final report

Project code: B.PAS.0267

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Date published: July 2011

PUBLISHED BY
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Feedbase investment plan BCA and market failure framework

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract
This contract was to conduct an economic assessment of the investments into pasture improvement, feedbase RD&E and develop a market failure assessment framework to guide public, industry and private investment. The project was modified, a preferred method was a more resource intensive project than envisaged in the tender EOI. Component 2 (feedbase RD&E BCA) was undertaken via a different path, while the effort was placed on defining an improved market failure process (Component 3).

Executive Summary

The MLA Board has requested a review of current feedbase RD&E investments and development of a comprehensive investment plan for future plant improvement, pasture management and grazing system RD&E for southern Australia.

A BCA was completed on value of investment in pasture improvement. The objectives of this study were:

- To validate MLA's preliminary BCA of R,D&E investments in pasture improvement over the period 2000-2010
- To undertake a BCA of increased investment in pasture research over the period 2010-2030
- To modify the analysis under the second objective to examine a scenario of no MLA investment in pasture productivity improvement research.

The net benefits of R,D&E, expressed as an NPV, BCR and IRR, for a range of increases in carrying capacity and a present value (PV) of R,D&E costs of $53 million (based on annual R,D&E expenditure of $7.5 million), are shown in Table 2. Estimates of the BCR range from 87:1 for a 1 per cent annual increase in carrying capacity for improved pasture to 154:1 for a 5 per cent increase in carrying capacity. The IRR ranges from 29 per cent to 43 per cent over the same range of carrying capacity increases. The results show that R,D&E investment in pasture improvement offers a significant rate of return to growers

The BCA on the proposed feedbase plan was not completed. This was the basis for terminating the project before completion of all objectives.

The public and private sector are participants in the pasture industry supply chain providing good and services to livestock producers. To assist planning of future investment, a market failure assessment framework is to be developed. The project was:

- To define market failure and describe the types of market failure that could arise in the pasture industry supply chain
- To provide a market failure assessment framework for evaluating MLA investment in R&D or other assistance.

The framework should not be seen as a recipe for identifying market failure. The complex and subtle nature of many types of market failure may mean that analysts have to revisit earlier steps in the framework as they learn more about the market and types of failures that exist. In other words, the framework should be adaptively to achieve the best outcome. Also, as analysts gain experience in using the framework, the types of questions that should be addressed can be augmented and revised.

Objectives

By December 6, 2010 to have completed and provided a report to MLA:

1) Validation of a preliminary BCA conducted by MLA and others in the pasture industry supply chain in plant improvement and adoption, and proposed investment 2010 to 2030

2) Ex-ante evaluation of the proposed MLA pastures investment plan currently being developed

3) Development of a framework to determine market failure

Success in achieving the Objectives

1) Validation of a preliminary BCA conducted by MLA and others in the pasture industry supply chain in plant improvement and adoption, and proposed investment 2010 to 2030

- Achieved. See appendix 1.

2) Ex-ante evaluation of the proposed MLA pastures investment plan currently being developed

- Not achieved - project modified and terminated as this was not completed. The proposed approach by GHD to the BCA was based on an assumption that the Feedbase Plan would be more detailed than it is in terms of deliverables and component projects (including costs and potential service providers). Also assumed was a more consolidated and comprehensive set of data than currently existed. The feedbase BCA task was removed from the scope and effort directed into the market failure component of the plan.

3) Development of a framework to determine market failure

- Achieved. See Appendix 2

APPENDIX 1

1 Report for Pasture Plan Evaluation

Component 1 - Benefit Cost Analysis of RD&E Investments in the Pasture Industry

1.1 May 2011

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1. Introduction

1.1 Background

Meat and Livestock Australia (MLA) is developing a Research, Development and Extension (R,D&E) Investment Plan for the Southern Australian Feedbase (the Plan) to guide future investment in R,D&E aimed at achieving productivity improvements in the beef, lamb and sheep meat industries in southern Australia through pasture improvement.

To assist in the development of the Investment Plan, the MLA has engaged GHD Pty Ltd to undertake the following three pieces of work:

- A review and validation of a preliminary internal benefit cost analysis (BCA) of investments in pasture improvement over the period 2000-2010 prepared by the MLA (Component 1)
- An economic evaluation of the proposed research investments identified in the draft Plan (Component 2)
- Development of a framework for determining market failure in pasture investment (Component 3).

This report describes the results of the first component – the review and validation of the preliminary BCA of the MLA's investments in pasture improvement for southern Australia over the period 2000-2010.

1.2 Objectives of this study

The objectives of this study were:

- To validate MLA's preliminary BCA of R,D&E investments in pasture improvement over the period 2000-2010
- To undertake a BCA of increased investment in pasture research over the period 2010-2030
- To modify the analysis under the second objective to examine a scenario of no MLA investment in pasture productivity improvement research.

2. Methodology

2.1 Approach

Benefit cost analysis (BCA) is the generally accepted approach to assessing the impact of research and development. In undertaking this project GHD adopted a tried and tested framework for BCA of agricultural research projects in which the net benefits of a research project (return on investment in R,D&E) are derived from the difference in annual benefits of a '*with R,D&E*' scenario (the *consequential scenario*) and a '*without R,D&E*' scenario (the *counterfactual scenario*) less the R,D&E project costs.[1] The net benefits are typically expressed as a net present value (NPV), a benefit cost ratio (BCR) or an internal rate of return (IRR).

The following steps were followed:

1.2.1.1 For the consequential scenario (i.e. the WITH R&D scenario)

- **Step 1** – Identify and cost the investment in R,D&E
- **Step 2** – Identify the outputs from the investment in R,D&E and the time profile of their adoption by industry
- **Step 3** – Specify the time profile of industry outcomes from the adoption of R,D&E outputs, and estimate the economic benefits of these outcomes.

1.2.1.2 For the counterfactual scenario (i.e. the WITHOUT R&D scenario)

- **Step 4** – Specify the time profile of industry outcomes that would have occurred in the absence of the adoption of R,D&E outputs, and estimate the economic benefits of these outcomes. As the industry is likely to change over time in response to other exogenous influences, the counterfactual is typically NOT the same as the 'before R,D&E' industry outcomes

1.2.1.3 To undertake the analysis

- **Step 5** – Estimate the net benefits of investment in R,D&E as the difference in economic benefits between the consequential scenario and the counterfactual scenario. Where applicable, the social and environmental impacts are treated in the same way
- **Step 6** – Identify the beneficiaries, assess the net benefit of the R&D investment, and estimate the return on investment.

2.2 Research outcomes

The BCA assumes the pasture improvement R,D&E leads to the development of new pasture varieties exhibiting greater productivity and hence carrying capacity than existing varieties. The analysis assumed increases in carrying capacities from 1 to 5 per cent.

[1] See Alston, J.M., Norton, G.W. and P.G. Pardey (1995). *Science under scarcity: principles and practice for agricultural research evaluation and priority setting*. Cornell University Press: Ithica.

2.3 Assumptions

The explicit assumptions and parameter values used in the analysis are shown in Table 1. These were taken mainly from the MLA's preliminary internal BCA. Additional assumptions used in the analysis are also shown in Table 1.

The preliminary BCA correctly identified the pivotal role of pasture renovation as necessary (but not sufficient) for uptake of new pasture varieties from the R,D&E. The approach taken in this analysis was to assume that the rate of pasture renovation remains constant over time for both the consequential and the counterfactual scenarios. In this way the impact of the R,D&E is isolated from the rate of renovation effect, which means the result provides a truer estimate of the impact of the R,D&E.

Because pasture improvement technology can only be adopted on renovated pasture, the annual area renovated sets an upper bound on the adoption of pasture improvement technology each year.

1.2.1.4 Table 1 Assumptions

	Improved Pasture	**Unimproved Pasture**
Annual R,D&E cost ($m) for initial 10 years	7.5	
Grazed ha - (m ha)	32	138
Renovation rate - counterfactual scenario	5.00%	1.25%
Renovation duration (yrs)	15	15
Renovation cost per ha	$300	$300
Base gross margin ($/ha)	$200	$100
Immediate lift in gross margin from renovation	10%	10%
Rate of progress in carrying capacity pa	3.0%	3.0%
Rate of progress in uptake of new pasture varieties pa	1.25%	0.31%
No. of years to full uptake of new pasture varieties	4	10
Time lag from start of R,D&E until first uptake of new varieties (years) [1]	10	10
R,D&E benefit duration (years from first uptake of new varieties)	40	40

1 Arguably this time lag is still too short, as for many crops the lag from initiation of a breeding cycle to production of the first new variety is more like 14 years, with a further 3 years or so for seed multiplication and for farmers to become aware of the new variety and to evaluate it.

3. Results

3.1 Base case analysis

A BCA spreadsheet, developed using the above assumptions, was used in the base case analysis to model the counterfactual scenario and the consequential scenario and estimate the net benefit (return on investment) of the pasture improvement R,D&E. The time period for the base case analysis was 50 years and the discount rate was 7 per cent.

The net benefits of R,D&E, expressed as an NPV, BCR and IRR, for a range of increases in carrying capacity and a present value (PV) of R,D&E costs of $53 million (based on annual R,D&E expenditure of $7.5 million), are shown in Table 2. Estimates of the BCR range from 87:1 for a 1 per cent annual increase in carrying capacity for improved pasture to 154:1 for a 5 per cent increase in carrying capacity. The IRR ranges from 29 per cent to 43 per cent over the same range of carrying capacity increases. The results show that R,D&E investment in pasture improvement offers a significant rate of return to growers.

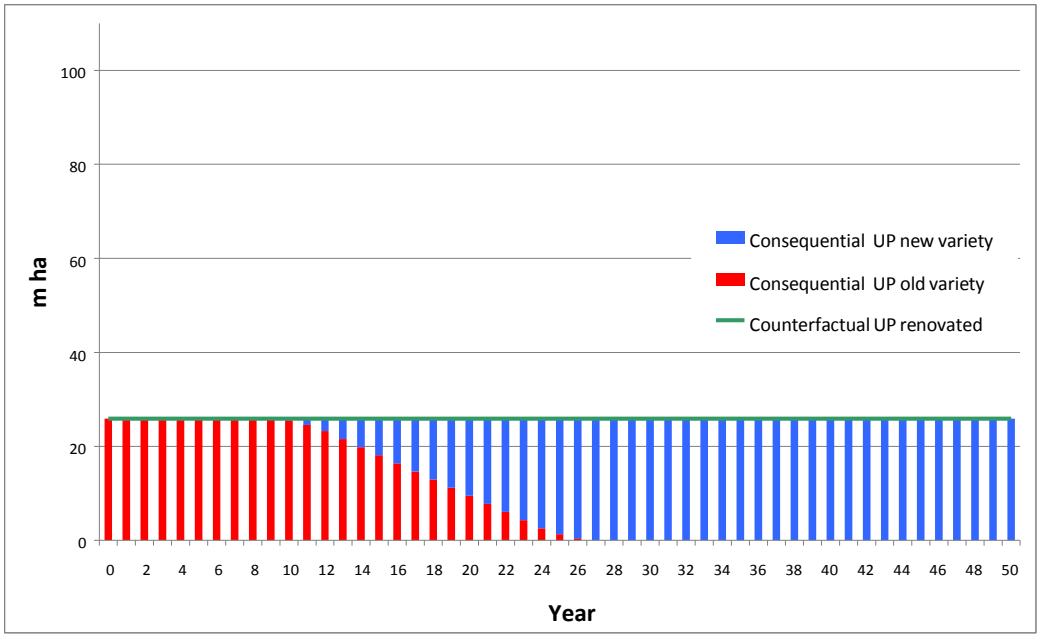
1.2.1.5 Table 2 Estimates of returns on investment in pasture improvement R,D&E

Annual rate of increase in carrying capacity for improved pasture	**1.0%**	**2.0%**	**3.0%**	**4.0%**	**5.0%**
NPV ($million)	$4,036	$5,976	$8,068	$10,322	$12,750
BCR	78:1	114:1	154:1	197:1	243:1
IRR	29%	34%	38%	40%	43%
PV R,D&E ($million)	-$53	-$53	-$53	-$53	-$53

The uptake over time in the area of pasture improvement technology for unimproved pasture and improved pasture respectively is illustrated in Figures 1 and 2. As noted above, it is assumed in each case that the availability of pasture improvement technology does not change the total area of renovated pasture, which sets an upper bound to area of uptake of pasture improvement technology. Whether this assumption is realistic ultimately is an empirical issue. If, as is likely, pasture renovation with pasture improvement technology is more profitable than pasture renovation without pasture improvement technology, then the uptake of pasture improvement technology may well result in an increase in area of pasture renovation, which would increase the returns to investment in pasture improvement technology R,D&E.

Another critical assumption is that uptake of the pasture improvement technology is profitable across all areas of renovated pasture within an agro-ecological zone. Often, climatic and other agro-ecological differences within the zone mean that the pasture improvement technology will only be suitable for some fraction of the total area of the agro-ecological zone.

1.2.1.6 Figure 1 Area Unimproved Pasture



1.2.1.7 Figure 2 Area Improved Pasture

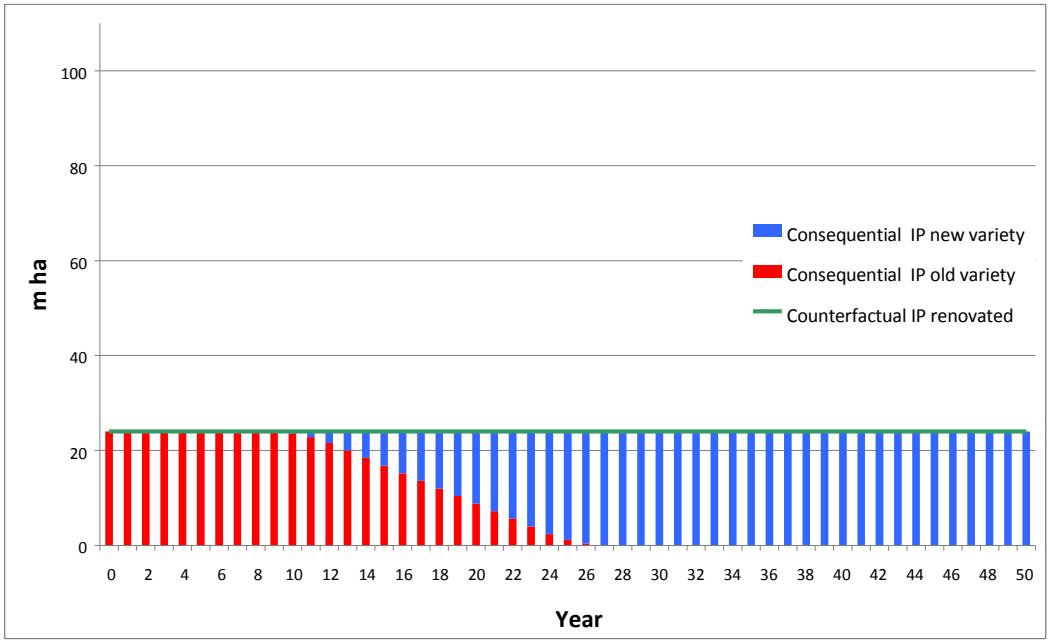
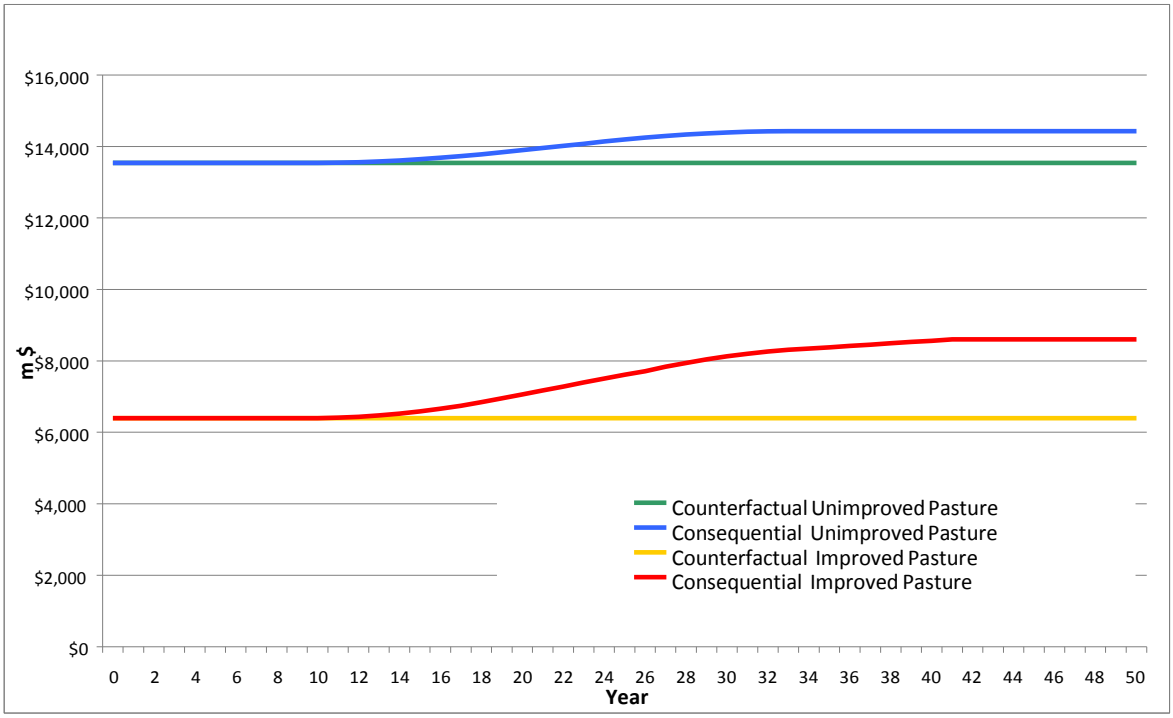


Figure 3 illustrates the difference in the net returns for the counterfactual and consequential scenarios for improved and unimproved pasture and shows that in the steady state the R,D&E has led to increases in

net returns for improved pasture of around $2.2 billion per annum for improved pastures and $890 million per annum for unimproved pastures.

1.2.1.8 Figure 3 Net Returns



3.2 Sensitivity analysis

The assumptions underpinning the base case analysis are based on a combination of the parameter values used in the MLA's preliminary analysis and professional judgement and, as such, are subject to a degree of uncertainty. Sensitivity analysis was carried out on the key parameter values using a 'range-of-values' approach to test the sensitivity of the results to changes in specific assumptions.

Discount rates

The base case used a discount rate of 7 per cent. The results of sensitivity analysis using discount rates of 4 per cent and 14 per cent are shown in Table 3.

1.2.1.9 Table 3 Sensitivity of estimated returns on investment to discount rate

	Discount rate		
	4%	**7%**	**14%**
NPV ($million)	$20,528	$8,068	$1,249

1.2.1.10 Discount rate

	4%	7%	14%
BCR	338:1	154:1	33:1
IRR	38%	38%	38%

Note: The internal rate of return (IRR) is the discount rate in the NPV formula which makes the NPV equal to zero. Consequently the IRR is invariant to changes in the discount rate.

Grazed area – ratio of improved/unimproved pasture

The base case assumed a grazed area of improved pasture and unimproved pasture of 32 million hectares and 138 million hectares respectively. The results of sensitivity analysis which varied the ratio of improved to unimproved pasture is shown in Table 4.

1.2.1.11 Table 4 Grazed area – ratio of improved to unimproved pasture

	Grazed area – ratio of improved/unimproved pasture			
	20 m ha/150 m ha	**32 m ha/138 m ha**	**50 m ha/120 m ha**	**70 m ha/100 m ha**
NPV ($million)	$7,103	$8,068	$9,516	$11,124
BCR	136:1	154:1	182:1	212:1
IRR	36%	38%	40%	42%

Base gross margin for improved pasture

The base case assumed a base gross margin for improved pasture of $200/ha. The results of sensitivity analysis using base gross margins of $100/ha, $200/ha, $300/ha, $400/ha and $500/ha are shown in Table 5.

1.2.1.12 Table 5 Sensitivity of estimated returns on investment to base gross margin

	Base gross margin				
	$100/ha	**$200/ha**	**$300/ha**	**$400/ha**	**$500/ha**
NPV ($million)	$6,475	$8,068	$9,661	$11,255	$12,848
BCR	124:1	154:1	184:1	215:1	245:1
IRR	34%	38%	40%	42%	44%

In summary, the sensitivity analysis shows that the BCRs and returns on investment remain significant when key parameter values are changed.

4. Concluding comments

The overall purpose of this study was to undertake an economic evaluation of pasture improvement research funded by the MLA. The BCA undertaken in this study utilised the generally accepted methodology for BCA of agricultural projects and conservative assumptions regarding the time period for the uptake of the new technology, the levels of pasture productivity improvement and persistence, and the area of pasture renovated per annum.

The returns on investment and BCR for pasture improvement research estimated in this analysis are significantly higher than the estimates obtained in the MLA's preliminary BCA and show that there are important economic benefits to be gained from research into pasture improvement. Some of the more important reasons for the substantial difference between the results of this analysis and that of the MLA's preliminary BCA are as follows:

- in the MLA's preliminary BCA, it is assumed that the duration of RD&E is contiguous with the flow of benefits from uptake of pasture improvement technology. In this analysis, it was assumed that RD&E expenditure precedes uptake of pasture improvement technology, but that the duration of the latter exceeds the duration of the former by many years.
- in the MLA's preliminary BCA, the economic returns from pasture renovation are conflated with the economic returns from uptake of pasture improvement technology. Because the benefit cost ratio for pasture renovation is negative given assumed values for renovation duration, renovation cost per ha, base gross margin ($/ha), and immediate lift in gross margin from renovation, conflating the two sources of economic returns underestimates returns to investment in pasture improvement technology RD&E.

Sensitivity analysis showed that uncertainty regarding the assumptions underpinning the analysis was unlikely to alter the broad conclusions.

1.3 Appendix A

Spreadsheet

1.3.1.1 Table 6 Counterfactual

	Improved Pasture				Unimproved Pasture				Aggregate
Year	newly renovated	total renovated	total not renovated	Annual net return	newly renovated	total renovated	total not renovated	Annual net return	Annual net return
	m ha	m ha	m ha	m $	m ha	m ha	m ha	m $	m $
0	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
1	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
2	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
3	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
4	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
5	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
6	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
7	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
8	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
9	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
10	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
11	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
12	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
13	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
14	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
15	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
16	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
17	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
18	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
19	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
20	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
21	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
22	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
23	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
24	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
25	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
26	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
27	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
28	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
29	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
30	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
31	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
32	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
33	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
34	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
35	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
36	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
37	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
38	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
39	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
40	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
41	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
42	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
43	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
44	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
45	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
46	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
47	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
48	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
49	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941
50	1.6	24	8	$6,400	1.725	25.875	112.125	$13,541	$19,941

1.3.1.2 Table 7 Consequential

	Improved Pasture												Unimproved Pasture												Aggregate
Year	renovated old variety	renovated new variety			total old variety	total new variety	total not renovated	Base GM	renovate cost	renovate GM	RDE GM	Annual return	renovated old variety	renovated new variety			total old variety	total new variety	total not renovated	Base GM	renovate cost	renovate GM	RDE GM	Annual return	Annual net return
	m ha	m ha	% gain	GM gain	m ha	m ha	m ha	m $	m $	m $	m $	m $	m ha	m ha	% gain	GM gain	m ha	m ha	m ha	m $	m $	m $	m $	m $	m $
0	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0			25.875	0	112.125	$13,800	-$518	$259		$13,541	$19,941
1	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
2	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
3	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
4	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
5	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
6	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
7	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
8	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
9	1.600	0.000			24.000	0.000	8.000	$6,400	-$480	$480		$6,400	1.725	0.000			25.875	0.000	112.125	$13,800	-$518	$259		$13,541	$19,941
10	1.200	0.400	0.030	$2	23.600	0.400	8.000	$6,400	-$480	$480	$2	$6,402	1.294	0.431	0.030	$1	25.444	0.431	112.125	$13,800	-$518	$259	$1	$13,543	$19,945
11	0.800	0.800	0.061	$10	22.800	1.200	8.000	$6,400	-$480	$480	$12	$6,412	0.863	0.863	0.061	$5	24.581	1.294	112.125	$13,800	-$518	$259	$7	$13,548	$19,960
12	0.400	1.200	0.093	$22	21.600	2.400	8.000	$6,400	-$480	$480	$34	$6,434	0.431	1.294	0.093	$12	23.288	2.588	112.125	$13,800	-$518	$259	$19	$13,560	$19,994
13	0.000	1.600	0.126	$40	20.000	4.000	8.000	$6,400	-$480	$480	$75	$6,475	0.000	1.725	0.126	$22	21.563	4.313	112.125	$13,800	-$518	$259	$40	$13,581	$20,056
14	0.000	1.600	0.159	$51	18.400	5.600	8.000	$6,400	-$480	$480	$126	$6,526	0.000	1.725	0.159	$27	19.838	6.038	112.125	$13,800	-$518	$259	$68	$13,609	$20,134
15	0.000	1.600	0.194	$62	16.800	7.200	8.000	$6,400	-$480	$480	$188	$6,588	0.000	1.725	0.194	$33	18.113	7.763	112.125	$13,800	-$518	$259	$101	$13,642	$20,230
16	0.000	1.600	0.230	$74	15.200	8.800	8.000	$6,400	-$480	$480	$261	$6,661	0.000	1.725	0.230	$40	16.388	9.488	112.125	$13,800	-$518	$259	$141	$13,682	$20,343
17	0.000	1.600	0.267	$85	13.600	10.400	8.000	$6,400	-$480	$480	$347	$6,747	0.000	1.725	0.267	$46	14.663	11.213	112.125	$13,800	-$518	$259	$187	$13,728	$20,475
18	0.000	1.600	0.305	$98	12.000	12.000	8.000	$6,400	-$480	$480	$444	$6,844	0.000	1.725	0.305	$53	12.938	12.938	112.125	$13,800	-$518	$259	$239	$13,781	$20,625
19	0.000	1.600	0.344	$110	10.400	13.600	8.000	$6,400	-$480	$480	$554	$6,954	0.000	1.725	0.344	$59	11.213	14.663	112.125	$13,800	-$518	$259	$299	$13,840	$20,794
20	0.000	1.600	0.344	$110	8.800	15.200	8.000	$6,400	-$480	$480	$664	$7,064	0.000	1.725	0.344	$59	9.488	16.388	112.125	$13,800	-$518	$259	$358	$13,899	$20,963
21	0.000	1.600	0.344	$110	7.200	16.800	8.000	$6,400	-$480	$480	$774	$7,174	0.000	1.725	0.344	$59	7.763	18.113	112.125	$13,800	-$518	$259	$417	$13,959	$21,133
22	0.000	1.600	0.344	$110	5.600	18.400	8.000	$6,400	-$480	$480	$884	$7,284	0.000	1.725	0.344	$59	6.038	19.838	112.125	$13,800	-$518	$259	$477	$14,018	$21,302
23	0.000	1.600	0.344	$110	4.000	20.000	8.000	$6,400	-$480	$480	$994	$7,394	0.000	1.725	0.344	$59	4.313	21.563	112.125	$13,800	-$518	$259	$536	$14,077	$21,472
24	0.000	1.600	0.344	$110	2.400	21.600	8.000	$6,400	-$480	$480	$1,104	$7,504	0.000	1.725	0.344	$59	2.588	23.288	112.125	$13,800	-$518	$259	$595	$14,137	$21,641
25	0.000	1.600	0.344	$110	1.200	22.800	8.000	$6,400	-$480	$480	$1,212	$7,612	0.000	1.725	0.344	$59	1.294	24.581	112.125	$13,800	-$518	$259	$653	$14,195	$21,807
26	0.000	1.600	0.344	$110	0.400	23.600	8.000	$6,400	-$480	$480	$1,312	$7,712	0.000	1.725	0.344	$59	0.431	25.444	112.125	$13,800	-$518	$259	$707	$14,249	$21,961
27	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,437	$7,837	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$755	$14,296	$22,133
28	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,543	$7,943	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$792	$14,334	$22,277
29	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,639	$8,039	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$824	$14,366	$22,405
30	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,724	$8,124	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$850	$14,391	$22,515
31	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,797	$8,197	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$870	$14,411	$22,608
32	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,858	$8,258	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$883	$14,424	$22,683
33	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,908	$8,308	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,739
34	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,944	$8,344	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,775
35	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$1,981	$8,381	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,812
36	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,018	$8,418	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,849
37	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,054	$8,454	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,885
38	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,091	$8,491	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,922
39	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,128	$8,528	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,959
40	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,164	$8,564	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$22,996
41	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
42	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
43	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
44	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
45	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
46	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
47	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
48	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
49	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032
50	0.000	1.600	0.344	$147	0.000	24.000	8.000	$6,400	-$480	$480	$2,201	$8,601	0.000	1.725	0.344	$59	0.000	25.875	112.125	$13,800	-$518	$259	$890	$14,431	$23,032

APPENDIX 2

Meat & Livestock Australia

2 Market Failure Assessment Framework

July 2011

Contents

Figure Index

1. Introduction

Historically, almost all plant breeding in Australia has been financed by government and/or collective industry funding. The supporting research in agronomy, plant pathology, entomology, biometry, plant nutrition, plant physiology, and other related disciplines has also been publicly funded. Improved varieties bred in public R&D agencies have typically been released to growers at a cost that covered seed multiplication, but not the costs of breeding or the cost of supporting research.

More recently, funding for plant breeding and cultivar development has come from Rural Research and Development Corporations (RDCs) like Meat and Livestock Australia (MLA). RDCs are funded mainly from grower levies matched by government contributions up to an agreed level (cap). This collective funding arrangement recognises that individual growers are beneficiaries of R&D and should be prepared to pay part of the cost of the R&D (the beneficiary pays approach).

The predominant justification for government funding of R&D (rural and other) has been the existence of market failure, typically evidenced by under-investment by the private sector.[1] Other forms of government intervention aimed at overcoming market failure have included legislation establishing and protecting intellectual property rights in research outputs, enabling the research funders to obtain a greater return on their investment, therefore encouraging greater private sector investment.[2]

Although government funding of R&D has declined in recent years the on-going existence of market failure continues to provide a rationale for government intervention in one form or another. However, recognition and definition of market failure can be complex when considering applications for R&D funding.

Meat and Livestock Australia (MLA) engaged GHD Pty Ltd to develop a framework for assessing market failure in the pasture industry supply chain to guide its decisions regarding future investment in pasture plant breeding R&D or other forms of intervention (e.g. market facilitation). [3]

The purposes of this report are:

- To define market failure and describe the types of market failure that could arise in the pasture industry supply chain
- To provide a market failure assessment framework for evaluating MLA investment in R&D or other assistance.

The market failure assessment framework developed in this paper should become an integral part of a broader MLA policy on R&D and industry assistance.

The remainder of the report is structured as follows. Section 2 defines market failure and describes the types of market failure that can occur in plant breeding. Section 3 presents the market failure assessment framework, which consists of a market failure decision tree and market failure assessment guidelines. Section 4 offers some concluding comments.

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[1] Industry Commission 1995, *Research and Development*, Inquiry Report No. 44, Canberra, May.

[2] For example, extensions to the intellectual property rights in new varieties brought about by the enactment of the *Plant Breeder's*

2. Market failure

Nevertheless, considerable confusion remains concerning the nature of market failure, its significance in theory and as an observable phenomenon, and the appropriate policy response to it.

(Randall 1983).[4]

Market failure, when detected can provide an economic justification for government support for R&D or other assistance. However, as Randall observed in the above quotation, identifying and responding to market failure can be a complex matter.

The economic notion of market failure derives from the concept of economic efficiency, and is defined as the failure of markets to achieve an efficient allocation of goods and services. In simple terms, the market may not always allocate scarce resources in a way that achieves the highest total social welfare.

The allocation of all goods and services in an economy is said to be efficient if it is impossible to reallocate resources to make someone better off without making someone else worse off, even after the gainers fully compensate the losers. Economists refer to this as Pareto efficiency. Conversely, if it is possible for those who gain from a reallocation of resources to fully compensate the initial losers and still be better off in net terms, then the original allocation of all goods and services is said to be inefficient, and is *prima facie* evidence of market failure.

It is widely accepted that market failure can present a case for some form of government intervention above and beyond that of redistributing income and providing the legal institutions necessary for the operation of a market economy. However, government intervention must be shown to be enhancing economic and social welfare, otherwise it should not occur. Failure of government intervention in the market (government failure) occurs when the intervention does not necessarily move the economy towards economic efficiency. One way to reduce the chances of government failure is to establish whether the benefits of intervention exceed the costs through benefit cost analysis.

2.1 Types of market failure

The four types of market failure most likely to occur in plant breeding and cultivar development are public goods, externalities, information asymmetry and imperfect competition.

2.1.1 Public goods

The defining characteristic of a public good is that consumption of it by one person does not actually or potentially reduce the amount available to be consumed by another person. This characteristic is known as non-rivalry (e.g. national defence).

Another characteristic of a public good is non-excludability in that nobody can be effectively excluded from using the good. The lack of a legal right to exclude and/or high exclusion costs can make it difficult for an individual (or firm) to acquire effective control or exclusive use of the good in question. This can result in free riding and generally leads to under-production of the good in question[5].

[3] Randall, A. 1983, The Problem of Market Failure, *Natural Resources Journal*, 23, pp. 131-148.

New knowledge produced by R&D exhibits both non-excludability and non-rivalry and is akin to a pure public good. The potential for free riding means that without some form of intervention (e.g. a system of intellectual property rights) there is little incentive for the private sector to invest in certain types of research (e.g. basic research) as there is no way they can appropriate a return on their investment. For example, in the past, many knowledge-based plant breeding technologies, unless patentable, were non-proprietary and relied on public funding for their development.

In some cases a person may have the legal right to exclude others from using a good and the cost of exclusion is low. However, that person may be restricted in transferring the right to use or own the good to another person (or group) on any terms (e.g. under a licence agreement). This is known as non-transferability and it can reduce the potential for the owner to obtain an adequate return on investment.

Public goods can be regarded as a special case of positive externalities, which are discussed in the next section.

2.1.2 Externalities

An externality is an effect (either positive or negative) that production or consumption of a good has on persons not involved in the production or consumption of the good. For example, if a chemical plant discharges pollution into a river and impacts production of a brewery downstream, then a negative externality is produced. In this situation, the chemical plant does not take into account the external costs of its actions on the brewery. This results in a divergence between the chemical plant's private costs and social costs, which leads to economic inefficiency.

Not all externalities are negative. For example, new knowledge generated by research can benefit other persons not involved in the research without a return to the investor. This is a form of positive externality or spillover benefit of the research and can result in the social rate of return from the research exceeding the private rate of return.[6] Because the researcher cannot appropriate all the returns from the research, it is not worthwhile them investing fully in the research and this can lead to under-investment in research from society's point of view.

2.1.3 Imperfect competition

Economic efficiency is based on the notion of a perfectly competitive market. However, there are circumstances in which the conditions for perfect competition are not satisfied, leading to various forms of imperfect competition. Examples include monopoly, oligopoly and monopolistic competition on the sellers' side and monopsony and oligopsony on the buyers' side.

In perfectly competitive markets all participants are price-takers (i.e. their actions do not affect market prices). In the case of monopoly however, a single seller can charge a price above the equilibrium price and reduce the output below the competitive level, which violates the conditions for economic efficiency.

As discussed previously, the outputs of pre-breeding research, such as genetic mapping and molecular marker development, information and database systems and molecular biology research (often referred to as 'essential plant breeding infrastructure' (EPBI)) are typically largely knowledge based, and unless they are patentable, are akin to pure public goods. Traditionally, these inputs to plant breeding were non-proprietary, publicly funded, and because they enabled non-rival use by plant breeding programs, were

[6] Positive externalities arising from research are largely due to the public good characteristics of knowledge - non-excludability and

freely available to others. However, Lindner (2003) shows that the production of EPBI by profit maximising monopoly suppliers could potentially lead to an under-supply of this type of technology.[7] Further, as Lindner (2004) notes, as plant breeding becomes increasingly privatised, the absence of appropriate access to EPBI will mean the potential benefits from scientific discoveries underpinning modern plant breeding may not be fully realised.[8]

2.1.4 Information asymmetries

The efficiency of the perfectly competitive market depends on all buyers and sellers of a good having full information about that good. In some circumstances, buyers and sellers may have different amounts of information about a goods attributes. This is known as information asymmetry and its existence can cause markets to be inefficient and fail.

For example, it can be very costly for individual growers to objectively evaluate new improved pasture cultivars in local farming systems, because differences in desirable traits, such as productivity, persistence and pest and disease resistance between improved cultivars are not readily observable. Growers facing similar climatic and agro-ecological conditions, and employing similar farming systems could all benefit from essentially the same information. Unless the seed companies provide this information there is a clear information asymmetry that could limit the uptake of new cultivars. This information asymmetry is a form of market failure, and may warrant funding of an extension program to disseminate information on new cultivars. Whether this is funded by the private sector or the MLA is moot.

[7] Lindner, B. 2003,. Privatised provision of essential plant breeding infrastructure, *The Australian journal of Agricultural and*

3. The market failure assessment framework

As discussed earlier in this report, the principle justification for government intervention in rural R&D funding is evidence of market failure. Consequently, market failure in the relevant market is an important consideration for MLA when considering requests for support, such as R&D funding, from research institutions and other organisations.

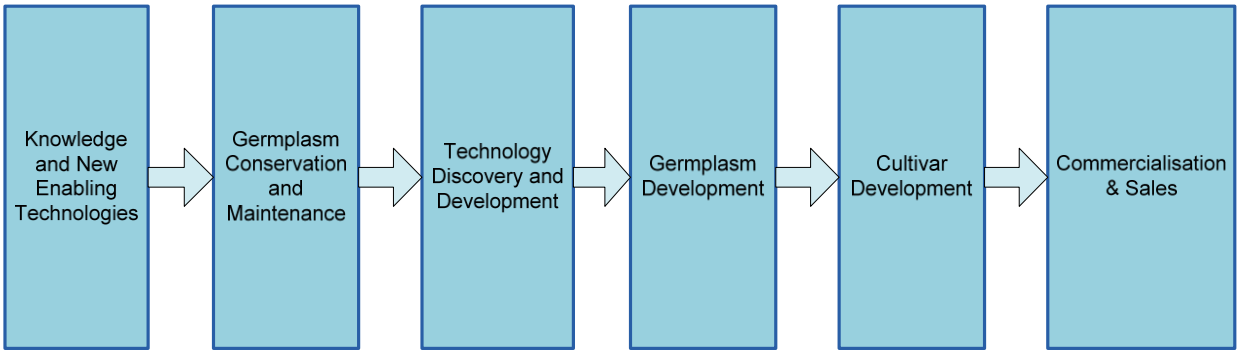
The following market failure assessment framework has been developed to guide MLA in investigating whether market failure exists and what might be an appropriate response. The framework consists of two parts:

- An over-arching market failure assessment decision tree, which provides a sequence of questions to help MLA make a decision as to whether to intervene or not based on evidence of market failure and whether the benefits of intervention would exceed the costs (Figure 2).
- Market failure assessment guidelines, which consist of a series of questions designed to assist the MLA work through the market failure assessment decision tree (Figure 3).

3.1 Pasture industry supply chain

Section 2.1 presented a brief discussion of the types of market failure that could occur in the pasture industry supply chain depicted in Figure 1.[9] This representation of the supply chain presents plant breeding as a continuum of activities leading to improved plant varieties.

2.1.1 Figure 1 Pasture industry supply chain



Source: Victorian Department of Primary Industry (2005). *Plant Breeding: Policies and Principles for Investment*, http://new.dpi.vic.gov.au/about-us/publications/economics-and-policy-research/2005 (accessed 28 June 2011)

This section discusses the possible/probable types of market failure in the various phases of the supply chain to assist MLA in identifying evidence of market failure in markets of interest.

[9] This depiction of the pasture industry supply chain is based on Victorian Department of Primary Industry 2005, *Plant Breeding:*

3.1.1 Plant breeding precursors

Two key knowledge-based precursors to plant breeding are:

- Knowledge and new enabling technologies
- Germplasm conservation and maintenance.

One potential source of market failure in plant breeding relates to the provision and utilisation of these knowledge-based inputs. Examples include the outputs of pre-breeding research, such as genetic mapping and molecular markers, germplasm collection and conservation, information and database systems and molecular biology research. Many of the most important advances in plant breeding have relied on the outputs of pre-breeding research.

These outputs are typically largely knowledge based, and unless they are patentable, are considered to be pure public goods. Traditionally, these inputs to plant breeding have been non-proprietary, publicly funded, and freely available to plant breeders (non-rival in use). However, if left to the private sector to develop there is a risk that there would be under-investment in this type of enabling technology or access to the technology could be restricted and costly.

3.1.2 Technology discovery and development

Technology discovery and development describes the strategic R&D required to support and enhance plant breeding. The outputs of this research are key enabling technologies and tools for plant breeding. These technologies typically exhibit public good characteristics and there is generally under-investment by the private sector unless the outputs can be patented. Lindner (2004) argues that all competing plant breeders should have access to these technologies on equal terms and conditions to ensure efficient utilisation and the benefits of more competition.

3.1.3 Germplasm development

Germplasm development relates to the identification and enhancement of new traits leading to greater productivity or environmental and other public benefits (e.g. salt tolerance). This type of research is often referred to as strategic plant breeding. While the private sector is likely to invest in research aimed at identifying traits for improved productivity, it is much less likely to invest in research yielding mainly public benefits. The public good characteristics of some of the outputs in this phase could result in market failure.

3.1.4 Cultivar development

Cultivar development involves the identification, breeding and evaluation of potential new cultivars (applied plant breeding) and the initial steps to commercialisation. The introduction of plant breeders' rights protection, seed r and end point royalties, and the use of licensing arrangements have encouraged private sector investment and reduced the potential for market failure in this phase of the supply chain. However, there exists the potential for seed companies to restrict promising new cultivars from reaching the market during this phase of the supply chain (monopolistic behaviour).

3.1.5 Commercialisation and sales

This step in the supply chain relates to the commercial production of seed, marketing and distribution of seed and royalty collection. As discussed previously, the widespread uptake of new cultivars could be limited if growers do not have sufficient information to allow them to evaluate the suitability of a new cultivar to their conditions (information asymmetry). It is also possible that seed companies' pricing and access arrangements for new cultivars could restrict some growers' access to them (monopolistic behaviour). The existence of spillover benefits or characteristics that make royalty collections difficult could reduce private sector investment in this phase of the supply chain.[10]

In summary, there is potential for the different types of market failure to occur in all phases of the supply chain. However, experience suggests that public goods and positive externalities are likely to be more common in the early phases of the supply chain, while information asymmetry and imperfect competition are more likely in the latter phases.

3.2 Market failure assessment decision tree

Figure 2 is the market failure assessment decision tree, which provides a sequence of key questions to help MLA make a decision as to whether to intervene or not based on evidence of market failure and whether the benefits of intervention would exceed the costs.

The following is a brief explanation of the purpose of each question in the decision tree. The market failure assessment guidelines shown in the next section provide further guidance to working through the decision tree.

Question 1: What is the problem being addressed?

This question is directed towards understanding the nature of the problem, including the background, extent of the problem, previous government involvement and consistency with MLA's strategic direction.

Question 2: What is the relevant market?

This question seeks to clarify the size and extent of the market and includes consideration of geographical spread, current private sector involvement and reasons for under-investment by the private sector.

Question 3: What is the evidence of market failure in the relevant market?

This existence of market failure is an important pre-requisite for government intervention. This question is aimed at identifying the existence and causes of market failure in the relevant market.

Question 4: Is there a case for government intervention in the relevant market based on market failure?

On the basis that market failure exists, this question aims firstly, to establish what actions should be taken to correct market failure. Secondly, it is necessary to decide which organisation should undertake the intervention (including MLA). Thirdly, do the benefits of intervention exceed the costs (benefit cost test)?

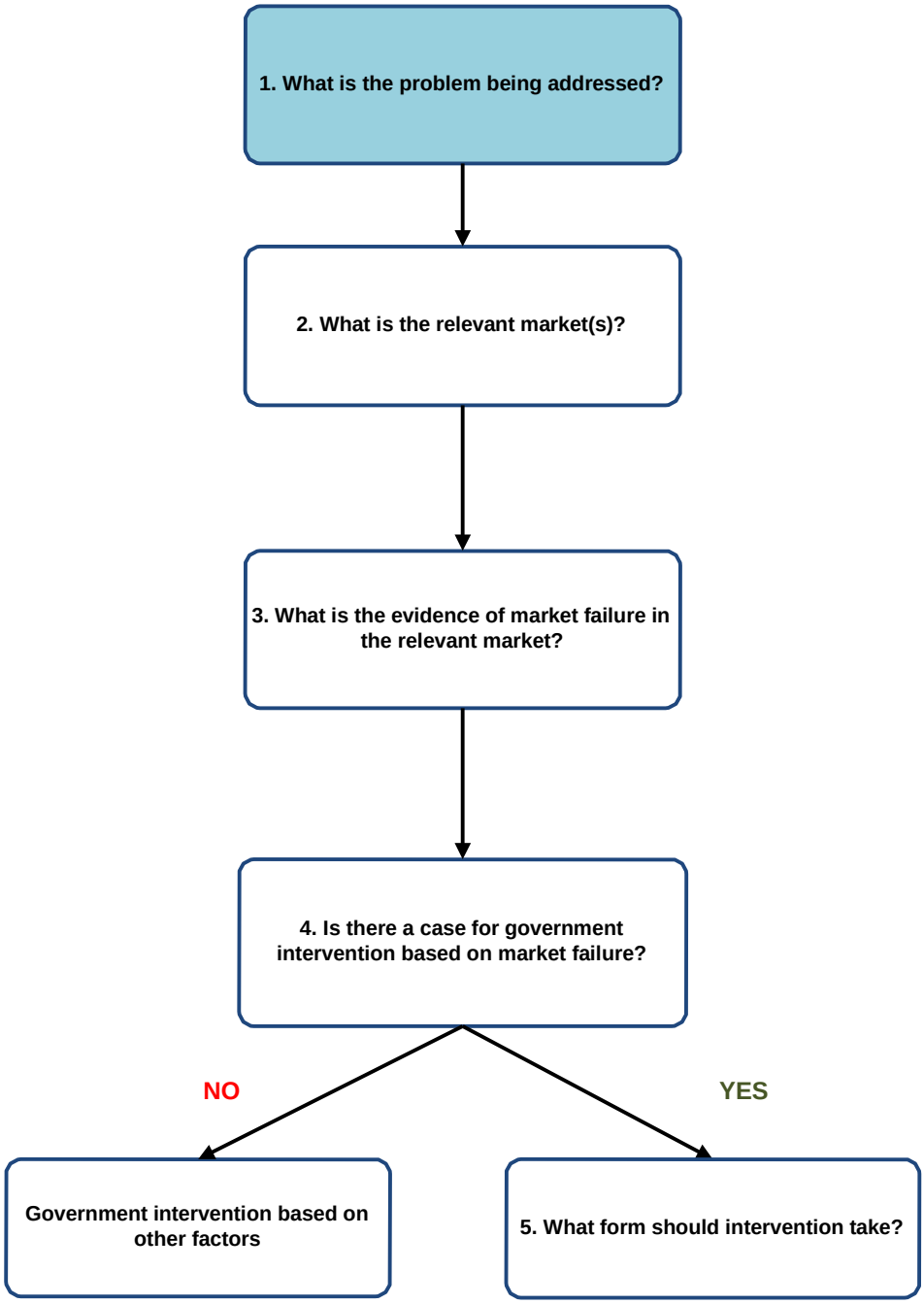
Question 5: What form should MLA intervention take?

If it is decided that MLA should intervene, then what form should the intervention take? (e.g. research funding, marketing, facilitation etc.)

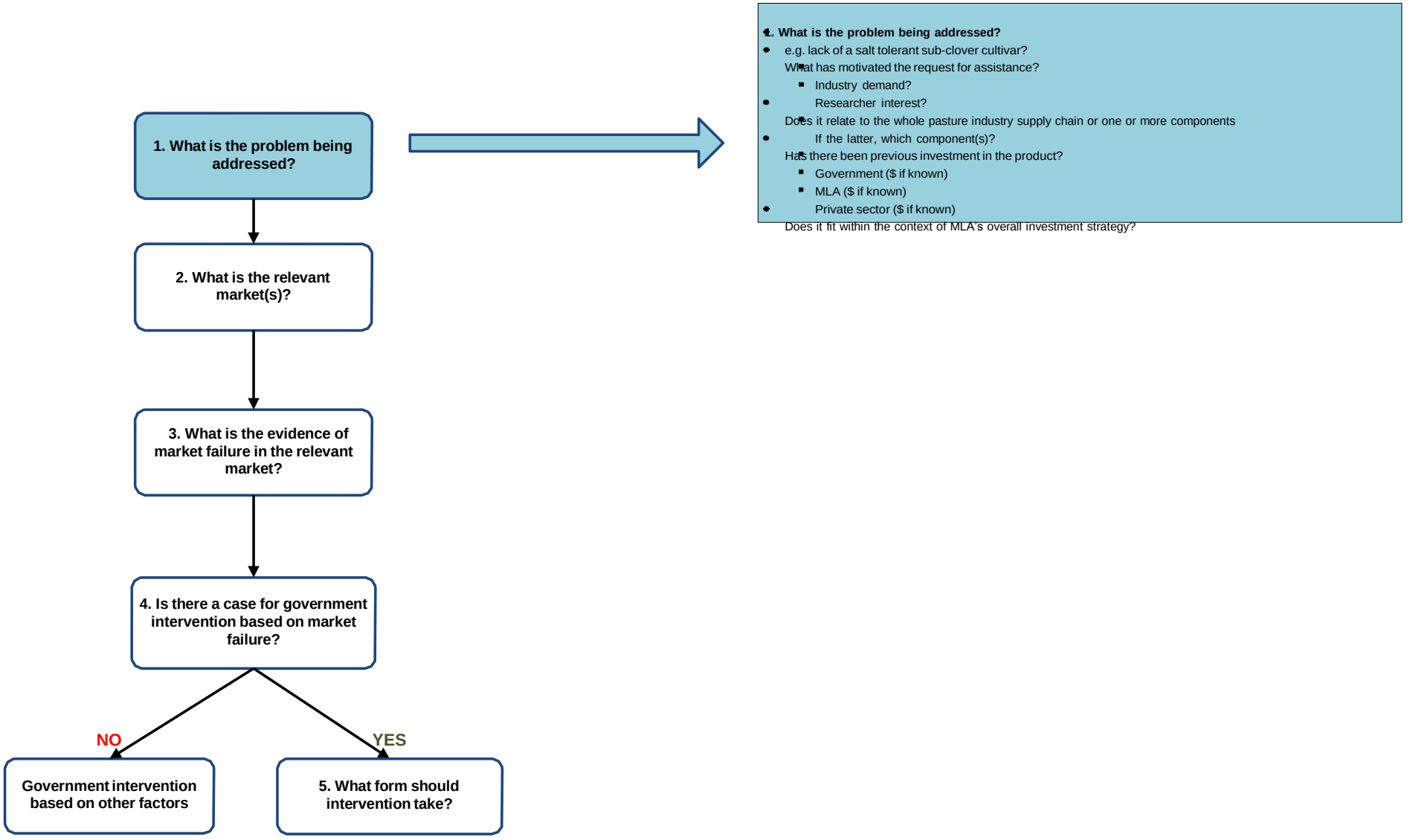
3.3 Market failure assessment guidelines

The market failure assessment guidelines shown in Figure 3 provide more detailed questions to assist MLA in answering the key questions in the market failure assessment decision tree. The questions are contained in a text box adjacent to the relevant key question in the decision tree.

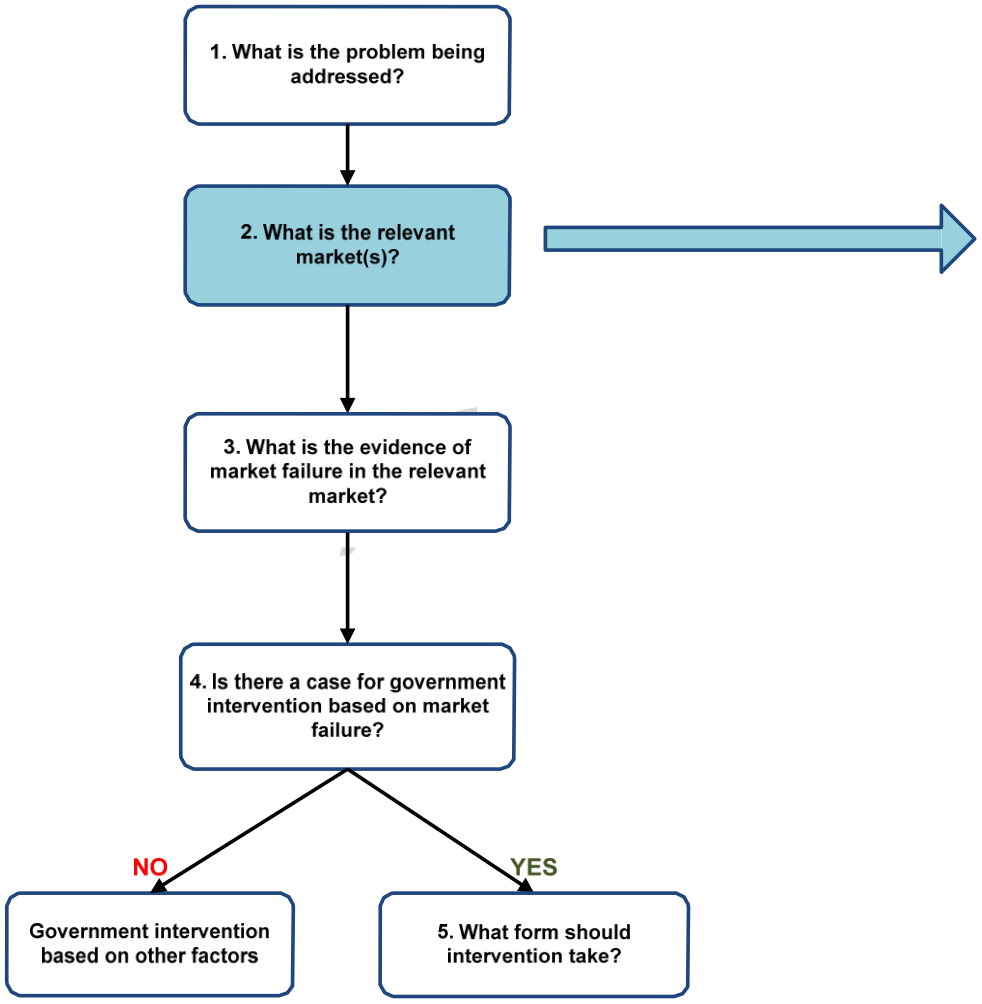
2.1.2 Figure 2 Market failure assessment decision tree



2.1.3 Figure 3 Market failure assessment guidelines



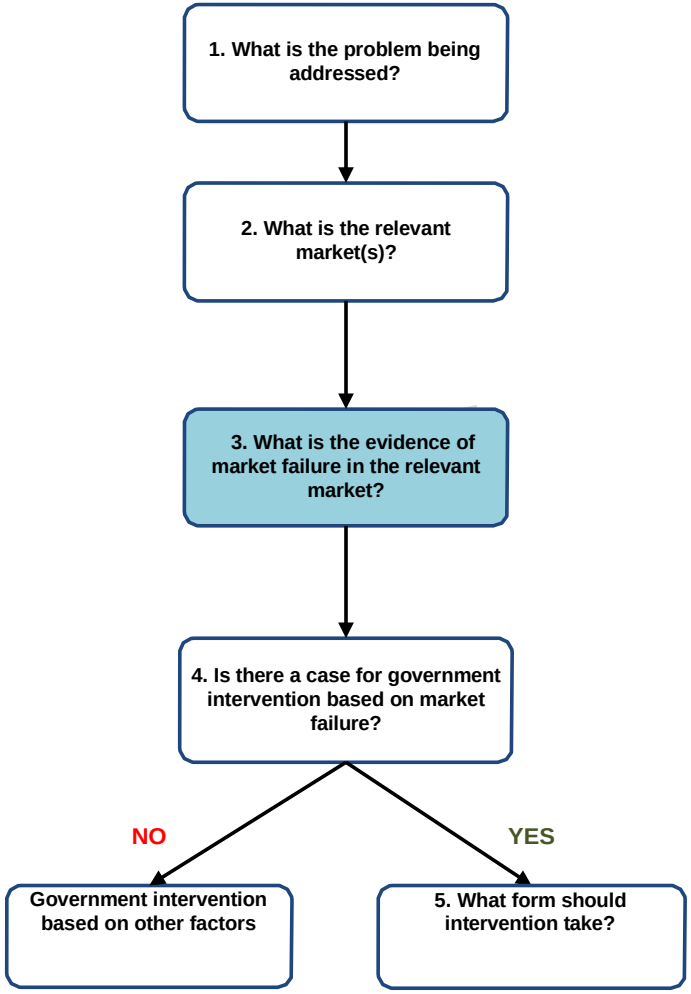
2.1.4 Figure 3 (Cont.)



2. What is the relevant market(s)?

- Where in the pasture industry supply chain?
- What is the geographic extent of the market (square km, ha, no. of growers)
  - Australia-wide
  - State-wide
  - Regional
  - Local
- What is the likely take up of the new technology/innovation
  - Rate and extent of adoption
  - Potential sales and revenue
  - Are there competing products?
- What is the extent of private sector involvement in the market
  - Is the market being met in some way already?
  - Is the technology currently under development?
    - What is the timeframe for development?
    - When will it be brought to market?
  - Is the technology on the drawing board for development?
  - Who is involved
    - Seed companies
    - Others?
  - Number of companies?
  - Company origins – domestic/overseas?
  - Are there barriers to entry if only a few firms in the market?
- If the private sector is not involved, then why
  - Presence of market failure (e.g. public goods, externalities, market power, information asymmetries)?
    - Market too small?
    - Availability of close substitutes?
    - Lack of expertise?
    - Costs too high and/or benefits too low?
  - Non-market failure reasons:
    - Barriers to entry
      - Intellectual property constraints
      - Significant sunk costs of infrastructure
      - Lack of access to proprietary technology – licensing issues
      - Riskiness - not core business and lack of confidence

Figure 3 (Cont.)



3. What is the evidence of market failure in the relevant market?

- What is the market failure?
  - Unable to appropriate returns on investment (public goods and private externalities)
    - Weak or non-existent IP protection
      - Difficulty in enforcing IP
      - Cost of IP protection and compliance
  - Problems of excludability and non-rivalry (public goods and private externalities)
    - Enabling technologies have public good characteristics
    - Positive externalities -others benefiting without paying - free rider problem
  - Lack of awareness by seed companies of growers' needs and the potential market (information asymmetry)
  - Lack of product information available to growers (information asymmetry)
    - From seed companies
    - Other agents (e.g. government agencies, private consultants)
  - Monopolistic behaviour by seed companies and technology providers (perfect competition)
  - Lack of access to essential plant breeding infrastructure and technology
    - Too costly to acquire
    - IP barriers
    - Does not exist
    - Beyond the capacity of the private sector to develop
  - Are there policies in place that are either causing the problem or with adjustment could address the problem?
  - What policies have been applied in the past?
    - Were they successful and why/why not?
  - Where in the supply chain is it occurring

2.1.5 Figure 3 (Cont.)

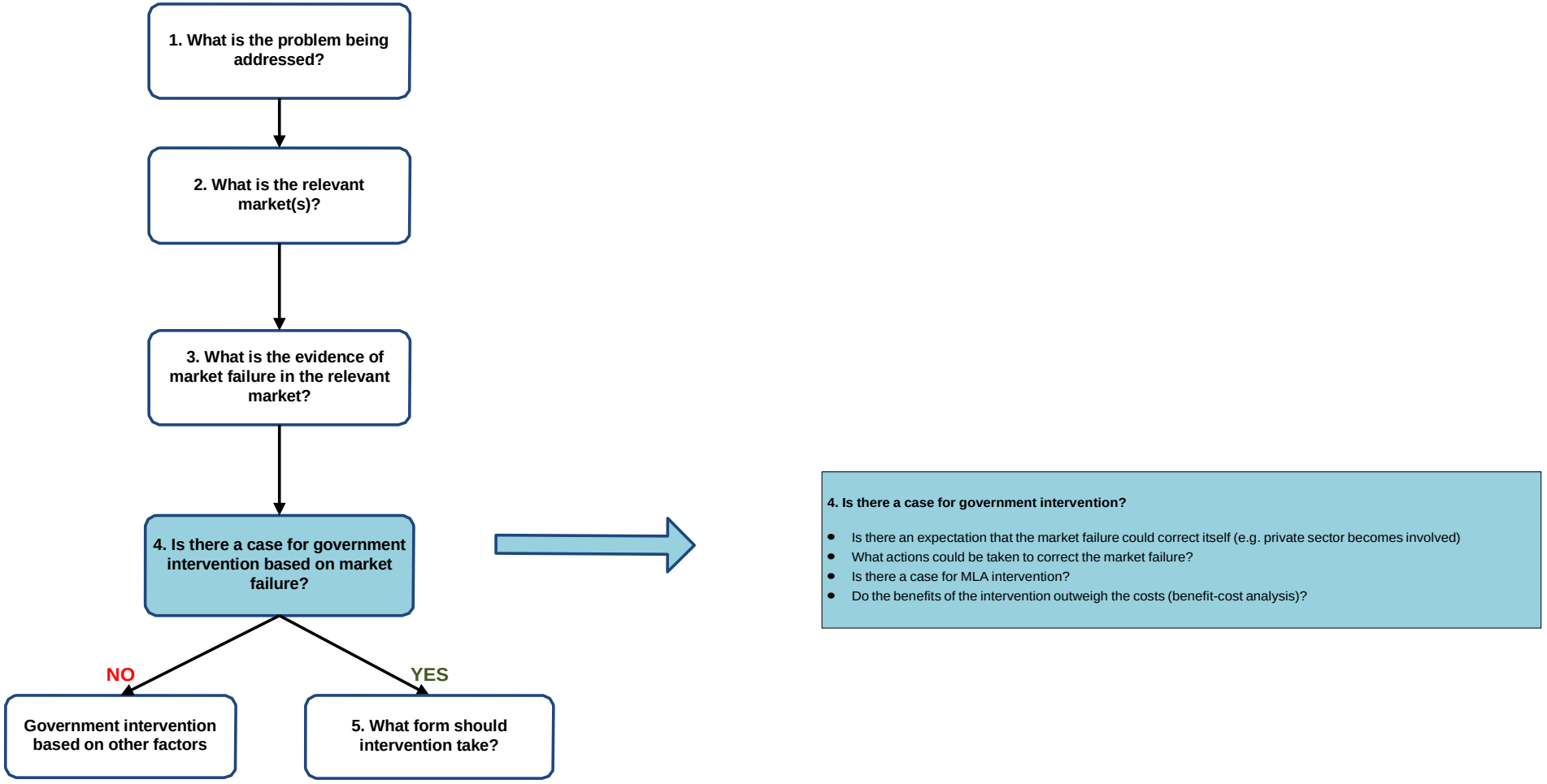
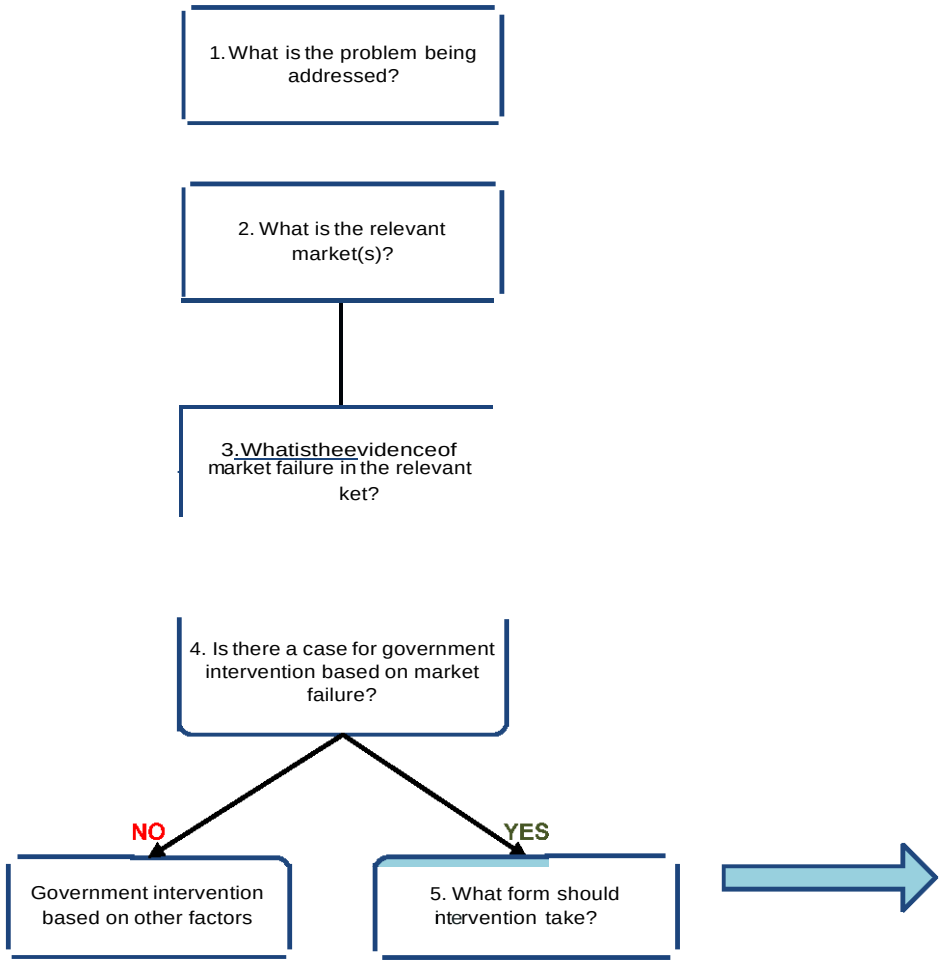


Figure 3 (Cont.)



5. What form should the intervention take?

- Can the market failure be corrected by MLA intervention?
- f no. what is an appropriate Intervention (eg legislative or regulatory change)?

f yes, what form can MLA 1ntervent1on take?

Research funding
- Development of essential plant breeding Infrastructure
- Development of supporting science-agronomy, entomology, plant pathology etc.
- Development of other cunivars

Intellectual property remedies
- Seek improved IP protection
- Adv1ce on IP management
- Assist researchers to obtain IP protection
- Seek reduced costs of compliance
- Seek return on Investment 1n IP assets

Acquisition of key enabling technologies
- Purchase of propnetary key enabling technologies
- Licensing of proprietary key enabling technologies

Extension activ"ies

Marketing act1v1t1es (e.g. JOintly w1th seed companies)

Facilitation
- Encourage greater private sector investment

Seek joint ventures with government agencies. universities and research institutes and the private sector

4. Concluding comments

The existence of market failure provides a rationale for public funding of R&D and other forms of assistance. The market failure assessment framework presented in this paper is designed to assist MLA in identifying and determining whether market failure along the pasture industry supply chain provides a justification for MLA investment in R&D and other assistance measures.

The framework should not be seen as a recipe for identifying market failure. The complex and subtle nature of many types of market failure may mean that analysts have to revisit earlier steps in the framework as they learn more about the market and types of failures that exist. In other words, the framework should be adaptively to achieve the best outcome. Also, as analysts gain experience in using the framework, the types of questions that should be addressed can be augmented and revised.