Strategies to support phenotyping for genomic selection R&D and implementation in beef (and sheep) industries

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Points:

- Genomic selection
  - What changes?
- Challenges in beef (and sheep) industries
  - Diversity
  - Limited scale and market orientation
  - What to breed for, how much to invest, how to fund phenotypes
- Options
  - Levels of investment
  - Cost-sharing
- Prospects
  - Structures
  - Roles
  - Investment perspective

Key change under genomic selection:

- Decoupling recording (collecting phenotypes) from selection

- Leads to:
  - Splitting of roles (recording, selecting, marketing) previously combined
  - More thought re breeding goal

Beef and sheep – challenges 1:

- Diversity:
  - of scale
  - in recording effort,
  - in selection applied
- Limited value-chain integration
- Leading to recording mainly on ETM traits (Easy-to-Measure)

	Cost of Recording: Low	Cost of Recording: High
Value of Trait: High	Worth recording: ETM	Worth recording: HTM
Value of Trait: Low	Not worth recording?	Not worth recording

Beef and sheep – typical outcomes:

- Effects – BLUP era:
  - Individual outcomes approximately reflect individual effort
  - Population typically makes progress at lower than potential rates

- Potential effects – genomics era:
  - Phenotyping effort likely to reflect market signals
  - Genomic accuracy depends on distribution (scale, focus) of phenotyping

- How to maximise profit from genetic improvement using genomic selection?

Think of this as an investment problem:

- What to invest in – what traits to record?
- How much to invest – what scale of recording?
- How to fund the investment?

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Two explorations:

- Modelling profit from recording
- Model for sharing costs

Modelling profit from recording:

- 2 traits:
  - ETM and HTM (h2 = 0.3 and 0.1; cost = $1 and $5 per record; REV = $1 and $5)
  - Vary genetic correlation between traits

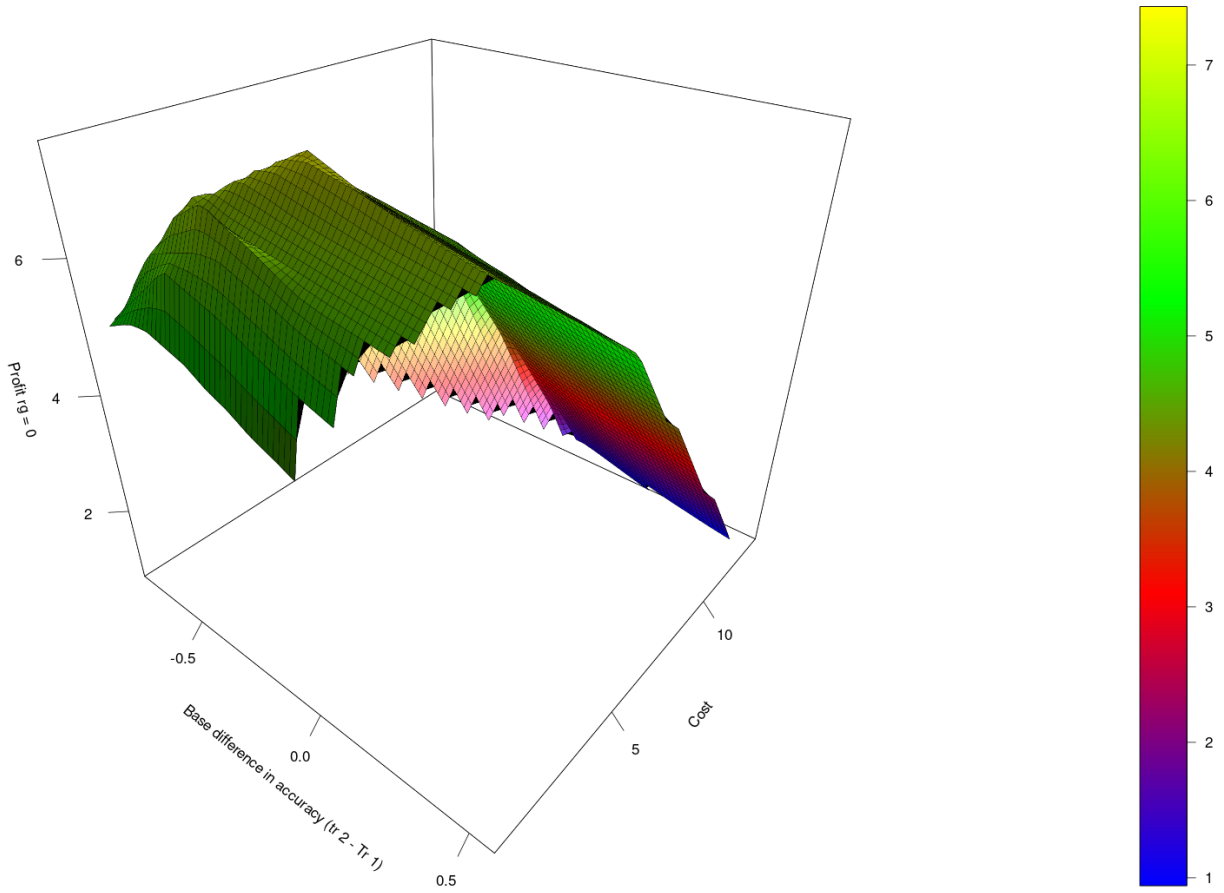
- Calculate response to selection at accuracy from very low to high (MTINDEX)
  - Calculate records needed to generate each level of accuracy (Me = 5,000)
  - NB: accuracy here is genomic accuracy (not identical to BIF accuracy)

- Model implementation via reference cost and commercial sector returns
  - Commercial harvesting over 5 years
  - Vary commercial scale

Example responses v accuracy for the 2 traits:

$ Response when rg = 0:

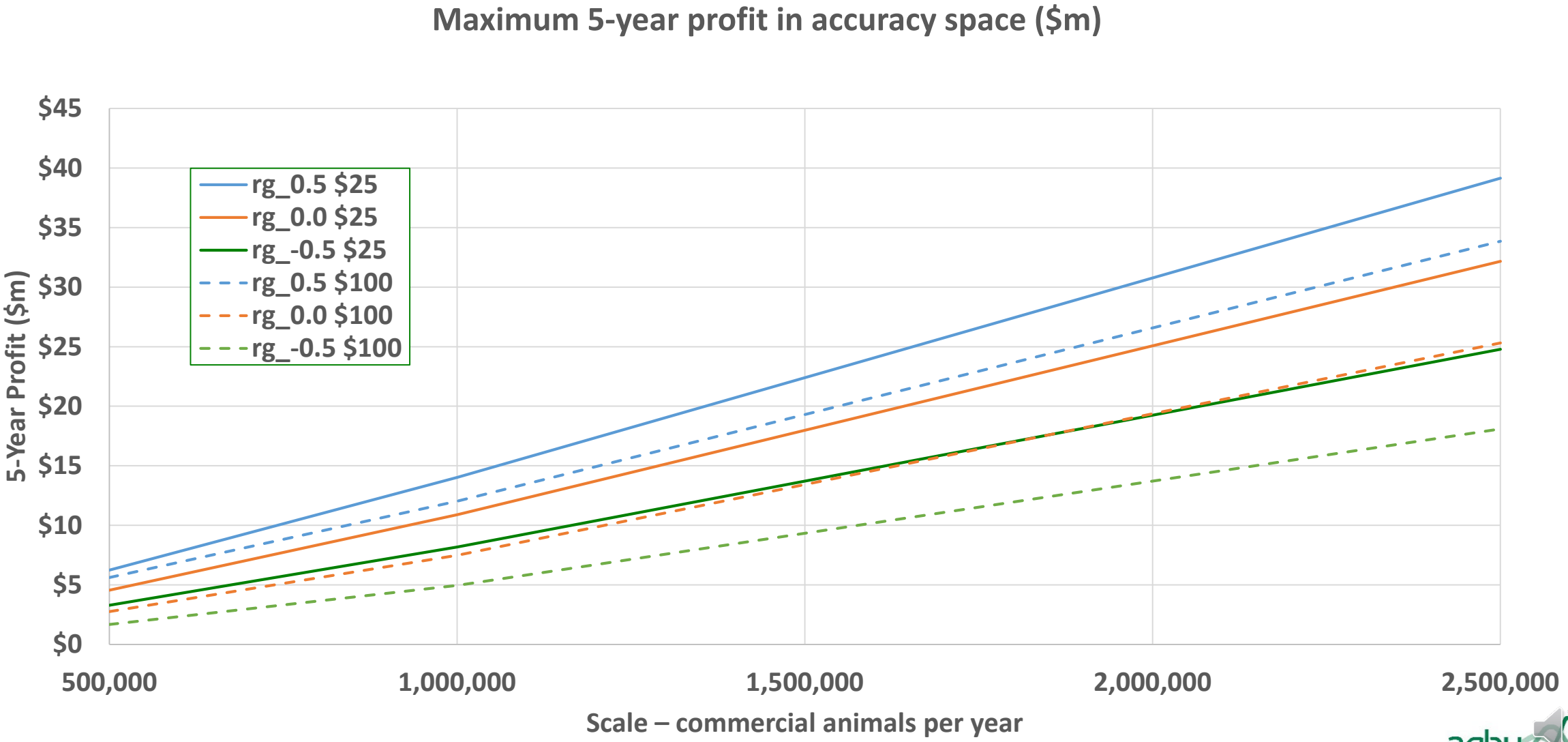
Trait 1 n		Trait 2 n						
		1,280	2,567	6,406	12,838	32,051	64,286	128,002
	accuracy	0.158	0.221	0.337	0.452	0.625	0.75	0.848
1,353	0.274	$0.292	$0.380	$0.554	$0.730	$1.000	$1.195	$1.349
2,710	0.374	$0.323	$0.405	$0.571	$0.743	$1.009	$1.203	$1.357
6,754	0.537	$0.386	$0.457	$0.609	$0.772	$1.031	$1.221	$1.373
13,503	0.669	$0.444	$0.506	$0.647	$0.803	$1.054	$1.240	$1.390
33,705	0.818	$0.513	$0.568	$0.696	$0.843	$1.085	$1.267	$1.414
67,857	0.896	$0.551	$0.602	$0.724	$0.867	$1.103	$1.283	$1.428
136,430	0.944	$0.574	$0.624	$0.742	$0.882	$1.115	$1.293	$1.437


Profit rg = 0
6
4
2
-0.5
0.0
0.5
Base difference in accuracy (tr 2 - Tr 1)
5
10
Cost
7
6
5
4
3
2
1

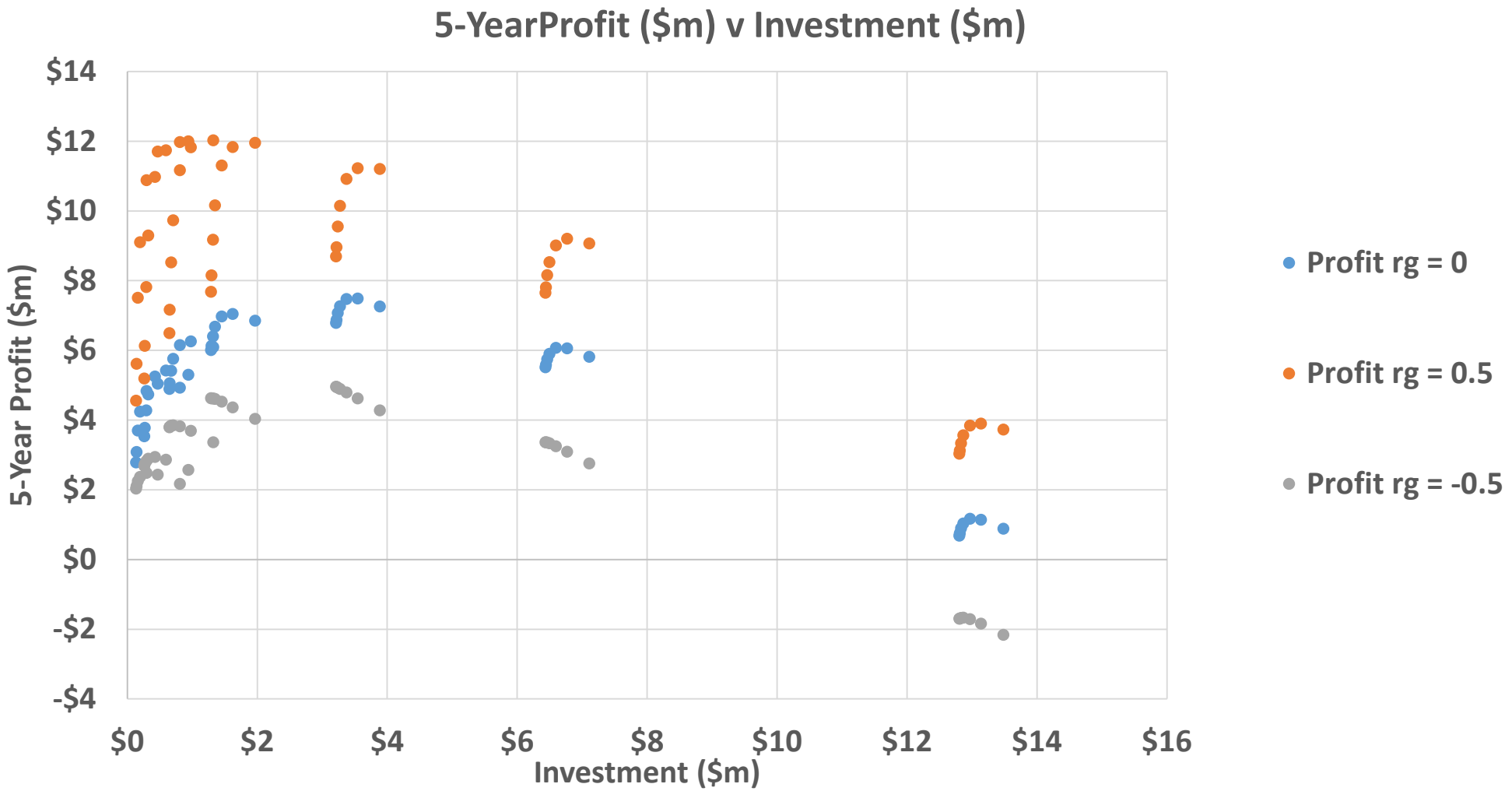
Maximum profit:

		Scale (# commercial animals per year)					
		500,000		1,000,000		2,500,000	
		$25	$100	$25	$100	$25	$100
rg = 0.5							
	Maximum profit ($m)	$6.24	$5.62	$14.02	$12.03	$39.14	$33.84
	nrec_1 at max (k)	68	68	68	136	136	136
	nrec_2 at max (k)	32	1	64	6	128	32
rg = 0.0							
	Maximum profit ($m)	$4.56	$2.76	$10.89	$7.49	$32.16	$25.31
	nrec_1 at max (k)	34	34	34	68	68	68
	nrec_2 at max (k)	64	13	64	32	128	64
rg = - 0.5							
	Maximum profit ($m)	$3.29	$1.67	$8.19	$4.96	$24.78	$18.09
	nrec_1 at max (k)	1	1	3	1	34	7
	nrec_2 at max (k)	64	13	64	32	128	64

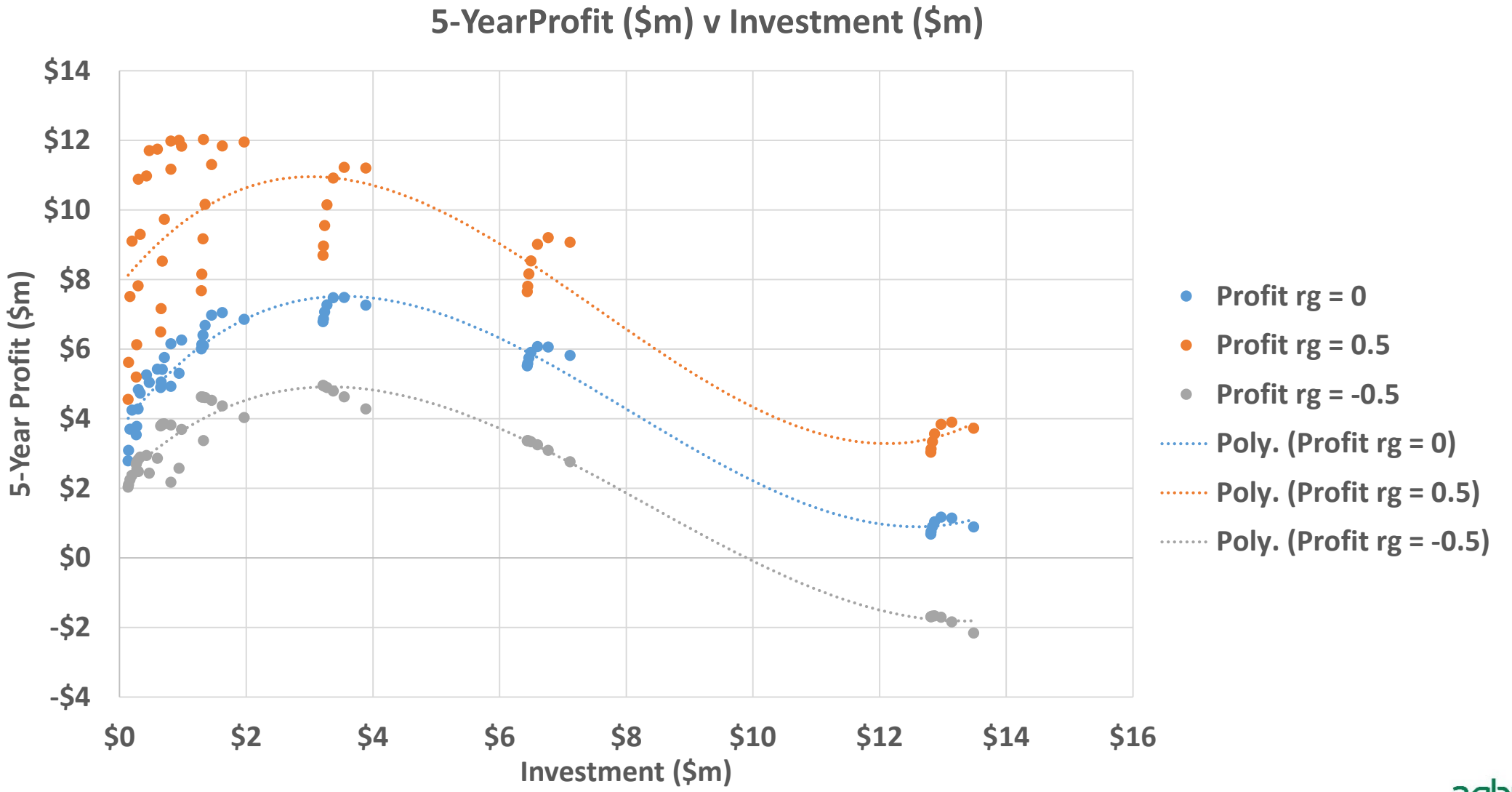
Maximum profit – effects scale and cost of recording:



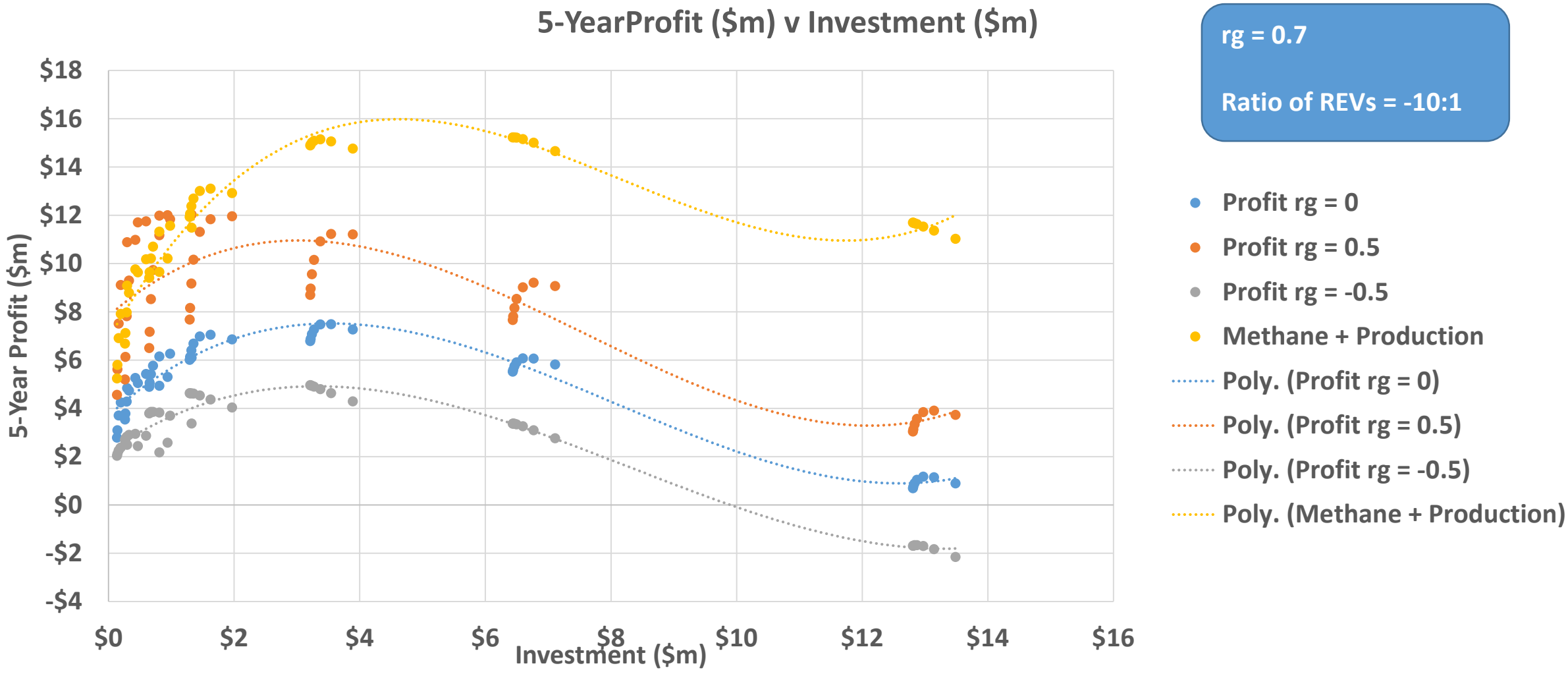
5-Year Profit v investment:



5-Year Profit v investment:



5-Year Profit v investment – including “VeryHTM”:



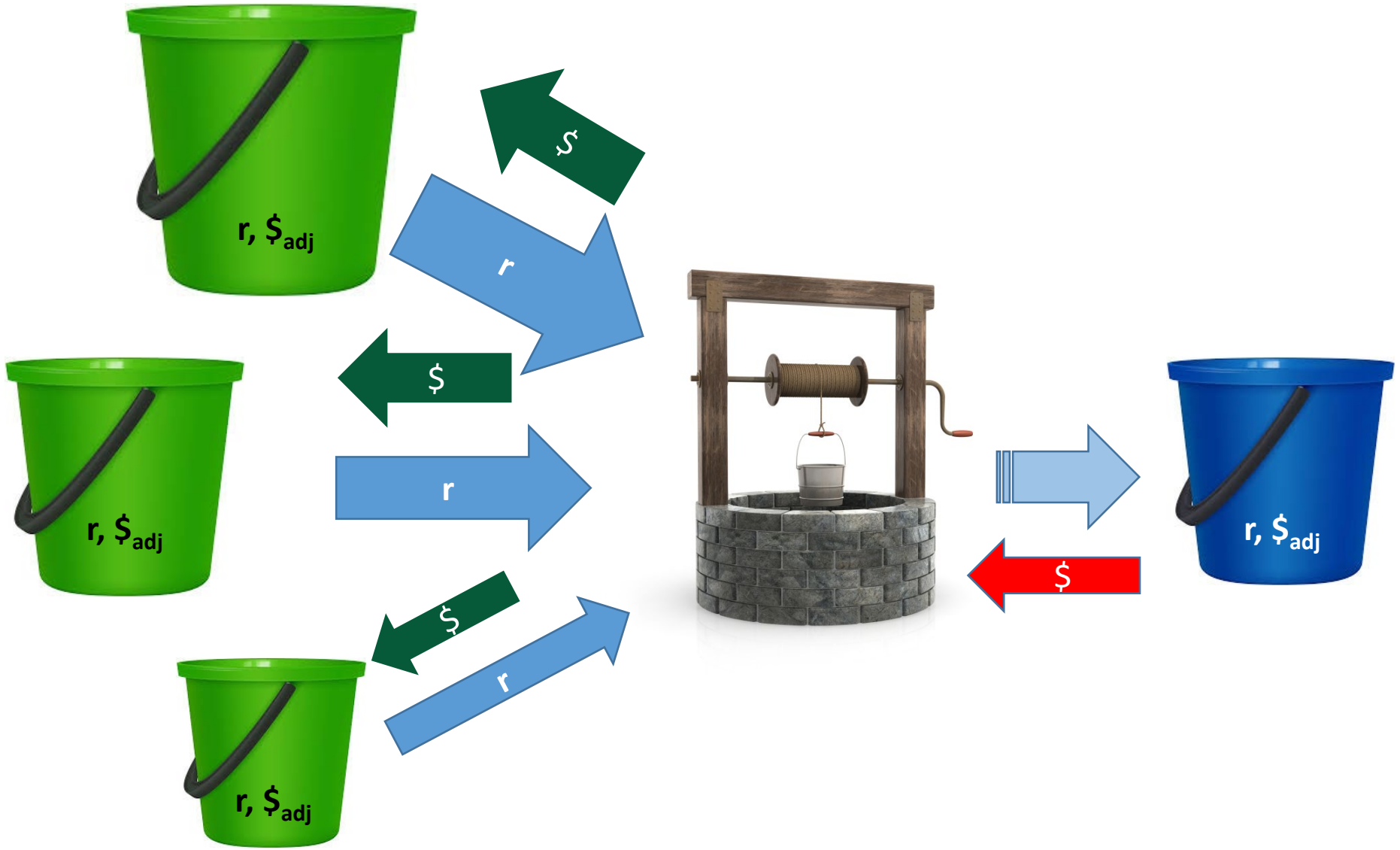
How to fund phenotyping?

- There will be:
  - Enterprises providing phenotypes, varying in cost and accuracy
    - Accuracy is for the breeding objective
    - In some of the phenotyping enterprises, there will (or should be) genotyping
  - Enterprises genotyping but not phenotyping

- Equalise Return on Investment ~ as Accuracy obtained/Cost

- Example is based on beef in Australia

Contributors & drawers: equalise r/$ for everyone



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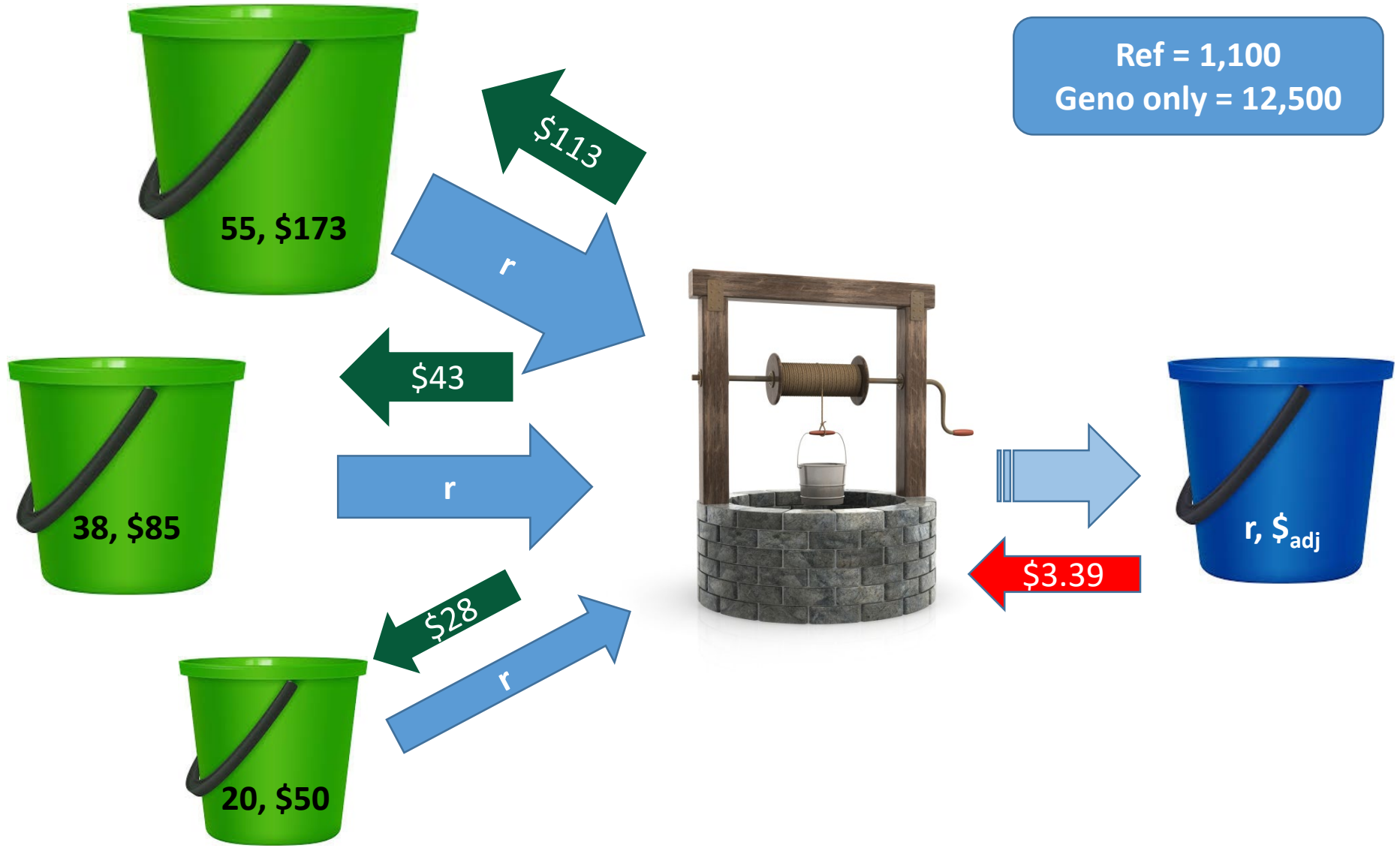

Overall:

- Its worth calculating (estimating) returns, in order to optimise level and trait allocation of phenotyping (applies everywhere – not just beef (and sheep)):
  - Parameter space: genetic parameters, REVs, recording costs, scale ~ case-by-case

- Definition of breeding objective is fundamental, because it determines the economic value of accuracy, and hence of phenotypes, including phenotypes of different traits

- Scale impacts optimum investment
  - But consider investing to grow scale

Overall 2:

- Phenotyping HTM traits is profitable ~ over a wide range of parameters
- Selecting on HTM traits will boost value of selection, and make it easier to fund phenotyping (makes it cheaper relative to returns)
- Levy or royalty model can be simple, equitable and efficient – and cheap (average in examples here up to $3.00 per commercial animal, at 1m animals per year)
- Easy to incorporate addressing market failure in price signals into the levy or royalty model
- Maximising accuracy available to users (per $) will be critical for platforms (evaluation centres, breeds)
- Accuracy for objective is the basic currency of genetic improvement, and investment in accuracy is the central problem

Background re R&D funding model in Australia:

- Applies to beef and sheep (and some other agricultural industries)

- Levy is collected from production:
  - Various mechanisms eg transaction
  - Think of it as similar to check-off
  - https://www.mla.com.au/about-mla/how-we-are-funded/about-your-levy/

- The levy is collected for:
  - Industry information systems
  - Industry marketing campaigns
  - R&D
    - R&D levy is matched by Federal Gov't up to a defined share of GVP

- R&D funds re genetics:
  - Into research and development of methods and tools
  - Into establishment of reference populations – continued with co-investment with some breeds