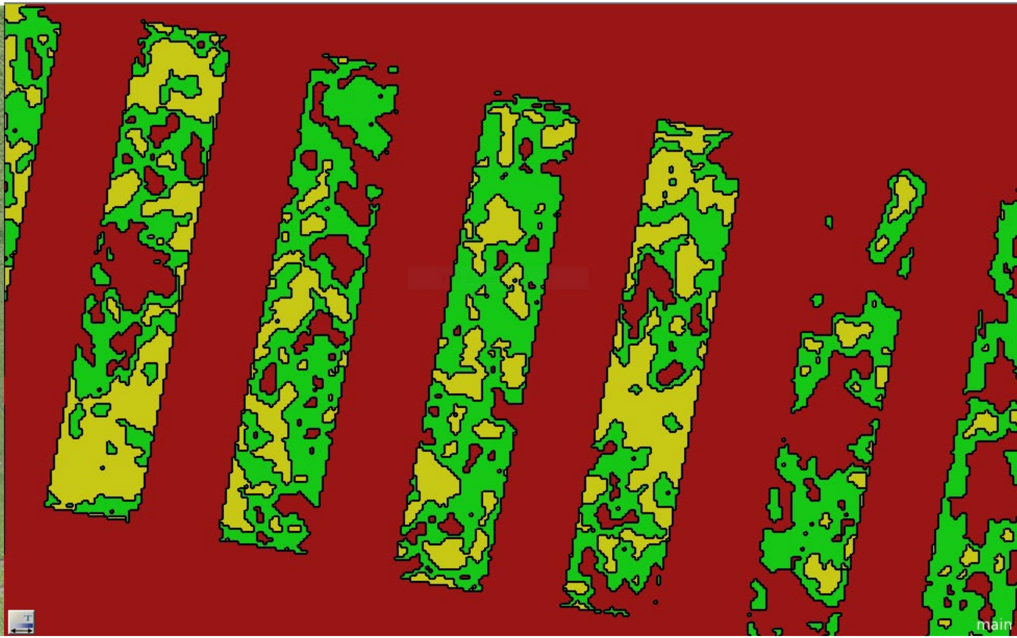
Lifetime Productivity/Persistence



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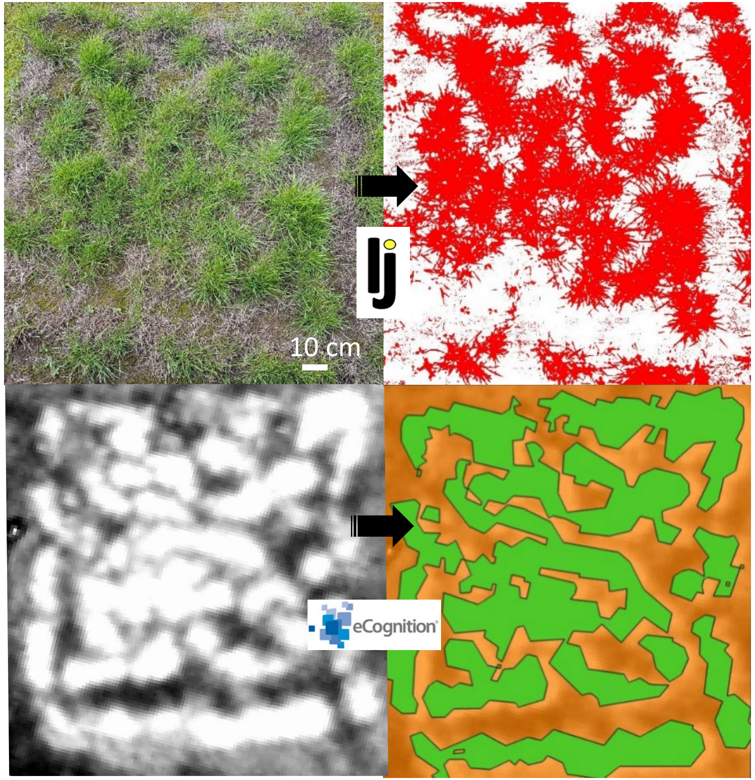
Persistence

RGB image

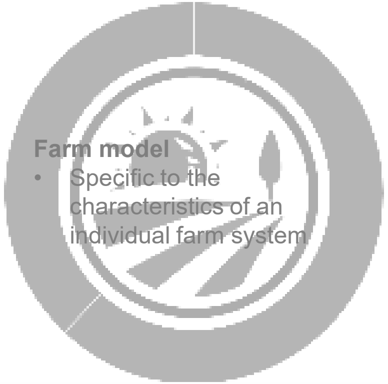
NDVI raster

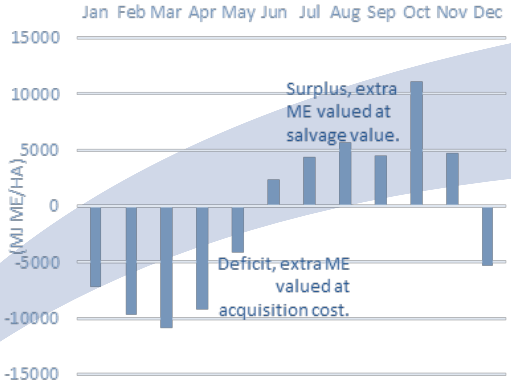


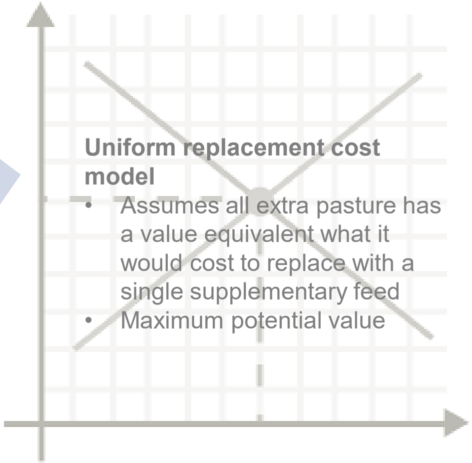
FVI Futures

Revised calculation of EV's

Alternative model to generate FVI economic values







Acquisition cost & salvage value model

- Extra pasture produced when pasture is typically in deficit is valued higher than that produced when typically in surplus
- Valued using a range of supplementary feeds

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- Farm Systems Economics – Clare Leddin, Claire Lewis, Christie Ho

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