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MLA's contribution to the environmental sustainability of the red meat industry

Measuring MLA's contribution to the change in natural resource management practices through adoption surveys

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Glossary

HRZ	High rainfall zone
MLA	Meat and Livestock Australia
NRM	Natural resource management
RDC	Rural Research and Development Corporation
ToT	Terms of trade

Summary

Maintaining and improving the condition of natural resources has grown as an issue over the last decade. It has evolved from being an altruistic pursuit into one of pragmatism and self-interest for the sustainability of many industries — in particular, the agriculture sector.

The importance of maintaining and improving the condition of natural resources continues to grow, particularly in light of the challenging environmental conditions of this past decade. It is increasingly recognised as a business imperative and, as such, greater effort is being made to contribute to, and track, the progress made by business and industry towards maintaining and improving the condition of natural resources.

MLA has already illustrated the importance of the environment to their business through its triple-bottom-line approach to evaluation, but now MLA is going a step further by developing a specific framework to measure its progress in, and contribution to, environmental sustainability. This framework is employed in this report, which presents a retrospective assessment of MLA's contribution to the environmental sustainability of the industry through its impact on the adoption of natural resource management practices.

While this study makes significant headway in undertaking the first assessment of MLA's contribution to the environment, the inference that can be drawn from the numbers is limited. This is for two main reasons: by focusing upon the management practices identified by the framework, the linkages between MLA investment and the management practices are unclear. Furthermore, the reliance upon existing data has constrained both the management practices that could be assessed, as well as the methodology that could be employed.

However, this study has some very important insights. It highlights the complexity associated with isolating MLA's impact and it provides recommendations for going forward and improving the ease with which this assessment can be repeated.

The methodology for measuring MLA's contribution and the results from implementing this methodology make up the main part of this study. The report concludes with the lessons learned from the experience of trying to estimate MLA's contribution to the environmental sustainability of the red meat industry, and looks at ways in which MLA might better facilitate future measurement of

MLA's contribution. This report also includes several appendices, which hold additional and technical information that may be of interest to some readers.

1 Background

In the current political and economic climate, the importance of incorporating environmental issues into the business operating environment has increased substantially. The importance of including environmental outcomes into existing reporting frameworks is now being recognised as part of the triple-bottom-line approach to evaluation. MLA is now attempting to make the importance of the environment to the operation of the red meat industry more explicit.

MLA has been working with the industry since 1998 in developing and improving the competitiveness and sustainability of the industry through research and development, and capacity building.[1] While MLA has a comprehensive framework with which to evaluate the economic contribution that its investment delivers, the technically more difficult question of evaluating MLA's contribution to the environmental sustainability of the industry provides the basis of this report.

The framework

This study follows on from an earlier study and implements the reporting framework developed in the first.[2] The framework is developed around the Signposts for Agriculture framework, which provides a comprehensive framework for thinking about how on-farm activities of the agriculture industry contribute to environmental outcomes and, in turn, the environmental sustainability of the industry. Building upon this framework, TheCIE has extended and modified this framework to make it more tractable and relevant to MLA and the red meat industry.

The key contribution of this modified framework is the linkage that it provides between natural resource management (NRM) practices that have scientifically been shown to improve resource conditions, and the resource itself. A description and illustration of the framework is provided in appendix A. MLA, through its investment in various programs disseminating information on NRM practices as

[1] In its current form. (MLA was formed from the amalgamation of the Australian Meat and Livestock Corporation and the Meat Research Corporation.)

[2] Centre for International Economics 2009, *MLA's Contribution to the Environmental Sustainability of the Red Meat Industry: A Stocktake of Surveys and Programs*, prepared for Meat and Livestock Australia.

well as building producers' capacity to implement them, has influenced the adoption of the management practices identified in the framework. By implementing NRM practices that have scientifically been shown to improve resource conditions, we can be confident that MLA's contribution to the adoption of NRM practices will improve environmental outcomes.

The metric

The most obvious measure of MLA's contribution to environmental sustainability would be to measure the change in environmental outcomes. However, there are many other factors that can positively and negatively impact upon this that are outside of the realm of MLA's control — the example of drought reinforces this, since resource conditions have deteriorated over this time independently of the actions of producers. Instead, we will benchmark MLA's contribution to environmental sustainability on the basis of their contribution to the adoption by producers of management practices that have a demonstrated link to improving environmental outcomes. Another alternative metric, for which sufficient data is not yet available, is to measure MLA's impact upon changing attitudes towards environmental sustainability and NRM practice adoption. While, perhaps, this is not as stringent a measure of MLA's contribution as adoption rates, it does capture the path to adoption that producers must take.

The data

In the first stage of the study of MLA's contribution to environmental sustainability, in addition to constructing the framework, a stocktake was undertaken on the availability of adoption data necessary to be able to make any kind of assessment of MLA's contribution to adoption.

In the preceding report we reviewed the existing sources of red meat surveys and NRM to be able to identify management practices that both correspond with the framework and record adoption over time.[3] Using this survey data, we can subsequently construct a time profile of adoption for several NRM practices. This is explored in chapter 2.

[3] Centre for International Economics 2009, op cit.

2 Methodology

This chapter focuses on developing the methodology for estimating MLA's contribution to the adoption of NRM practices.

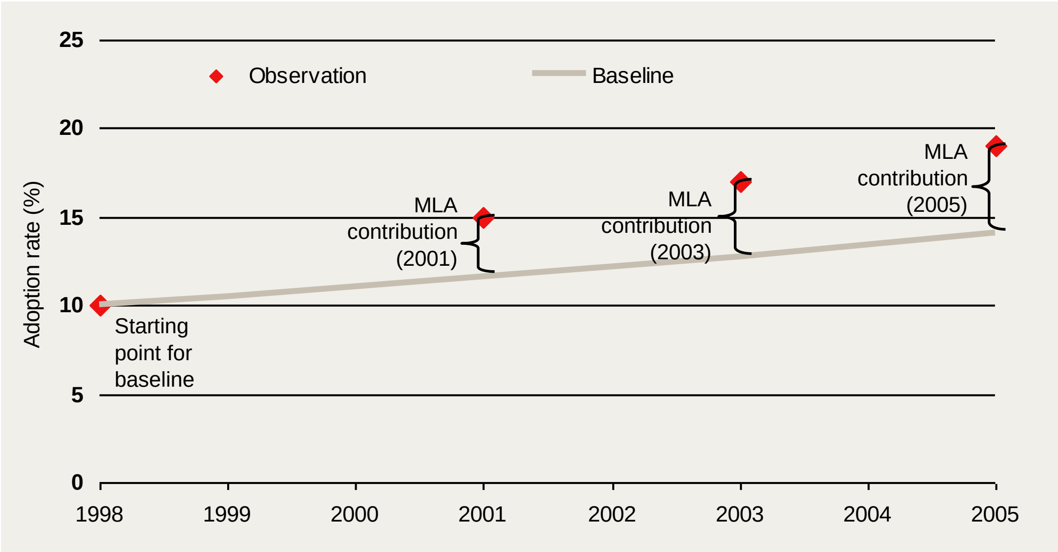
After reviewing over 20 surveys and studies, three surveys were distilled and determined to be similar enough in their coverage of management practices and survey methodology to enable comparison. While the survey data does tell us the adoption rate for NRM practices, it is does not tell us what MLA's contribution to this adoption rate is. Consequently, it was necessary to isolate MLA's impact upon the adoption rate from other influences, since it is well recognised in agricultural literature that there are many determinants in the adoption of NRM practices. Some of the most important are farm income, education and future farm planning, the latter two of which can be directly influenced by MLA's activities (in regards to NRM).[4]

One method of isolating MLA's contribution to adoption from other factors is to develop a baseline against which to compare the observed adoption rates. That is, what would the adoption of NRM practices have been if not for MLA's activities that encouraged adoption? By developing a baseline scenario for the adoption of NRM without MLA's influence and comparing it to the observed adoption rate, we assert that the difference is MLA's contribution. This is illustrated in chart 2.1, which provides a stylised example of the baseline scenario, observed adoption rate data points and the resulting estimate of MLA's contribution.

The rest of this chapter expands upon the key elements of the methodology, developing the adoption profile and baseline scenarios. Together, these components drive how information on MLA's contribution will be presented and, as such, will be discussed.

[4] Lyle GM and Ostendorf BF 2005, Drivers and determinants of natural resource management adoption at the farm scale, University of Adelaide paper presented at the 'International Congress on Modelling and Simulation', Modelling and Simulation Society of Australian & New Zealand, Melbourne, 12–15 December.

2.1 **Illustration of baseline and adoption profile**



Developing the adoption profile

Given the alignment between the management practices covered in the survey and those included in the environmental mapping framework (see appendix A), there are seven management practices (box 2.2) for which we will report adoption rates:

- contour banks
- permanent pastures (targeting erosion)[5]
- perennial pastures (targeting salinity)
- soil testing
- drainage cover
- exclusion of stock
- piping stock water supplies.

For each of these management practices, we have three observations — 2001, 2003 and 2005 — obtained from three separate surveys. This enables us to create a short time profile of adoption for each of the management practices.

[5] Permanent Pastures is not a management practice that is part of the *MLA Mapping Framework*. However, it is used as a proxy for perennial pastures in relation to erosion issues.

2.2 Definition of management practices

Contour banks
Earthen structures placed across and at intervals down a slope so as to intercept and divert run-off.

Perennial pastures
Deep-rooted pastures designed to provide groundcover throughout the year, but should be combined with appropriate grazing to ensure complete groundcover.

Soil testing
Testing soil for its nutrient status and pH level.

Drainage cover
Maintaining groundcover along drainage lines to prevent run-off with a high sediment load and nutrient load from entering watercourses.

Exclusion of stock
Selectively restricting and regulating stock access to waterways and riparian land to minimise the negative effects of stock on stream-bank integrity, riparian vegetation and water quality.

Piping stock water supplies
The installation of a piped and reticulated stock watering system.

Source: Signposts for Agriculture: Beef Industry Profile.

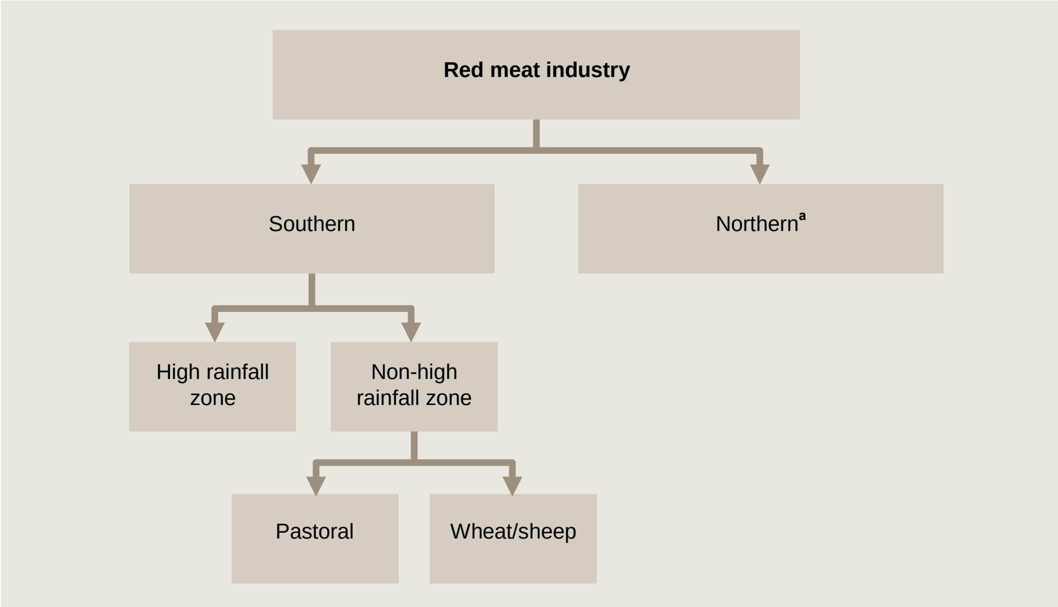
Furthermore, the surveys have all been stratified such that the adoption rates can be analysed for different geographical regions. Some management practices are more relevant to particular regions, so it makes sense to analyse adoption rates by geographical regions. Chart 2.3 shows the geographical breakdown of Australia for the red meat industry.

The survey data has been constructed using the ‘broadacre’ classification and, as such, can be broken down into high rainfall, pastoral and wheat–sheep zones. However, the sample for the pastoral zone is very small and, as such, the adoption rates are not necessarily representative of the population. Consequently, adoption rates will only be presented for the high rainfall zone (HRZ) and wheat–sheep zone.

Chart 2.4 presents the time profile of adoption of contour banks. An equivalent chart has been constructed for each of the seven management practices and is presented in appendix B to maintain the tractability of this document. Chart 2.4 illustrates that the rate of adoption of contour banks has increased from 2001 to

2003 — however, from 2003 to 2005 it appears to have increased for the wheat–sheep zone, but decreased slightly for the HRZ.

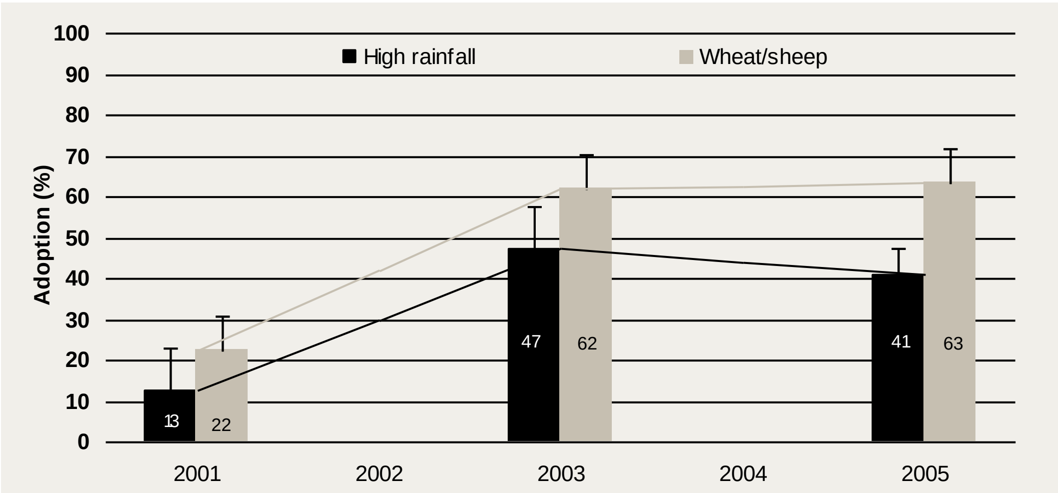
2.3 Geographical classification for red meat industry



[a] Northern red meat refers to producers in QLD and NT. Conversely, southern red meat captures the remaining states.

Note: The high rainfall, pastoral and wheat–sheep zones together form the ‘broadacre’ regional classification, as defined by ABARE 2009, *Survey methods and Definitions*, p. 5.

2.4 Adoption profile of contour banks



Note: Lines extending from bar represent the upper band for the confidence interval associated with the adoption rate.

Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*, Canberra; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

We can investigate this trend a little further by looking at the error terms associated with each of the observed adoption rates. The error terms measure ‘how far off’ the survey adoption rate is from the population adoption rate. This is then used to construct an interval (upper and lower bound) around the adoption rate. This interval tells us with 95 per cent confidence that the true value of the adoption rate falls within the upper and lower bounds of the interval.[6] The upper bound is represented in chart 2.4 by the line extending from the bar. Where confidence intervals overlap, this tells us that we cannot be confident that the two observations are statistically different. We can, therefore, infer that there has been no increase (statistically speaking) in the rate of adoption between 2003 and 2005 for both the HRZ and wheat–sheep zone. Conversely, we can see from the chart that there has been a substantial increase in adoption from 2001 to 2003 for both zones.

Developing the baseline

The adoption profile tells us what proportion of beef, sheep and goat producers currently use particular management practices. What it does not tell us, however, is whether producers have adopted the management practice in response to the activities undertaken by MLA. Determining the motivations of producers is not possible without the specific question being put to producers in surveys and, even then, it can be difficult for producers to accurately identify the role that MLA has or has not played in their adoption (box 2.5). We can, however, construct an estimate of what the adoption rate of management practices would have been if MLA did not provide the services that it did. By comparing this ‘without MLA’ scenario to the observed adoption rate ‘with MLA’, we can estimate the contribution that MLA has made to the adoption of environmentally sustainable management practices.

Defining these scenarios is conceptually and mathematically difficult. On one hand it may be reasonable to argue that, if MLA were not around, another one of the other research and development corporations (RDCs) would have likely filled the gap. On the other hand, the leverage that has been generated by MLA having joined forces with these RDCs on numerous occasions would have been lost. And what would have happened to the funding that MLA currently captures from the government and from levy payers? Would these funds have been captured and invested by other RDCs, or would the pool of funds for investing have been smaller? These questions of attribution and leverage are difficult at the best of times, but in this case there is insufficient information to be able to provide any meaningful insight. Consequently, we will make the assumption that the

[6] Specifically, if a random sample was repeatedly selected, the adoption rate would be within the upper and lower bound of the confidence interval 95 per cent of the time. Intervals can be constructed for any confidence level, but are typically constructed at the 90 per cent, 95 per cent and 99 per cent level.

relationship between MLA and the other RDCs remains constant between 1998 and 2005.

2.5 Data issues

The compilation of survey data from several sources has meant that several issues with the data have arisen. Where possible, we have tried to impute data so that we could continue our analysis for illustrative purposes. The following points summarise the data manipulation that has been implemented. A full discussion of the reasons and methods of imputation are discussed in appendix C.

- MLA's contribution has not been constructed for the Pastoral zone.
- Observations have been imputed for:
  - adoption rate for Permanent Pastures in 1998-99 (for both HRZ and wheat–sheep);
  - adoption rate for Drainage Cover in 2001 (for both HRZ and wheat–sheep);
  - adoption rate for Excluding Stock in 1998-99 (for both HRZ and wheat–sheep); and
  - adoption rate for Piping Water in 1998-99 (for both HRZ and wheat–sheep).
- Data has been manipulated to reflect differences in survey questions for:
  - adoption rate for Perennial Pastures in 1998-99 (for both HRZ and wheat–sheep).

Starting point: 1998 NRM survey

To develop the baseline scenario we have sourced the adoption rate of the management practices from a 1998-99 ABARE survey.[7] This survey was conducted at a point when MLA had only recently evolved into its current form. As such, we can take this data point as a 'without MLA' rate of adoption. By extrapolating from this data point under several different growth scenarios we can develop several scenarios of 'without MLA' that we can compare to the observed adoption rates and thereby determine MLA's contribution.

Table 2.6 presents the adoption rate for each of the management practices in each of the regions, which also acts as the starting point for the baseline. This

[7] Appendix D provides an assessment of the feasibility of using this survey.

infers that there are 14 baselines — one for each management practice–region combination.

2.6 **Starting point for baseline**

	Contour banks	*Perennial pastures*	*Permanent pastures*	*Soil tests*	*Drainage cover*	*Excluding stock*	*Piping water*
	%	%	%	%	%	%	%
HRZ	8	15	15 [a]	60	81	24 [b]	49[b,c]
Wheat–sheep	15	19	19 [a]	46	58	24 [b]	41 [b,c]

[a] Data on *Permanent Pastures* not collected in this survey, observation imputed from *Perennial Pastures* adoption rate. [b] Data only collected for pastoral farms. Adoption rate imputed for HRZ and wheat–sheep zone. [c] Imputation based upon relationship between HRZ and pastoral using 2005 data.

Source: ABARE 2000, *1998-99 Natural Resource Management Survey*; and CIE calculations.

Extrapolation: scenarios

Building upon the starting point provided by the 1998 survey, we extrapolate, for each of the 14 management practice–regions, combinations under several different scenarios. The benefit of this approach is that it reflects the uncertainty associated with knowing what would have happened 'without MLA'.

Each scenario represents a growth pattern for adoption, which is common across all management practices, but which has a different starting point, as determined by the 1998 survey (and presented in table 2.6). Ideally, each management practice would have a growth pattern unique to it, reflecting the different growth rates that would be expected across the different management practices. For example, some management practices deliver greater returns for effort and/or investment than others, and some management practices lend themselves to trials, which enables producers to try the management practice without having to commit significant resources. These kinds of management practices are likely to have more rapid adoption relative to others.

While these factors may affect the adoption of one management practice relative to another, there are other factors that affect the adoption of management practices more generally. Prokopy et al. provide a comprehensive literature review of determinants affecting the adoption of NRM practices.[8] It is best summarised by table 2.7, reproduced from their paper, which tells us how many models and studies that the listed variables have been found to have a statistically positive impact upon the adoption of NRM practices.

[8] Prokopy, L.S., Floress, K., Klotthor-Weinkauf, D. and Baumgart-Getz, A. 2008, 'Determinants of Agricultural best management practice adoption: Evidence from the literature', *Journal of Soil and Water Conservation*, September, Vol.63, No. 5, pp. 300–11.

2.7 **Vote count for determinants of NRM practice adoption**

Determinants	***Positive significance***[a]		***Total***[b]	
	Models	Studies	Models	Studies
Capacity				
Acres	37	21	110	34
Age	5	4	109	26
Capital	23	8	181	24
Diversity	22	6	69	8
Education	46	21	168	42
Farm Experience	3	2	58	22
Income	33	14	156	34
Information	15	12	46	20
Labour	24	15	127	28
Networking	50	17	204	22
▪ Agency	35	11	146	18
▪ Business	3	2	24	3
▪ Local	12	7	33	12
Ownership type	5	3	49	11
Tenure	9	8	116	26
Attitude				
Overall attitude	50	17	329	26
Adoption payments	15	4	43	9
Environmental	16	6	80	10
Profitability of practice	4	3	21	6
Heritage	5	5	77	11
Quality of environment	2	2	10	2
Risk	8	6	98	13
Environmental awareness				
Overall awareness	25	10	157	16
Cause	9	5	36	9
Consequence	–	–	16	4
Knowledge	5	4	45	5
Program	12	4	62	8
Farm characteristics				
Animal	7	5	87	14
Grain	19	6	33	6
Operator gender	1	1	31	2
Other	4	1	22	7
River	10	3	86	4
Slope	21	7	52	11
Soil quality	21	12	96	22

[a] Measured at the 95 per cent confidence level. [b] Total is the sum of models and studies found to have a positive significance, negative significance or no significance at all, for each of the respective variables.

Source: Prokopy LS, Floress K, Klotthor-Weinkauf D and Baumgart-Getz A 2008, 'Determinants of Agricultural best management practice adoption: Evidence from the literature', *Journal of Soil and Water Conservation*, September, vol. 63, no. 5, table 3, pp. 300–11.

As the study of Prokopy et al. shows, factors affecting capacity are most regularly analysed and shown to have a positive impact upon adoption (with the exception of 'overall attitude'). This study is good at identifying what the relevant determinants are — however, it does not tell us what the relative importance of these determinants are. According to Lyle and Ostendorf, the most important factors influencing the adoption of NRM practices are farm income, education and future farm planning.[9] As MLA is an important source of education on management practices, we can assume that this variable remains relatively constant in the 'without MLA scenario'. In regards to future farm planning, this tends to be a binomial variable (farmers either forward plan or they do not), which makes it difficult to use in constructing our scenario. Consequently, the income variable has been used as the key variable to construct some of the scenarios.

In total, four scenarios have been constructed:

- income change
- farmers' terms of trade
- no change
- small growth.

The first two scenarios use different metrics to capture income effects. All scenarios present a growth path upon which the starting point — the adoption rate in 1998 — is extrapolated to create a baseline scenario. The construction of each of these scenarios is now discussed.

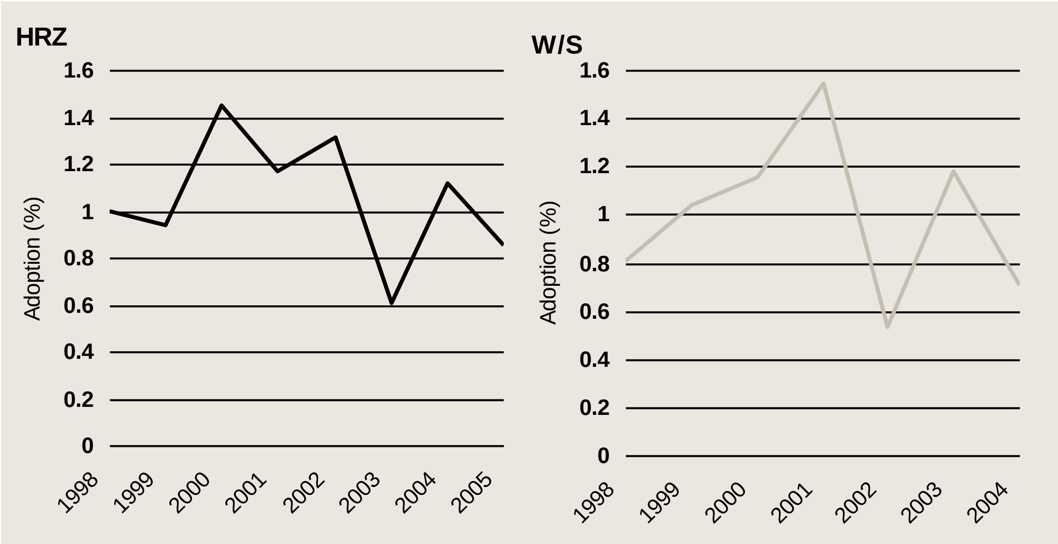
Income change

Reflecting that income is a primary determinant of farmers' capacity to adopt management practices, a scenario based upon farmers' cash income was constructed. Using data compiled by ABARE, a time series of farm cash income growth was constructed. However, farm cash income is highly variable across time, which means the scenario based upon changes in farm cash income has significant variability. This is illustrated in chart 2.8.

This high degree of variability reflects the variability in income across farms, rather than for any particular farm year on year. Consequently, it is likely that this scenario exaggerates the variability in the adoption rate of NRM practices. Furthermore, we would not necessarily expect a decrease in income to correspond with a decrease in the adoption of NRM practices — once a practice has already been adopted it is unlikely that a farmer would then drop it as they would have already overcome the informational barriers and because of the fixed costs associated with its implementation.

[9] Lyle GM and Ostendorf BF 2005, op cit.

2.8 **Income change baseline scenarios for contour banks**



Data source: ABARE 2009, *AgSurf,* http://www.abareconomics.com/interactive/agsurf/index.htm, Accessed 5 August 2009; ABARE 2008, 'Index of Prices Paid', *Australian Commodity Statistics*, p. 17.

Farmers' terms of trade

Another, more stable, measure of a farmers' financial capacity to adopt NRM practices is their terms of trade (ToT). The farmers' ToT is an index constructed from the ratio of the prices received to prices paid, where values greater than 100 indicate that the prices received are larger than those paid. While this measure does not take into account input costs, it is a good proxy for farm income and, hence, their financial capacity to implement and adopt NRM practices.

No change

Using this same rationale (that farmers do not drop management practices after they have adopted them), the minimum level of adoption that we can expect to see over time is that which was observed in 1998-99. This sets a floor upon adoption and a maximum for MLA's contribution. Obviously, it is unlikely that the 'without MLA' baseline would see no increase in the observed adoption of NRM practices, but the insight of this scenario is that it places an upper bound on MLA's contribution to the adoption of NRM practices.

Small growth

To reflect the fact that it is likely that other RDCs will have continued to encourage and influence the adoption of NRM practices, a small growth rate in the adoption of management practices is likely. Our fourth scenario is a 2 per cent growth in the adoption of management practices. This scenario captures the fact that we would only expect to see an upward increase in the adoption rate. Although this scenario presents a linear uptake of the management practices, in practice adoption of singular management practices is more likely to be an S-shape (the left panel of chart 3.3 provides an illustration of this). On the aggregate, across all NRM, we can assume that there will be a steady increase in adoption, as captured by this scenario.

Now that we have established the methodology for how MLA's contribution will be measured, the results are presented and discussed in chapter 3.

3 MLA's contribution

This chapter presents the results of the analysis and informs us of MLA's contribution to the environmental sustainability of the red meat industry through its impact upon the adoption of NRM practices.

MLA's contribution to the adoption of NRM practices

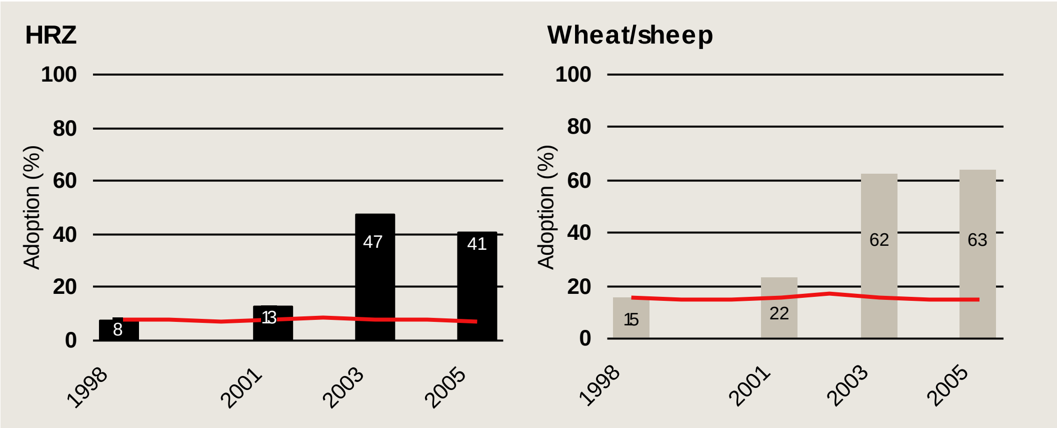
To determine MLA's contribution to the adoption of NRM practices, we bring together both the adoption profile and the baseline, the difference being MLA's contribution. As set out in chapter 2, for each of the seven management practices we have constructed an adoption profile for the HRZ and wheat–sheep zone, which equates to 14 management practice–region combinations.

In recognising the uncertainty associated with the 'without MLA' baseline, we have constructed four scenarios. All together that makes 56 management practice–region scenario combinations. To improve the tractability of these results, only selected management practices will be included in the body, with full coverage of all management practices provided in appendix E for the adoption and baseline profile, and appendix F for MLA's contribution profile.[10] The management practices presented in the body of this report have been selected to illustrate some insights about the data and the constraints that the data places upon our interpretation of MLA's contribution to the adoption of management practices.

Furthermore, we will restrict our analysis to just the one baseline scenario — farmers' ToT. Farmers' ToT is a stable indication of farmers' income, which is the best indicator that we have of producers' capacity to adopt NRM practices. Chart 3.1 presents the adoption rate of contour banks for both the HRZ and the wheat–sheep zone.

[10] Results under the 'income change' scenario will not be presented due to the problems associated with this scenario as discussed in chapter 2.

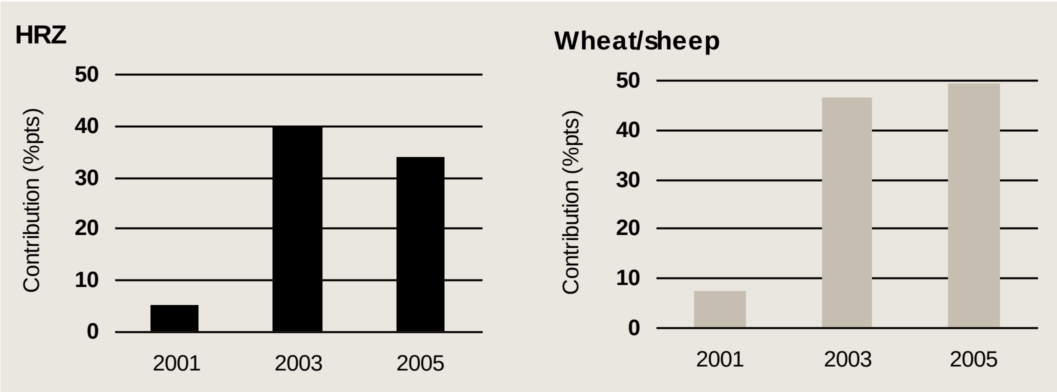
3.1 **Contour banks — adoption and baseline profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

Overlayed on the adoption profile are the respective baselines for contour banks in the different regions. These charts show that the adoption profile is higher than the baseline, which infers that MLA has made a positive contribution to the adoption of contour banks. This is further clarified in chart 3.2, which illustrates the time profile of contribution.

3.2 **Contour banks — contribution profile**

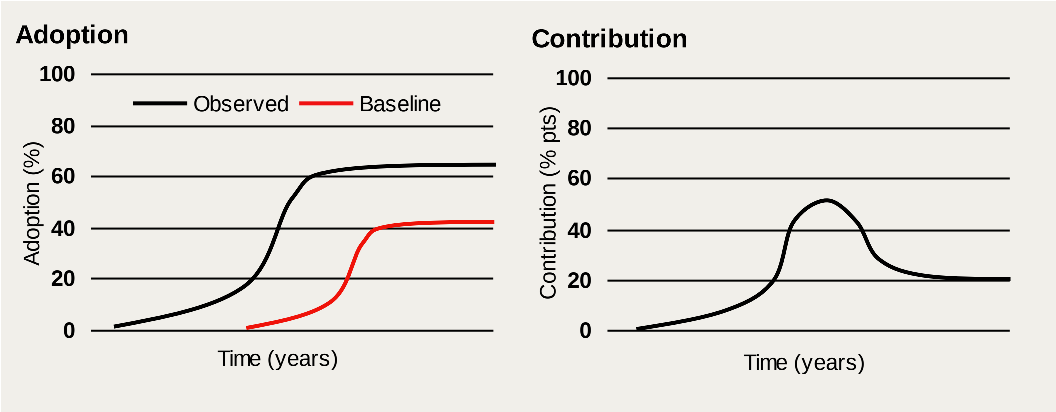


Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

Chart 3.2 illustrates that MLA's contribution has increased from 2001 through to 2005 for the wheat–sheep zone, but that it decreased between 2003 and 2005 for the HRZ.

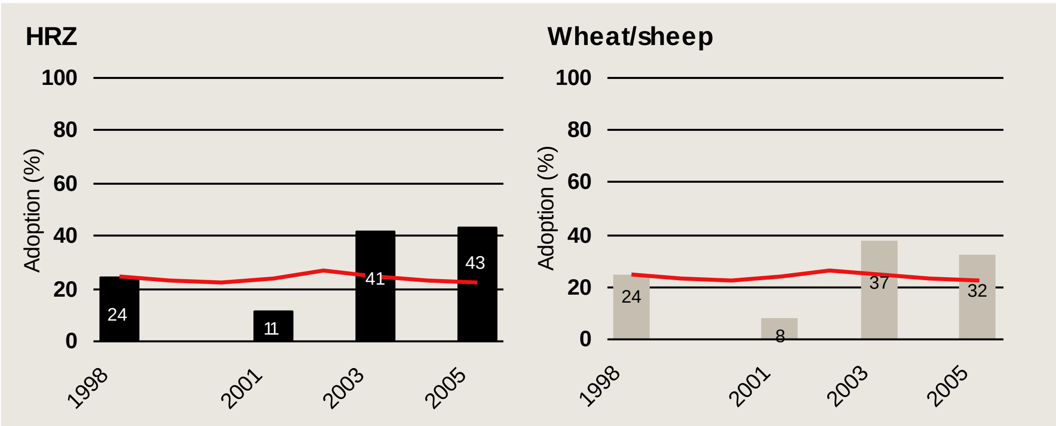
The time profile of contribution is dependent upon both the trend for adoption as well as the baseline. This is illustrated in a stylized example (chart 3.3), where the adoption profile and baseline are presented in the left panel, and the contribution corresponding to these is in the right panel. This shows that the contribution stabilises over time.

3.3 **Illustration of contribution profile**



While the stylized example in chart 3.3 shows that the contribution time profile is always positive, when we used our survey data, MLA's contribution was, at times, negative. This situation arises when the adoption rate is lower than the baseline, and is illustrated for the management practice 'excluding stock' in chart 3.4.

3.4 **Excluding stock — adoption and baseline profile**



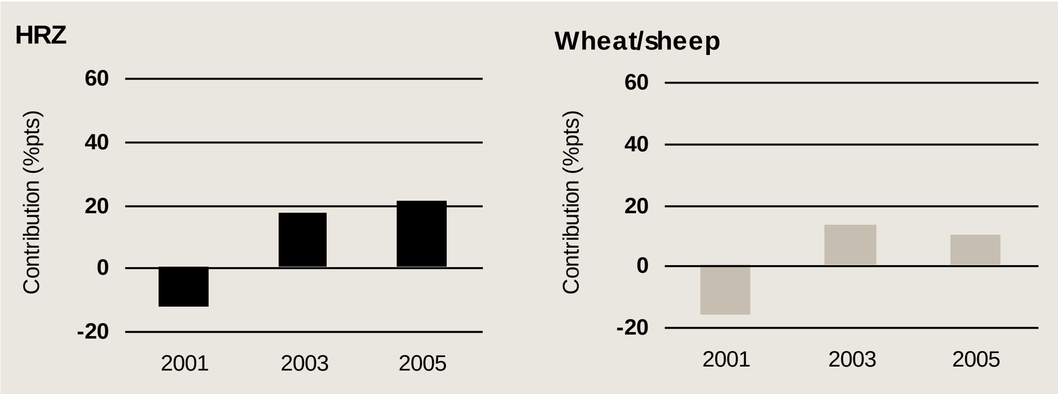
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

Corresponding to the baseline being higher than the adoption rate, the contribution time profile is negative in 2001, as illustrated in chart 3.5.

A negative contribution infers that MLA's activities detract from the adoption of NRM practices, which is counterintuitive. Consequently, we review two elements that result in this outcome:

- the baseline is too high, or
- the adoption rate is too low.

3.5 **Excluding stock — contribution profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

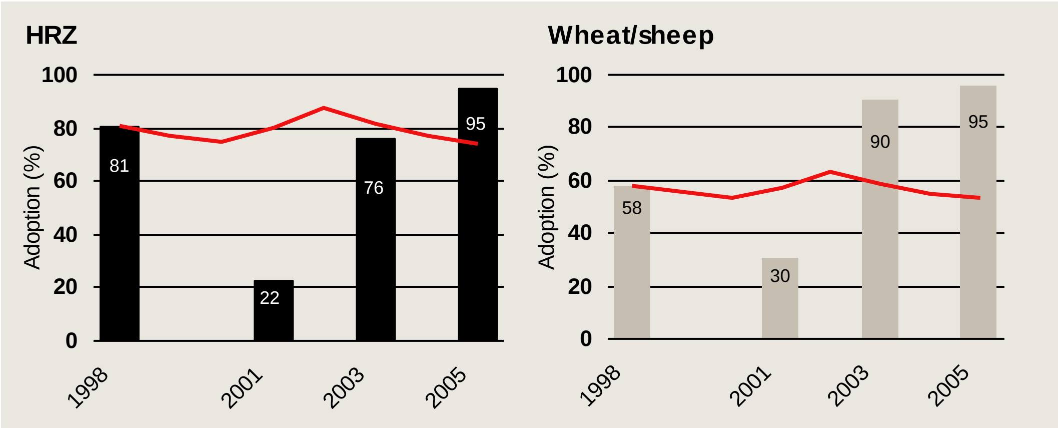
Given that contribution is positive for both 2003 and 2005, the negative contribution for 2001 suggests that the adoption rate for excluding stock is too low. The reasons for this are not clear — the survey methodology used for the 2001 survey is very similar to that used for the 2003 and 2005 survey. The only discernable difference is that the 2001 (and 1998) survey restricts the survey to farms that have more than 100 sheep or 30 beef cattle. Because this creates a bias to larger farms, survey weights have then been applied, readjusting this imbalance. It is possible that this procedure, or the lack of it in the 2003 and 2005 survey may explain the comparatively lower adoption rates for 2001.

A negative contribution was also found for 'drainage cover'. Converse to excluding stock, the resulting negative contribution for drainage cover appears to be a consequence of the baseline being too high (chart 3.6). The baseline is perhaps too high because the adoption rate in 1998 (our starting point) is high in comparison to the adoption rate in the following years.

It is feasible that the adoption rate is 'too high' due to differences between the 1998 survey and the 2001, 2003 and 2005 surveys. In assessing the feasibility of using the 1998 survey data, we concluded that the surveys were similar enough for our purposes. However, it should be noted that the questionnaire for the 1998 survey differed from the other surveys in one key way. The 2001, 2003 and 2005 surveys were structured such that they first asked about the natural resource condition and, second, about the use of particular management practices in response to the natural resource condition.[11] However, the 1998 survey only asked producers about their adoption of the natural resource management practices. As the earlier (1998) approach is more general and encompassing, it is

[11] For example, a question may be phrased as 'Is salinity an issue on your farm?', and the choice for response (if yes) is a list of several management practices.

3.6 **Drainage cover — adoption and baseline profile**



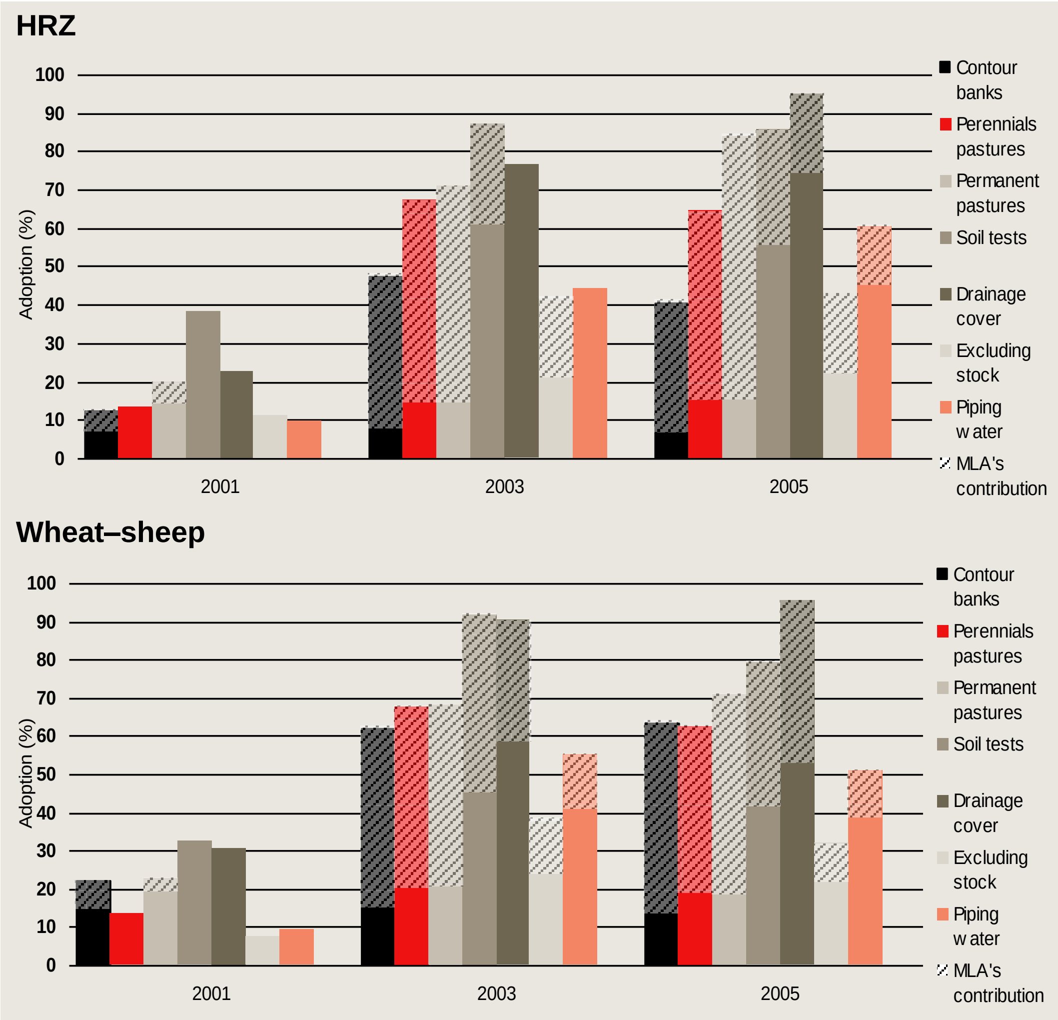
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

possible that the adoption rate is overstated in comparison to the other surveys. So it is feasible that the baseline based upon the 1998 adoption rate will understate MLA's contribution for drainage cover.

Chart 3.7 provides a summary of MLA's contribution across all NRM practices. The bars represent the adoption rate, with the shaded area of the column reflecting MLA's contribution (under farmers' ToT baseline scenario). Where contribution is 'negative', no contribution has been assigned to MLA, since this outcome is considered to be an anomaly of the data and construction rather than a reflection upon MLA's efforts.

The shaded area reflecting MLA's contribution is measured in percentage points. This is transformed in to percentage of adoption, and illustrated in chart 3.8 below. So in 2001, MLA has contributed 40 per cent to the observed adoption of contour banks. The benefit of this approach is that it allows clearer comparison across management practices, making it very clear, for example, that MLA has made a significant contribution to the adoption of contour banks and perennial and permanent pastures.

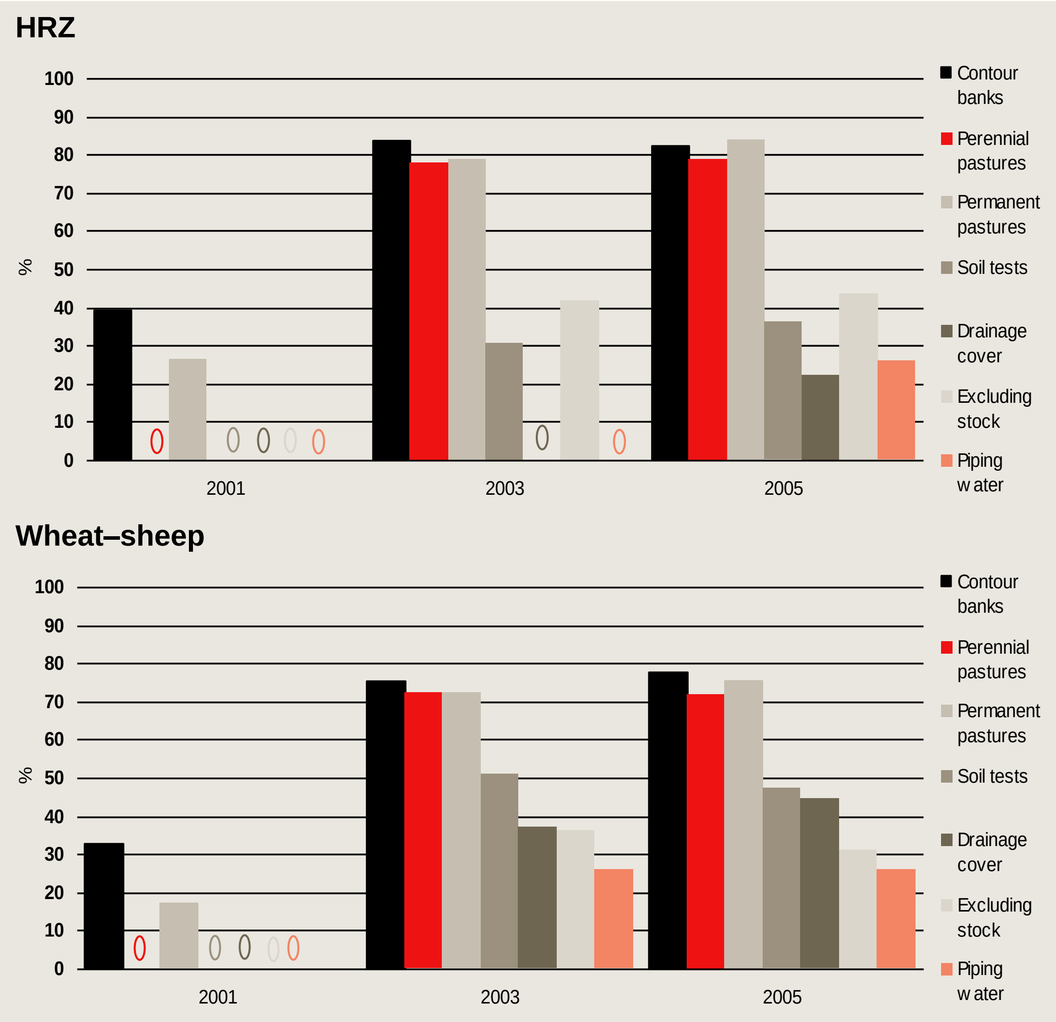
3.7 Adoption of NRM practices and MLA's contribution



Note: Contribution calculated under the Farmers' ToT baseline scenario.

Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

3.8 MLA's contribution to the adoption of NRM practices (HRZ)



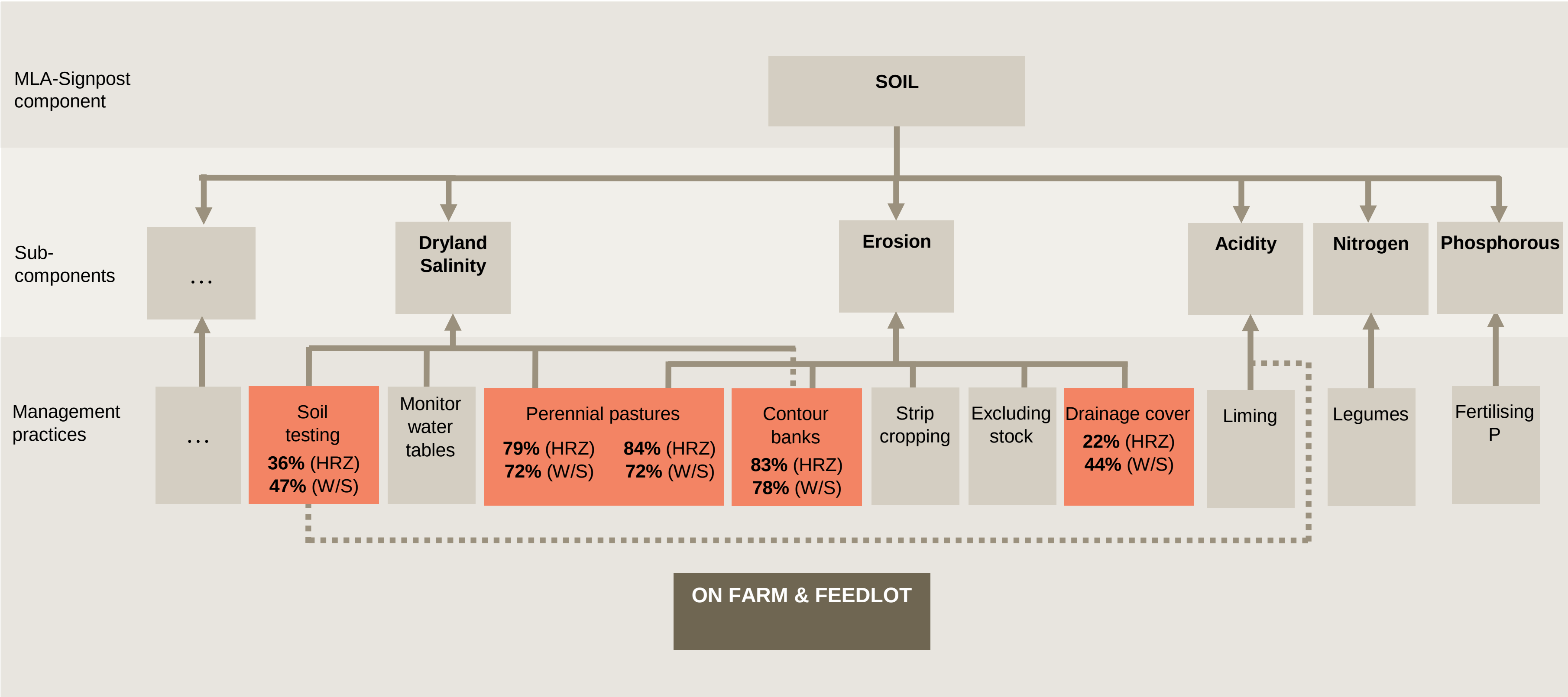
Note: Contribution calculated under the Farmers' ToT baseline scenario.

Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

MLA's contribution to environmental sustainability

The purpose of this analysis is to assess MLA's contribution to the environmental sustainability of the red meat industry. The results from the analysis of MLA's contribution to the adoption of NRM practices have been incorporated into the mapping framework and are presented in charts 3.9 and 3.10. Note, only the soil and water component are presented, since insufficient survey data was available on the management practices relevant to the biodiversity and atmosphere components.

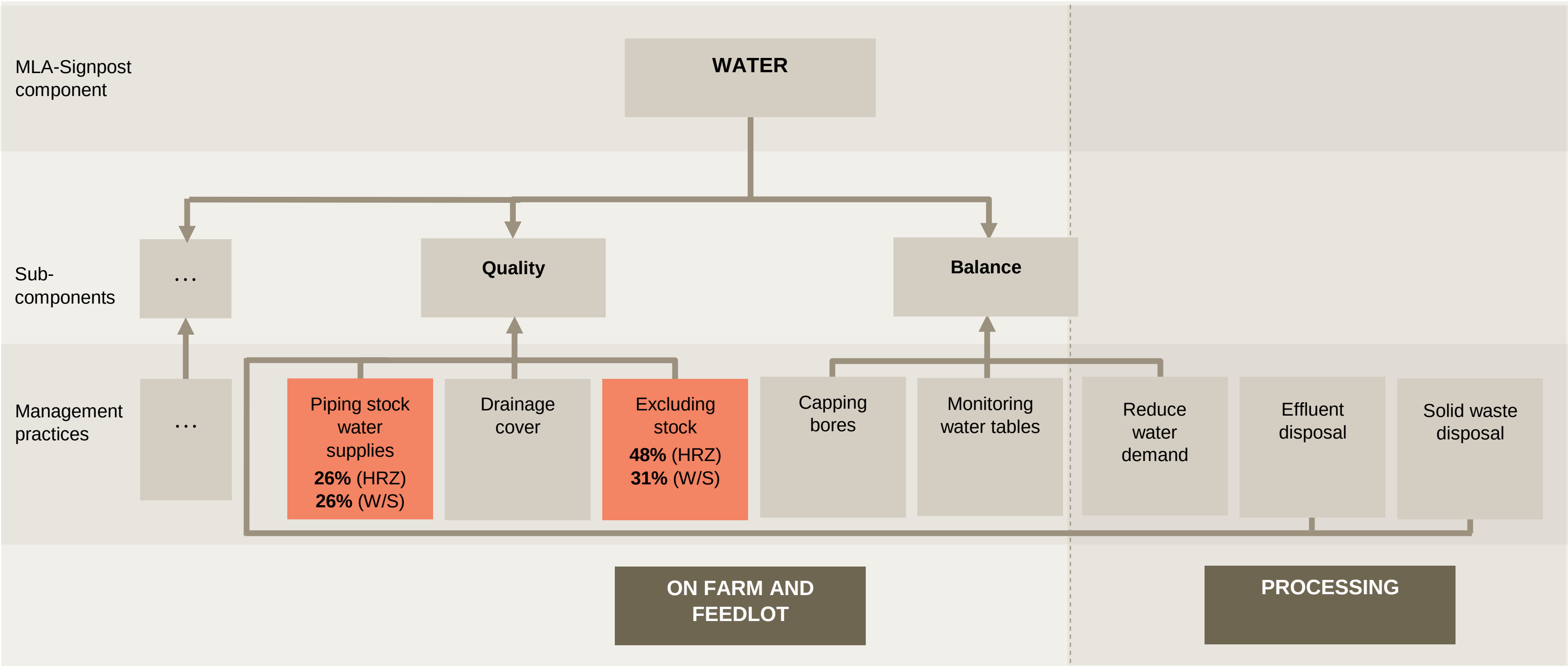
3.9 **MLA's contribution to environmental sustainability — soil component (2005)**



Note: The dashed line is used to indicate that the adoption data does not correspond with this environmental condition, despite the linkages recognised in this framework. Also, the processing sector has been removed from this diagram due to space constraints — it can bee seen in the original mapping framework in appendix A.

Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

3.10 **MLA's contribution to environmental sustainability — water component (2005)**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

4 Lessons for improving ability to report contribution

This study has been a retrospective assessment of MLA's contribution to environmental sustainability. This assessment has presented two primary difficulties in terms of measuring MLA's contribution to environmental sustainability: first, determining what proportion of the adoption rate can be attributed to MLA and, second, developing a time profile of this attribution so that MLA's progress over time can be measured.

Attribution

This assessment has been based upon survey data and, moving forward, it continues to be the best tool to ascertain the impact MLA is having upon the adoption of NRM practices. Consequently, survey design will be the key to ensuring that attribution is feasible and representative.

A simplistic approach could be to simply ask producers whether or not they have adopted a management practice in response to MLA's activities. This could facilitate the collection of data on all of the management practices covered by the framework. However, this approach does not sufficiently identify what MLA's activities are and how they are linked to the management practices surveyed. Nor does it lend itself to collecting data on the management practices that MLA *does*, in fact, encourage. For example, suppose the survey results show that MLA's contribution to the adoption of contour banks is zero — it is unclear whether this is because MLA's activities are not effective, or simply that MLA is not targeting this management practice through any of its programs. Therefore, it is important that the management practices surveyed are linked directly to the MLA's activities. One of the greatest practical advantages of this is that it coincides with the program evaluation process already undertaken.

However, it should be noted that attributing adoption of a management practice to a particular program does not necessarily correspond directly with MLA's contribution — there are often many contributors to the one program and/or investment, which continues to make the process of contribution difficult. Consequently, the process of determining contribution will still require careful consideration of how each of the co-funders has contributed both to the overall program and the adoption of management practices more specifically.

In determining MLA's impact upon the adoption of management practice, it is also feasible that the impact of MLA on attitudes could also be assessed. This is a good intermediate measure of the progress that MLA is making towards the environmental sustainability of the industry, since changing attitudes are an important precursor to the adoption of new NRM practices.

Time profile of contribution

The success of MLA's ability to measure their impact across time will be driven by commitment to the process. This requires incorporating the environmental framework into their program design and development, as well as providing the financial resources necessary to undertake surveys and calculate MLA's contribution.

Other issues

The feedlot sector is currently not covered by the farm surveys and will need to be incorporated into future survey coverage. This will facilitate a more accurate representation of the red meat industry and MLA's stakeholder base. The processing sector is also not covered by these surveys. However, evidence of practice change in meat processing has been tracked since 1998 via a separate survey.[12]

[12] Meat and Livestock Australia (MLA) 2005, *Industry environmental performance review: Integrated meat processing plants*, prepared by URS Australia, April.

Appendices

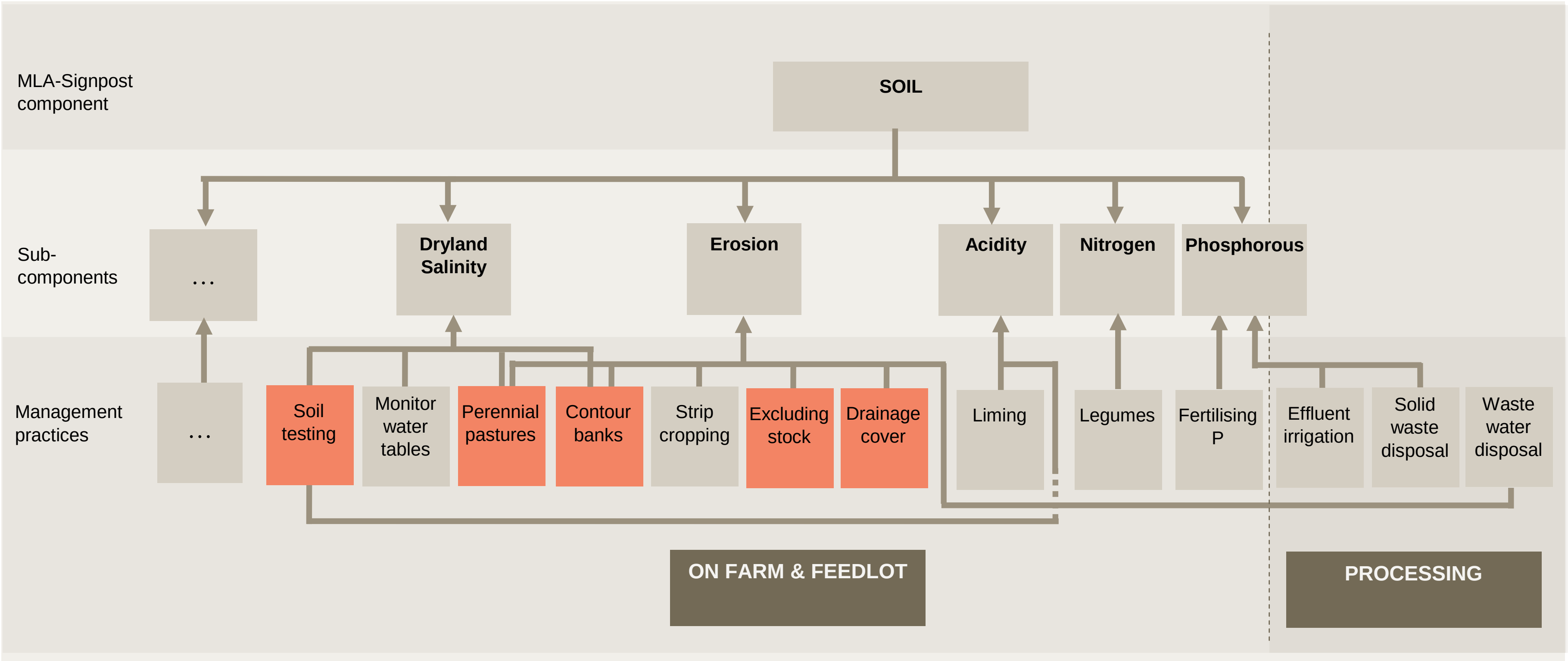
A Mapping framework for environmental components

Signposts for Agriculture provides us with a comprehensive framework for thinking about how on-farm activities of agriculture contribute to environmental outcomes, and in turn, the environmental sustainability of the industry. Building upon this framework, TheCIE has extended and modified this framework to make it more tractable and relevant to MLA and the red meat industry. Specifically, the modifications are:

- the addition of feedlot and processing sectors, to reflect the breadth of the red meat value chain (only on-farm practices are already captured by Signposts);
- inclusion of the four, overarching environmental conditions, decided upon by the RDCs, which overlap well with key headings in the Signposts framework;
- simplification the framework in terms of the numbers of and levels of 'branches' and the environmental issues covered (to better reflect the issues of the industry); and
- the inclusion of management practices as part of the mapping, as opposed to the qualitative discussion provided in Signposts.

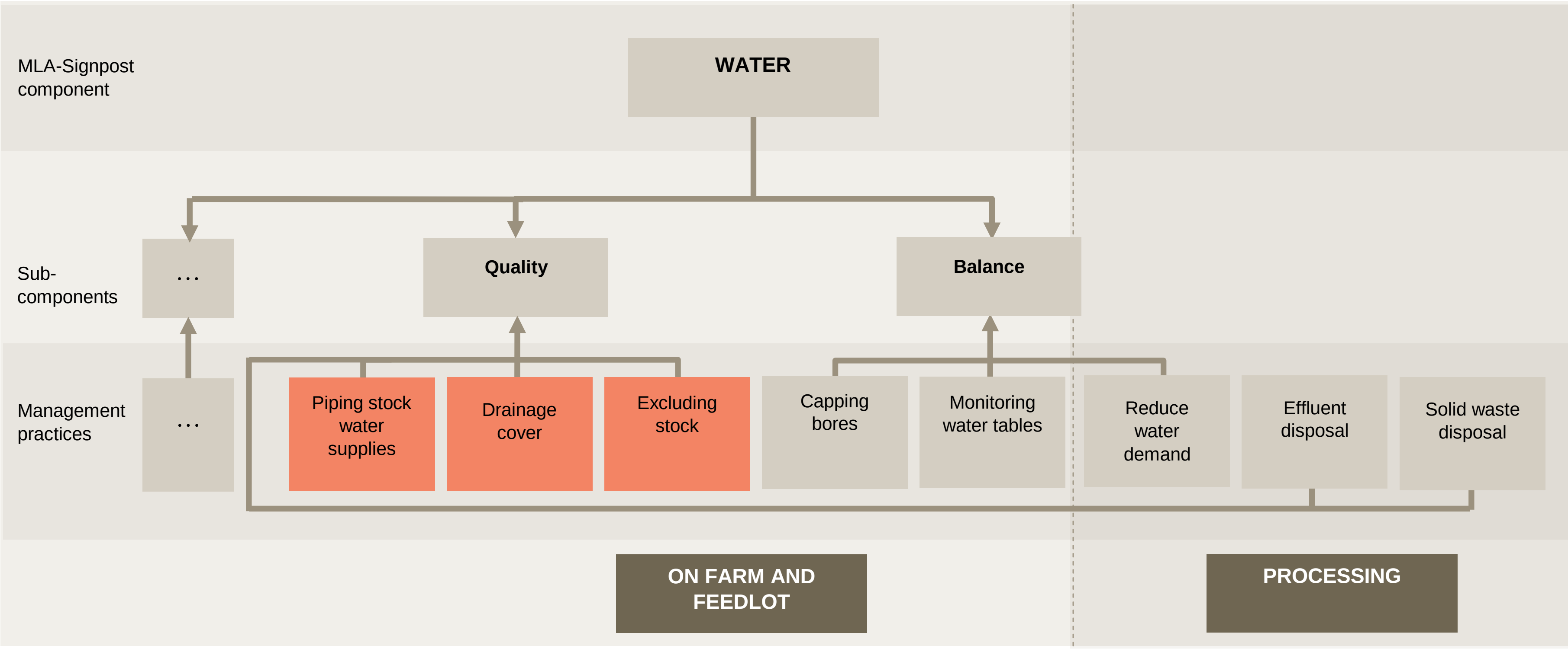
This framework provides the conceptual link between the management practices that MLA contributes to the promotion of and environmental outcomes across the 4 core components (charts A.1 to A.4). To validate these linkages, the on-farm management practices have been sourced directly from the Signposts for Agriculture literature, which is supported by extensive research.

A.1 **Mapping framework for Soil component**



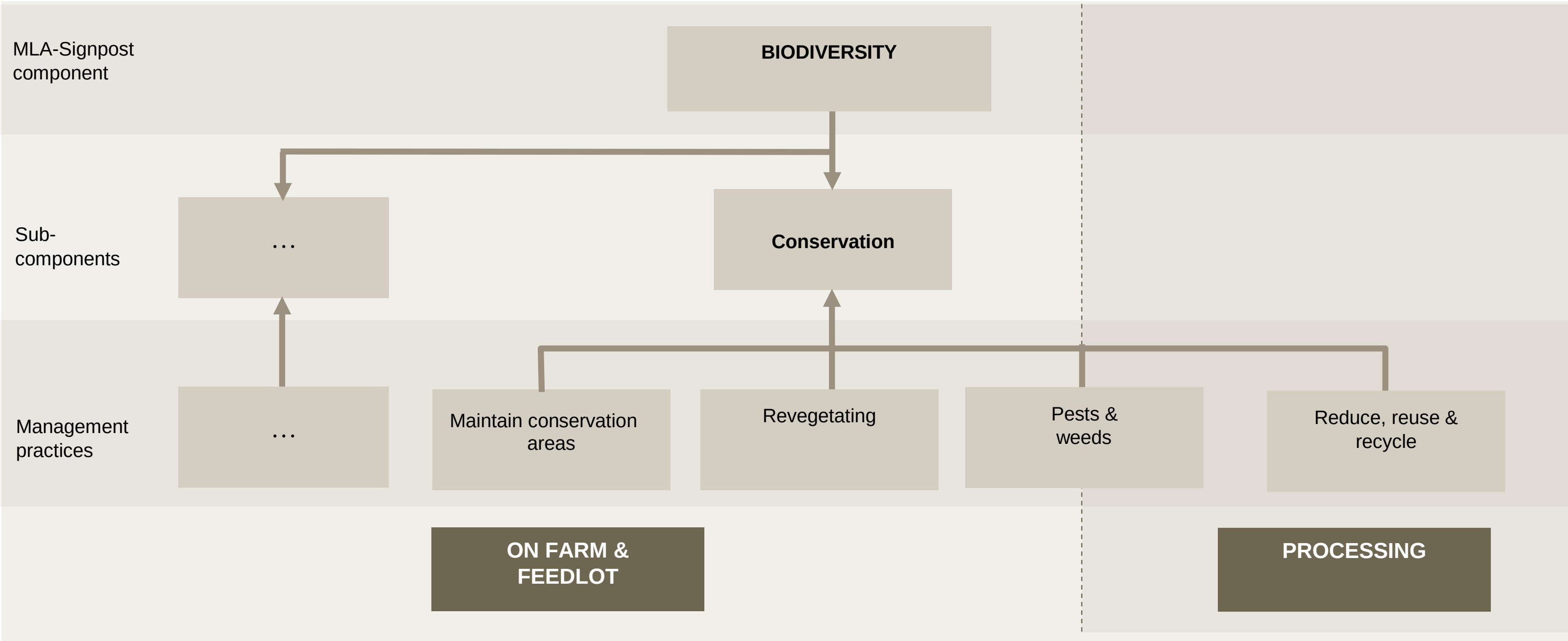
Source: Compiled by TheCIE, based upon the Signposts for Agriculture Framework.

A.2 **Mapping framework for Water component**



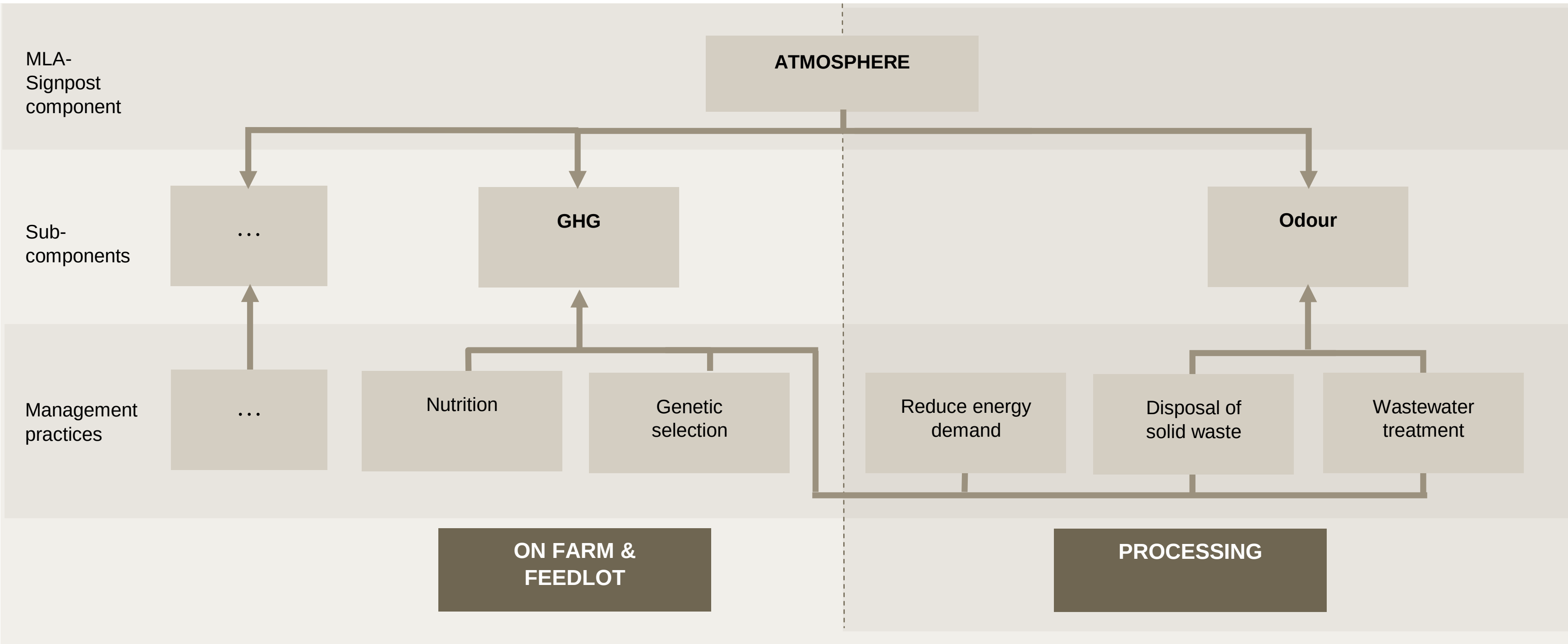
Source: Compiled by TheCIE, based upon the Signposts for Agriculture Framework.

A.3 **Mapping framework for Biodiversity component**



Source: Compiled by TheCIE, based upon the Signposts for Agriculture Framework.

A.4 Mapping framework for Atmosphere component

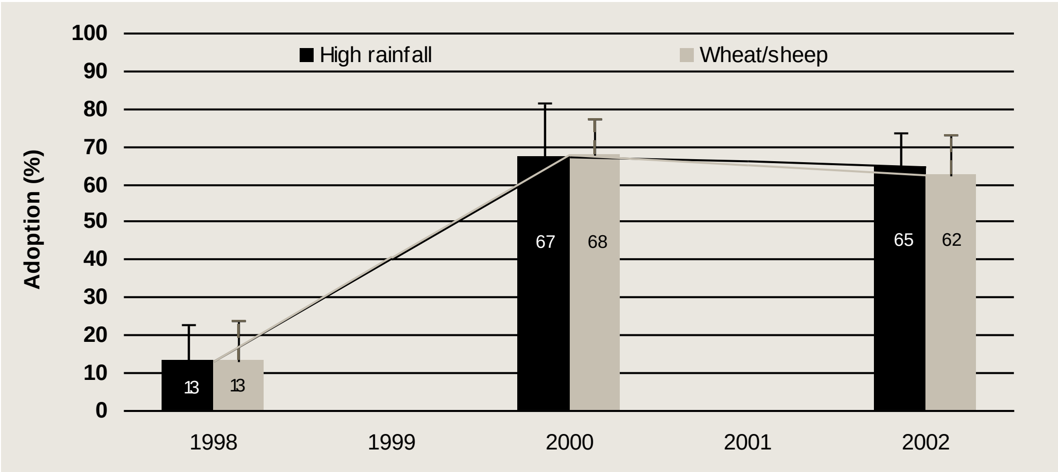


Source: Compiled by TheCIE, based upon the Signposts for Agriculture Framework.

B Adoption profile

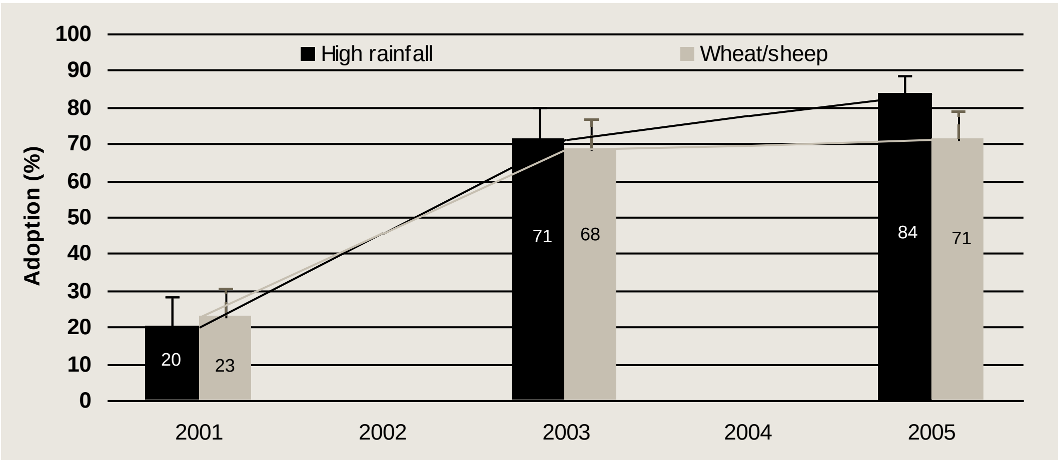
Charts B.1 to B.6 show the estimated adoption profiles for each of the management practices examined in this report (excluding contour banks which are shown in chart 2.4).

B.1 **Perennial pastures — adoption profile**



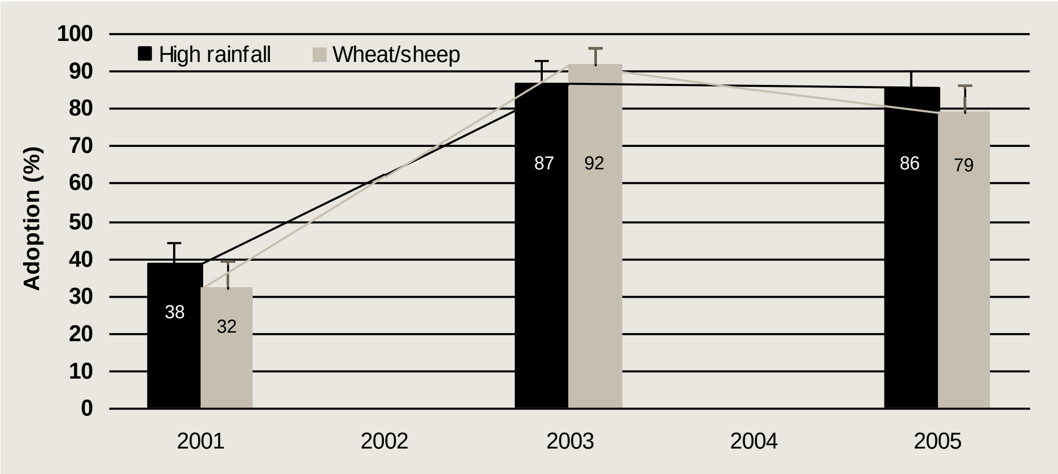
Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

B.2 **Permanent pastures — adoption profile**



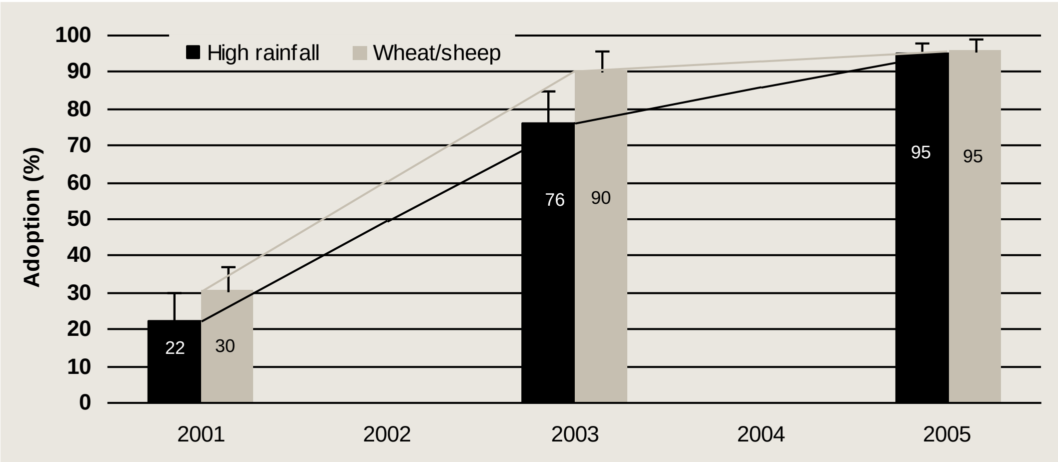
Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

B.3 **Soil tests — adoption profile**



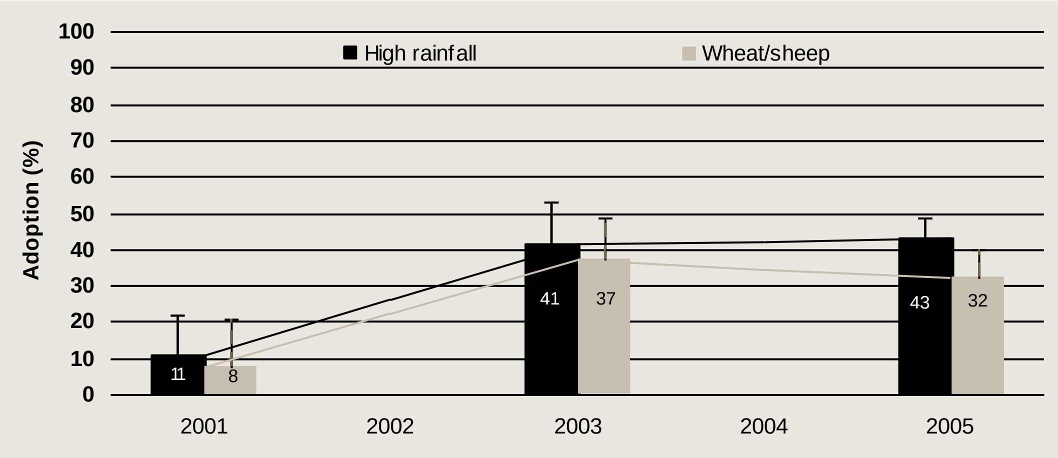
Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

B.4 **Drainage cover — adoption profile**



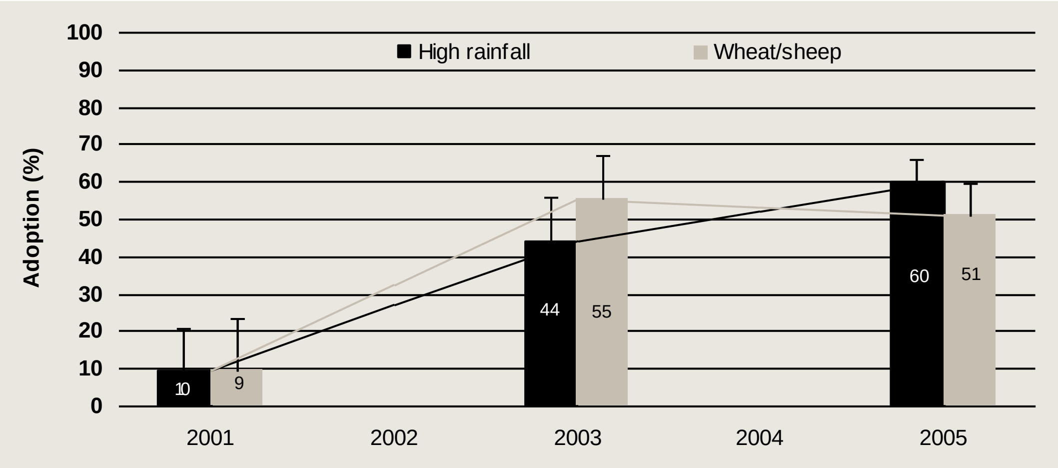
Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

B.5 **Excluding stock — adoption profile**



Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

B.6 **Piping water — adoption profile**



Data source: ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

C Data issues

As discussed in chapter 2, coverage of the existing surveys is across the broadacre region of Australian agriculture, which includes three zones: high rainfall (HRZ), pastoral and wheat–sheep. This available data required manipulation in line with this report's methodology by:

- exclusion of data from the pastoral zone; and
- modification of adoption rates due to differences in survey methodologies.

In the data provided from the 2001, 2003 and 2005 surveys, the pastoral sample is very small, which means that the sample is not necessarily representative of the population. For this reason, we have not been able to report the adoption profile for the pastoral zone.

Table C.1 summarises the changes that were made to survey data from various years.

C.1 **Adoption rates imputed and transformed from survey data**

Adoption rate	***Methodology and rationale***
'Permanent pastures' in 1998	Data not collected on permanent pastures, therefore, adoption rate for Perennial pastures used. This is considered a reasonable substitute given the similarity between the practices
'Drainage cover' in 2001	There was no specific management practice focusing on goundcover of drainage lines. Have therefore used the adoption rate for the broader 'Manage grazing to maintain groundcover' management practice from the 2001 survey.
'Excluding stock' in 1998	This question was only asked of Pastoral farmers. Pastoral farmers' adoption rate has therefore been used for both the HRZ and wheat–sheep zone.
'Piping water' in 1998.	This question was only asked of Pastoral farmers. Pastoral farmers' adoption rate has therefore been used for both the HRZ and wheat–sheep zone.
'Perennial pastures' in 1998	The original adoption rate was reweighted by perennials sown in response to dryland salinity using 2001 data to calculate weighting. The reason for the weighting is that the 1998 data on sowing perennials is not done so in response to dryland salinity, and may therefore overstate adoption when compared to later survey data, which asked the respondent whether perennials were sown in response to dryland salinity.
	Note, it assumed that we can sum the adoption of these two sowing of perennials because it is not likely that the same farmers will sow perennials in response to both acidity and salinity issues.

Source: TheCIE.

D Feasibility of signposts

In assessing the feasibility of using ABARE 1998-99 survey data, the same process as that which was undertaken in our preceding report will be used. The first step is to look at whether they ask the same questions about the same management practices.

Management practices

The ABARE survey data covers the majority of the management practices required:

- Piped bore water supplies for stock (as opposed to open drains) — pastoral properties only.
- Controlled grazing pressure (domestic livestock and pests) by excluding access to water — pastoral properties only.
- Soil or plant tissue tests to determine fertiliser or soil conditioner requirements.
- Dryland cropping using contour banks.
- Use deep-rooted perennial pasture species.
- Maintain vegetative cover along drainage lines.

These management practices, although they differ slightly from the management practices covered by other surveys, are sufficiently similar to be used for our purposes. The language is slightly different, but the management practice that the question is targeting is the same.

Questions

The ABARE survey asks: which of the following farm practices are part of your farm management program? For:

- farms in the pastoral zone
- farms in the cropping (wheat–sheep) and high rainfall zone
- dairy farms
- irrigation farms
- all farms.

Unlike the other surveys, the question about implementing the NRM practice is not asked in the context of a particular environmental issue. To be able to differentiate between those farmers that don’t use a management practice because there is no issue to be addressed, and those that simply haven’t adopted a relevant practice, an ‘X’ and ‘N’ is recorded respectively. We therefore need to adjust the adoption rate (yes) by the proportion of farmers for which the management practice is applicable (those that responded with either or yes or no).

Survey methodology

Responses to the 1998-99 survey of management practices were collected through personal interview. Given the type of survey, this shouldn’t have any impact upon the responses given by the farmers. However, face-to-face interviews typically have a better response rate than surveys conducted through mail or phone.

Table D.1 provides a summary of the sampling methodology of all data sources, which is an extension of table 3.5 from our preceding report.[13] As this table illustrates, the sampling methodology across all the surveys is very similar, and gives us confidence that the same population has been surveyed across the different surveys.

In constructing the 2005 survey (Axiom), care was taken to ensure that the two survey results are comparable; ‘…where the survey questions asked in the two surveys are the same, the results can be directly compared.’[14]

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[13] Centre for International Economics 2009, op cit, p. 21.

[14] Logan, J. 2005, *LPI Awareness & Adoption 2005 – Executive Report*, Prepared by Axiom Research for Meat and Livestock Australia Program Adoption and Awareness Survey, July.

D.1 **Summary of sampling methodology**

Survey	*Frame*	*Sample*	*Stratification*	*Comment*
ABARE (1998)	Business Register (ABS)		▪ Farm size ▪ Industry (ANZSIC[b]) ▪ Region (broadacre)	▪ Frame was reduced to only those farms with at least 100 sheep or 50 beef cattle ▪ Estimated value of agricultural operations greater than $22 500[a].
SGS (ABARE 2001)	Business Register (ABS) ▪ 31 972 producers	1632	▪ Farm size ▪ Industry (ANZSIC[b]) ▪ Region (broadacre)	▪ Frame was reduced to only those farms with at least 100 sheep or 30 beef cattle ▪ Estimated value of agricultural operations greater than $22 500[a].
Awareness (2003)	Solutions Rural database ▪ 90 000 producers ▪ 2000 producers were removed from frame to avoid the potential for heavy respondent burden.	800 ▪ North? ▪ South?	▪ Farm size ▪ Industry (ANZSIC[b]) ▪ Region (broadacre)	▪ Only Southern beef (and sheep) surveyed on management practices ▪ Quota sampling of strata employed
Awareness (2005)	Axiom's 'FARMbase' ▪ 73 592 red meat producers	907 ▪ Southern beef: n=321 ▪ Southern lamb: n=270	▪ Farm size ▪ Industry (ANZSIC[b]) ▪ Region (broadacre)	▪ Only Southern beef (and sheep) surveyed on management practices

[a] Australian Standard Industrial Classification, 1983 (ABS cat. No. 1201.0). [b] ANZSIC: Australian and New Zealand Standard Industrial Classification, 1993, (ABS cat. No. 1292.0].

Note: MLA Producer R&D awareness research (2003) and MLA Producer R&D awareness research (2005) abbreviated to Awareness (2003) and Awareness (2005) respectively; ND = not defined; MP = management practice.

Source: ABARE 2000, ABARE Farm Surveys Methodology, available online http://www.abareconomics.com/ame/lrm/
LRMMethod.htm; Hooper S, Rile C and Lubulwa C 2001, *Sustainable Grazing Systems (SGS) Survey*, ABARE, prepared for Meat & Livestock Australia; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption Research: Southern Producers Report*; prepared for Meat & Livestock Australia; Logan J 2005, *LPI Awareness and Adoption*, Axiom Research, prepared for Meat & Livestock Australia.

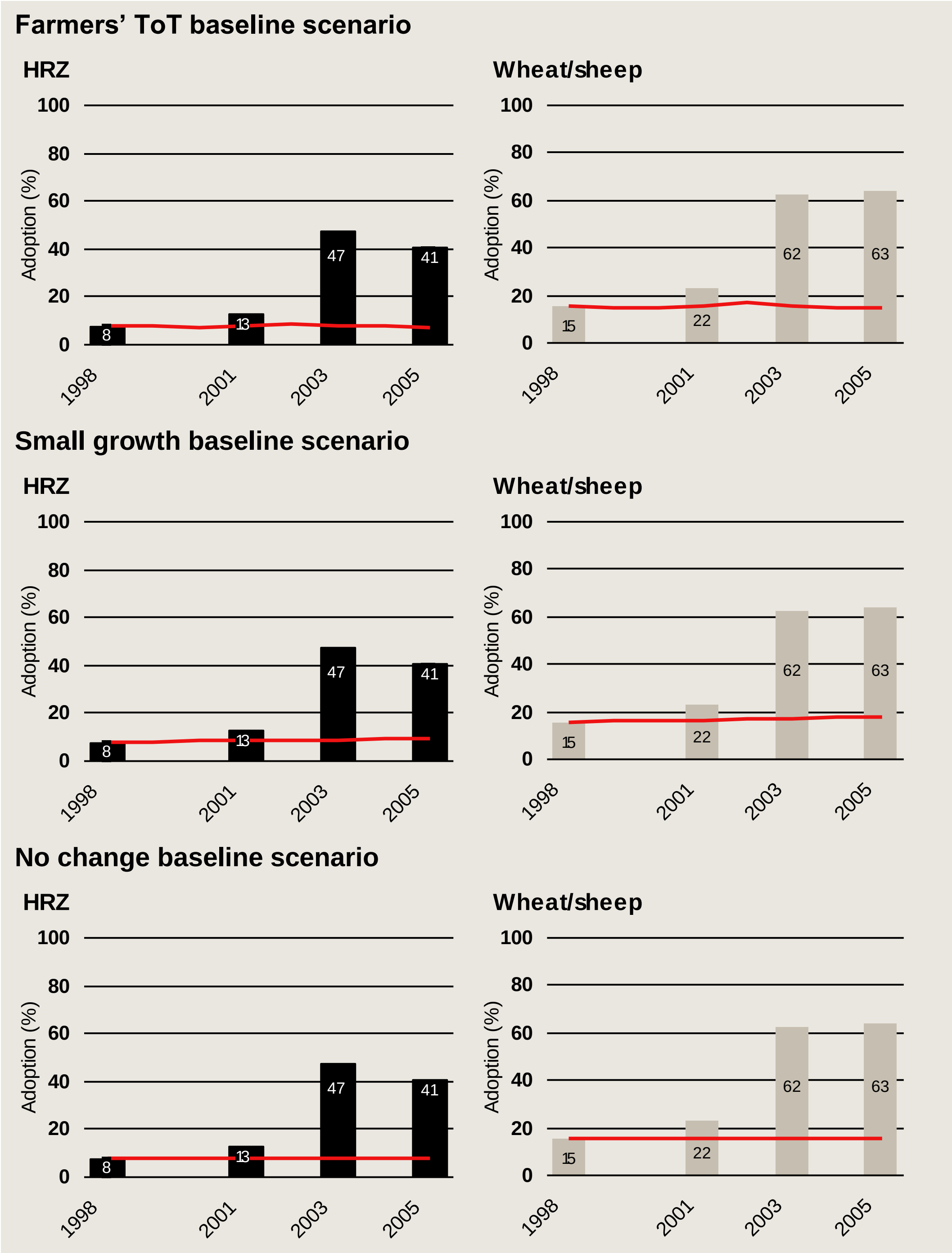
E Adoption and baseline profiles

Charts E.1 to E.7 sets out the adoption and baseline profiles for each of the:

- seven management practices
- three alternative baselines.

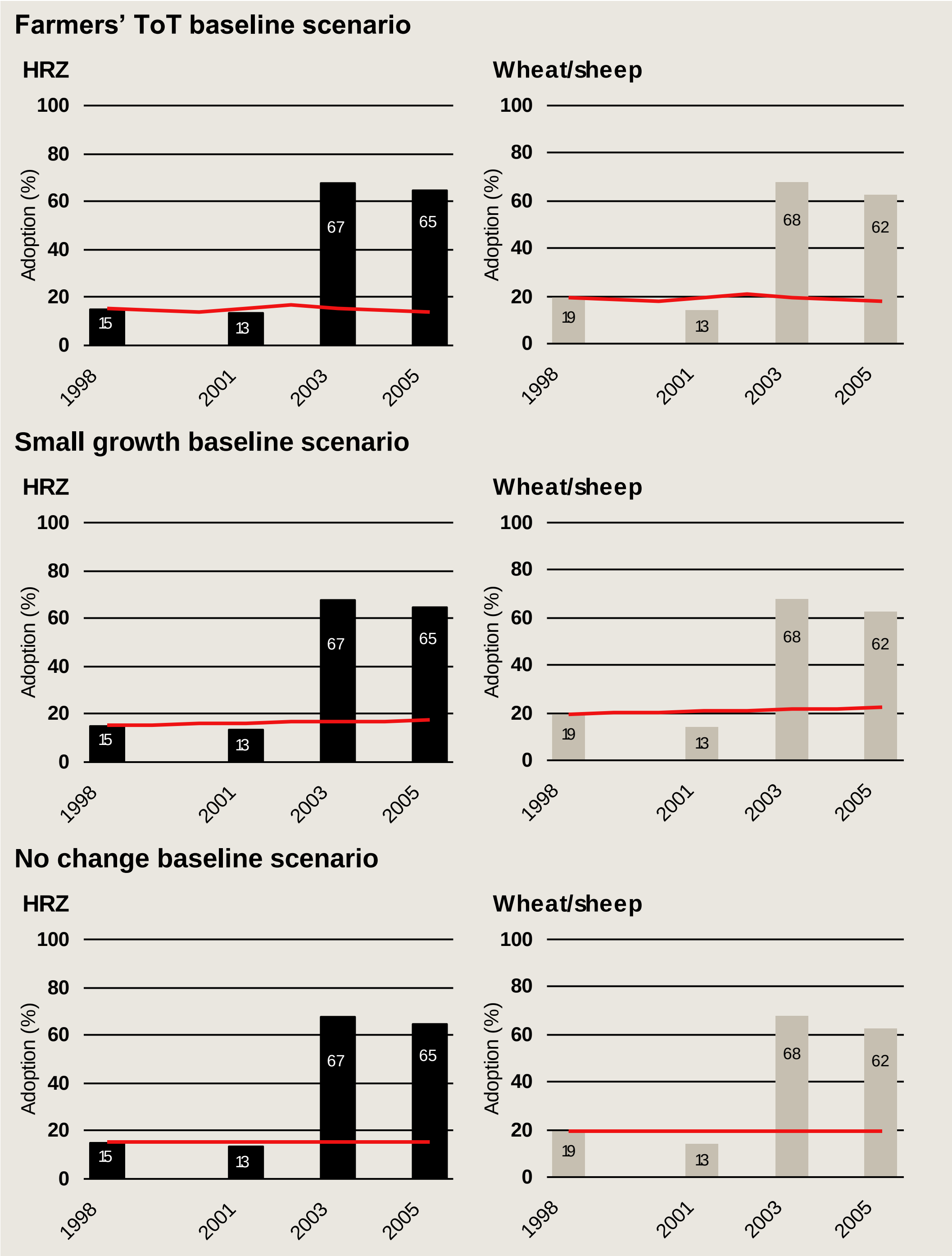
These charts correspond to charts in chapter 3 of this report.

E.1 **Contour banks — adoption and baseline profile**



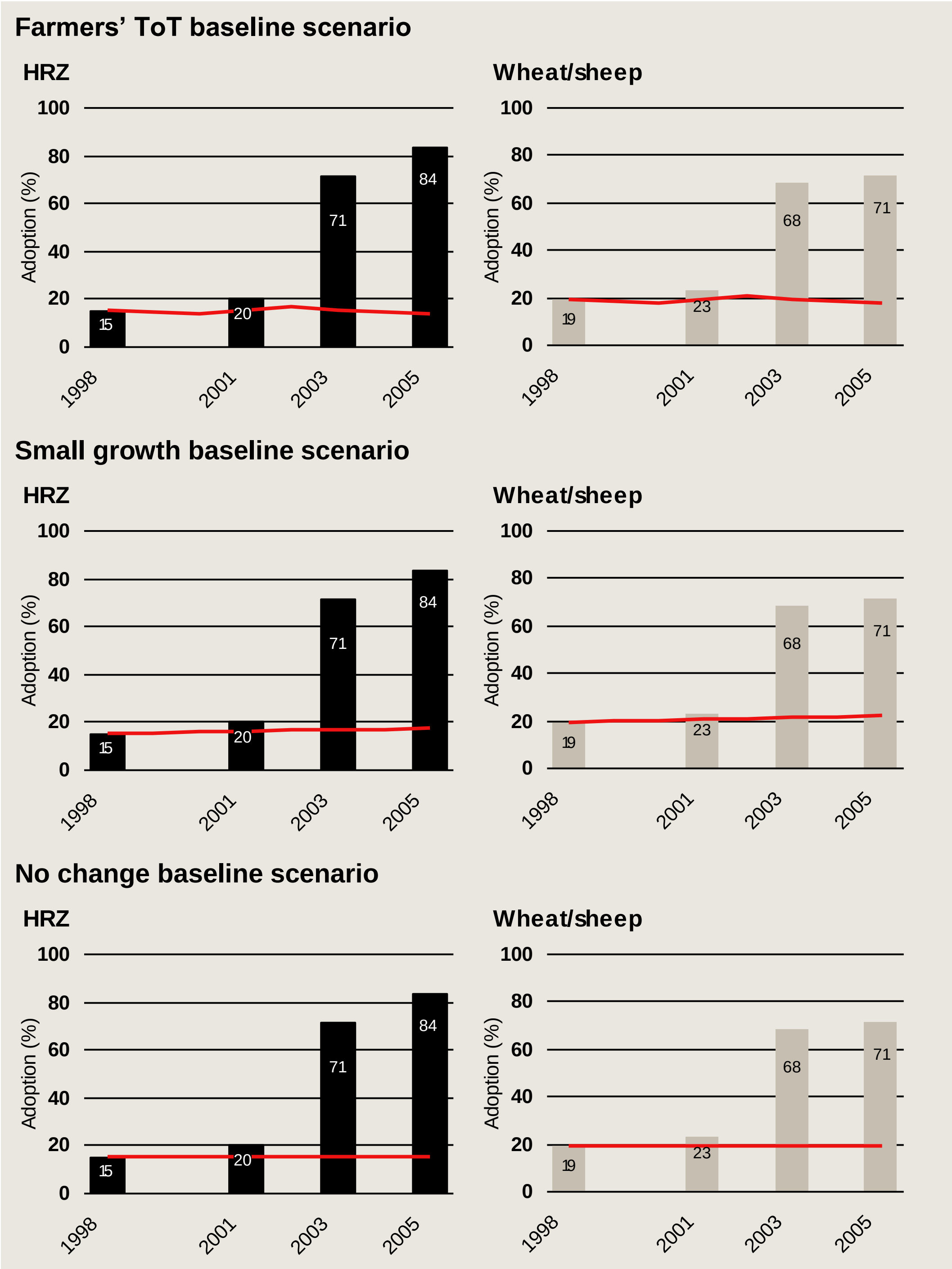
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

E.2 **Perennial pastures — adoption and baseline profile**



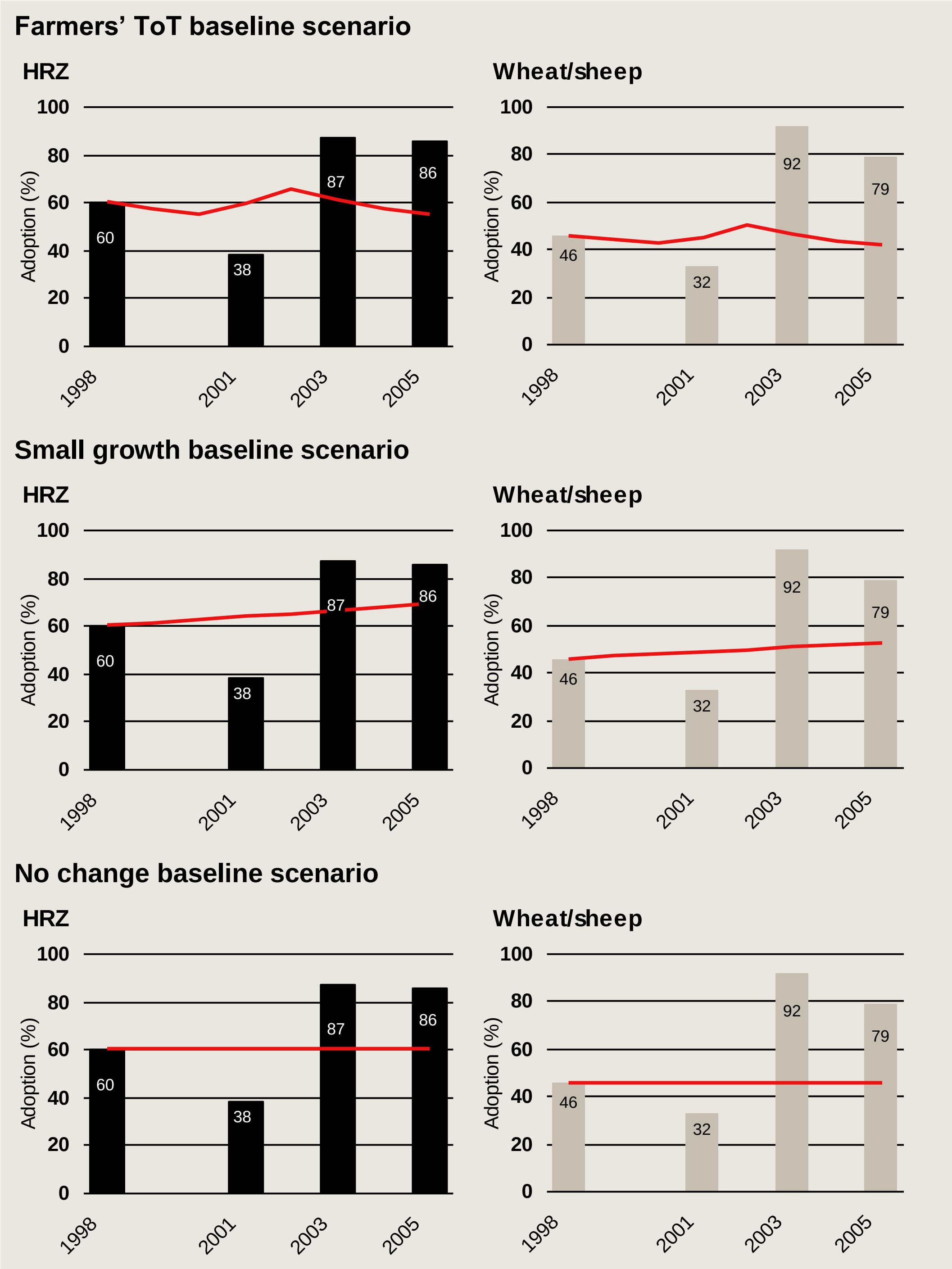
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; CIE calculations.

E.3 **Permanent pastures — adoption and baseline profile**



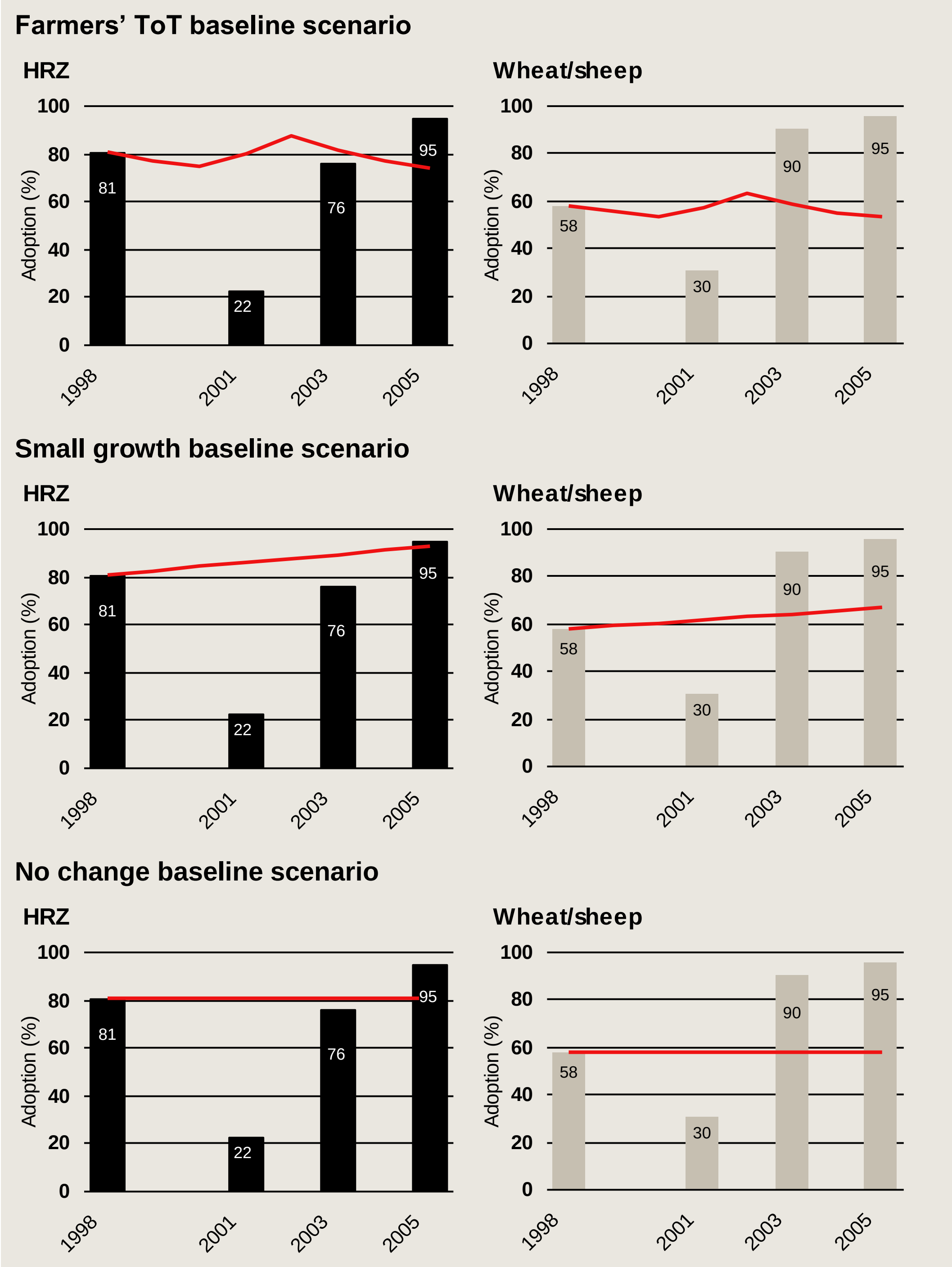
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

E.4 **Soil tests — adoption and baseline profile**



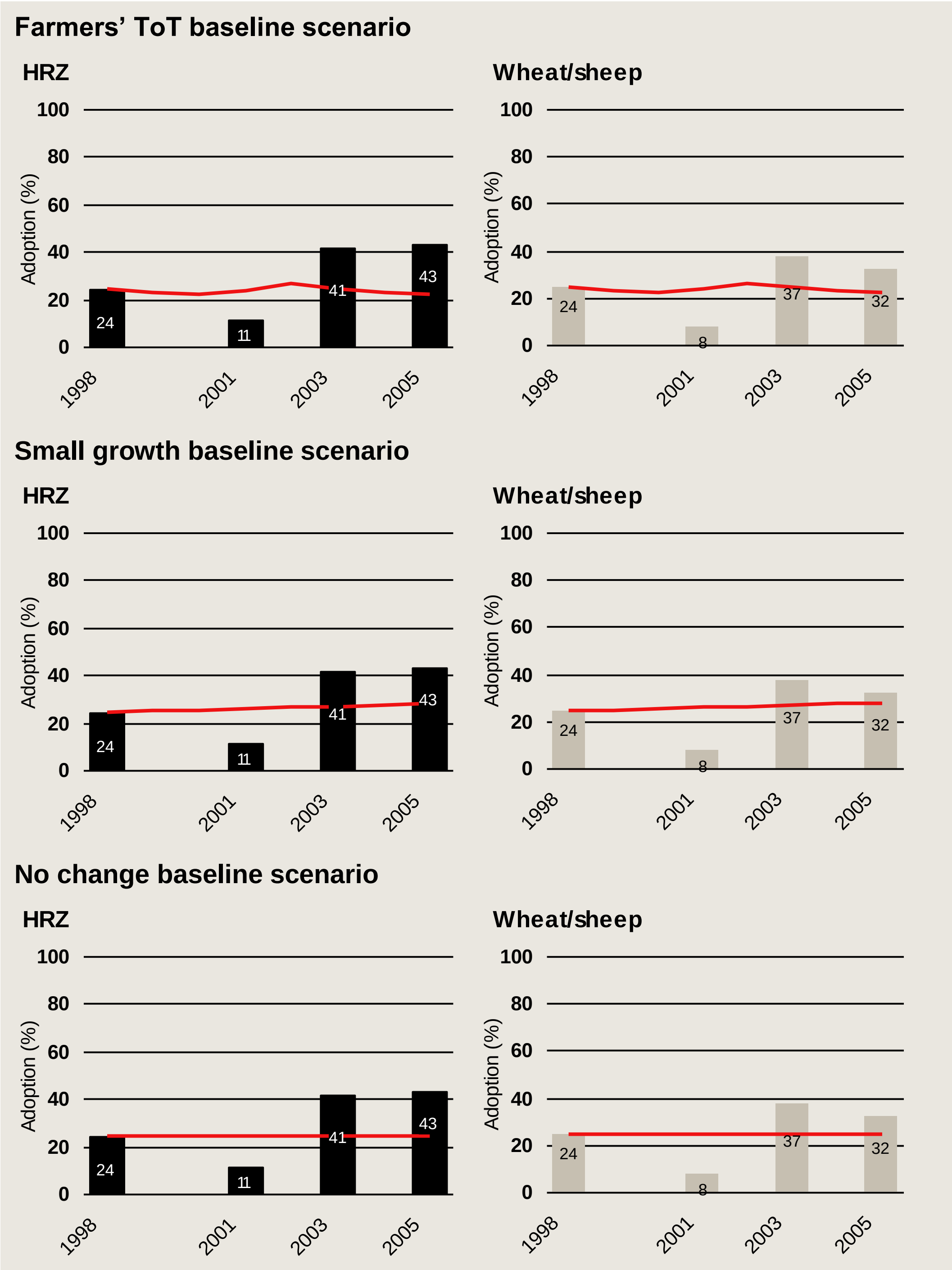
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

E.5 **Drainage cover — adoption and baseline profile**



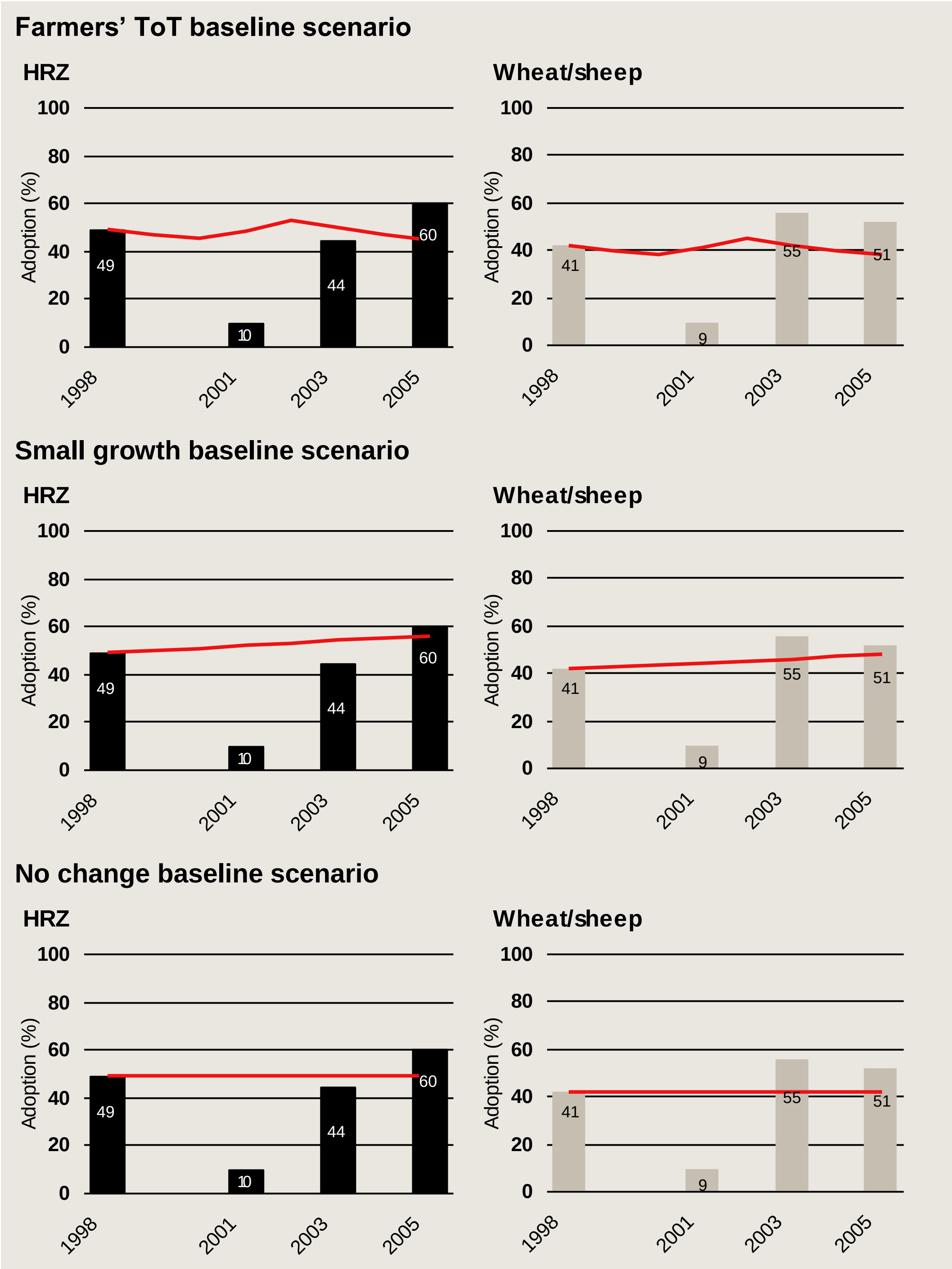
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

E.6 **Excluding stock — adoption and baseline profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

E.7 **Piping water — adoption and baseline profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

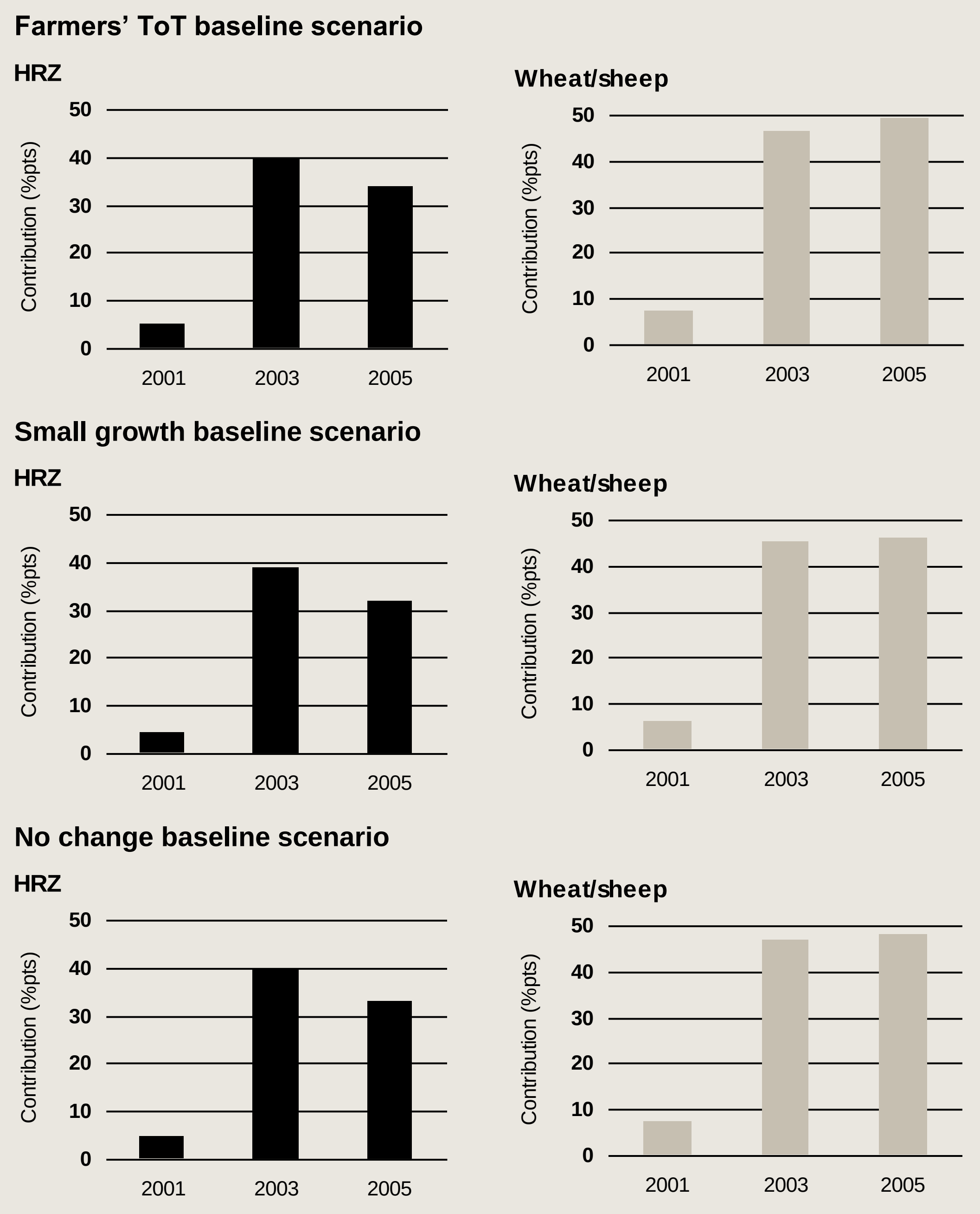
F MLA's contribution

Charts F.1 to F.7 set out the estimated MLA contribution for each of the:

- seven management practices
- three alternative baselines.

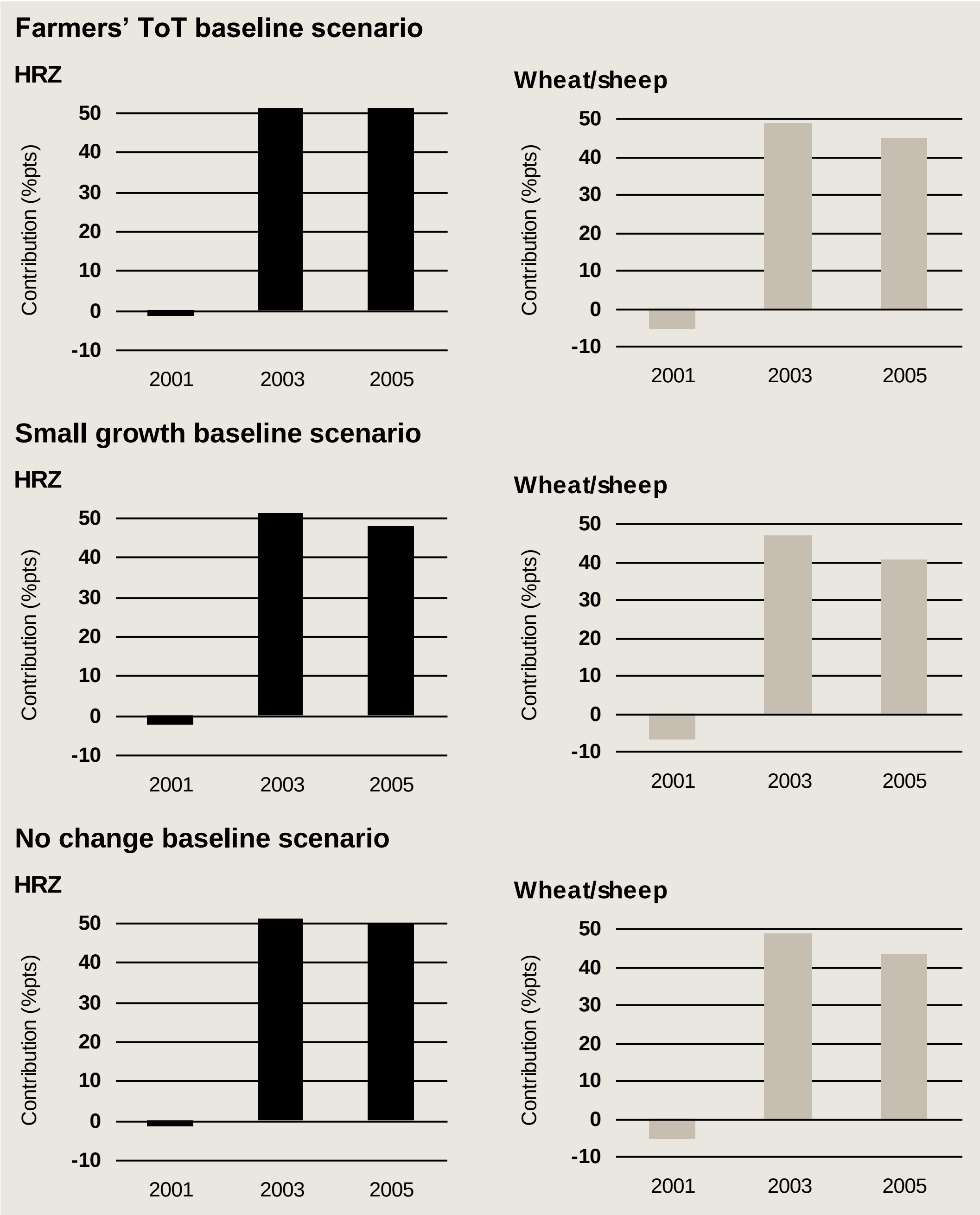
These charts correspond to charts in chapter 3 of this report.

F.1 **Contour banks — contribution profile**



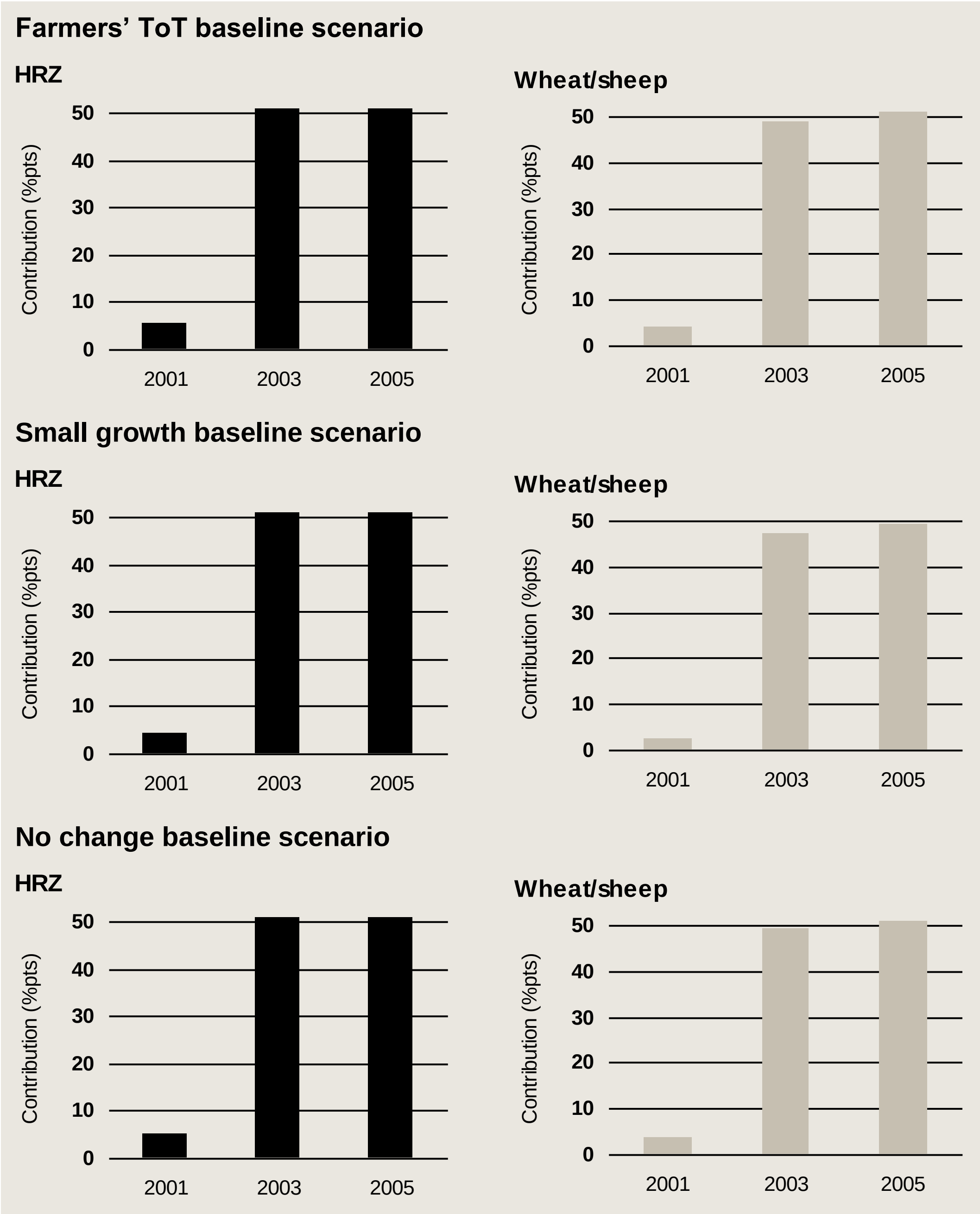
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.2 **Perennial pastures — contribution profile**



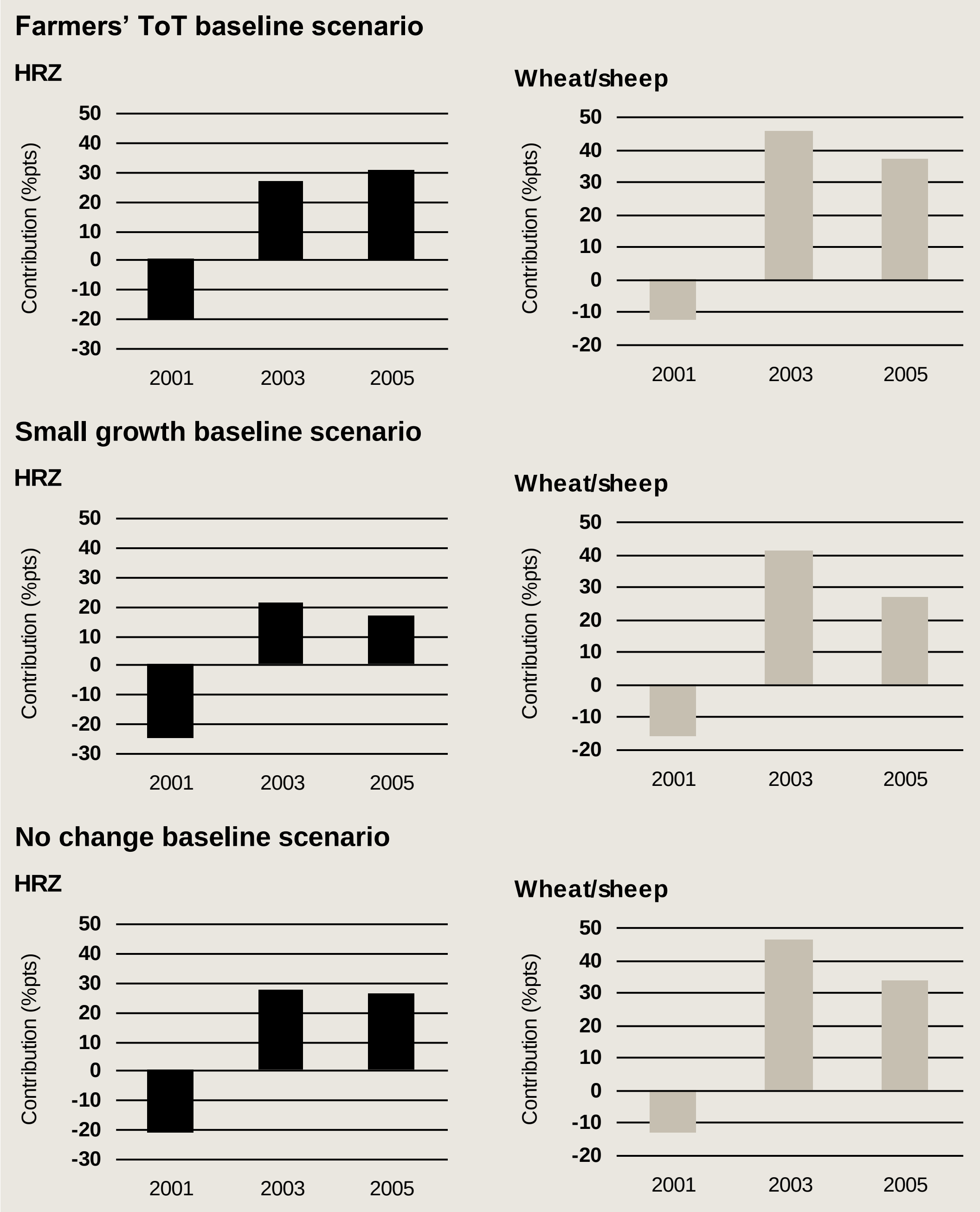
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.3 **Permanent pastures — contribution profile**



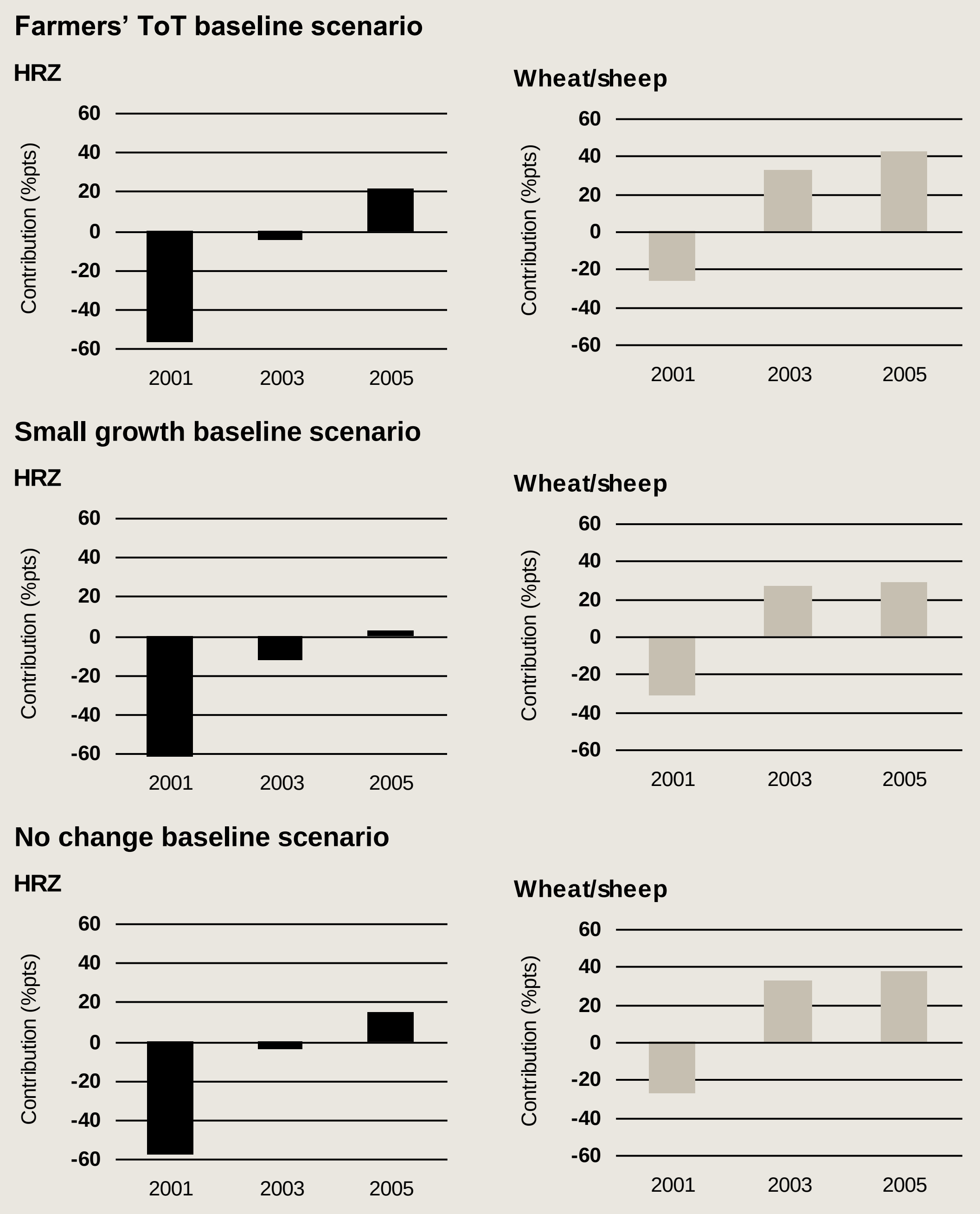
Data source: ABARE 2008, ‘Farmers’ Terms of Trade Index’, *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.4 **Soil tests — contribution profile**



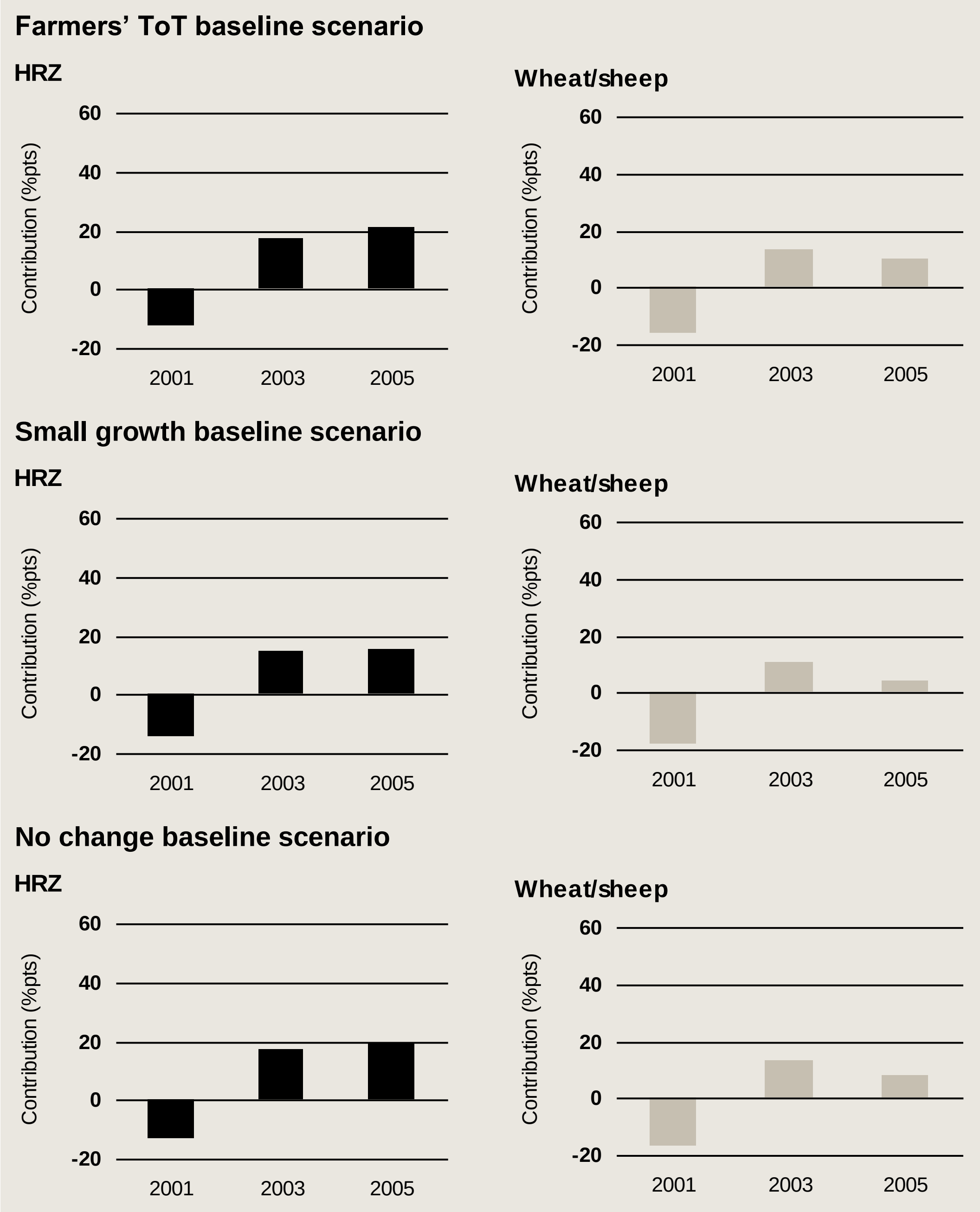
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.5 **Drainage cover — contribution profile**



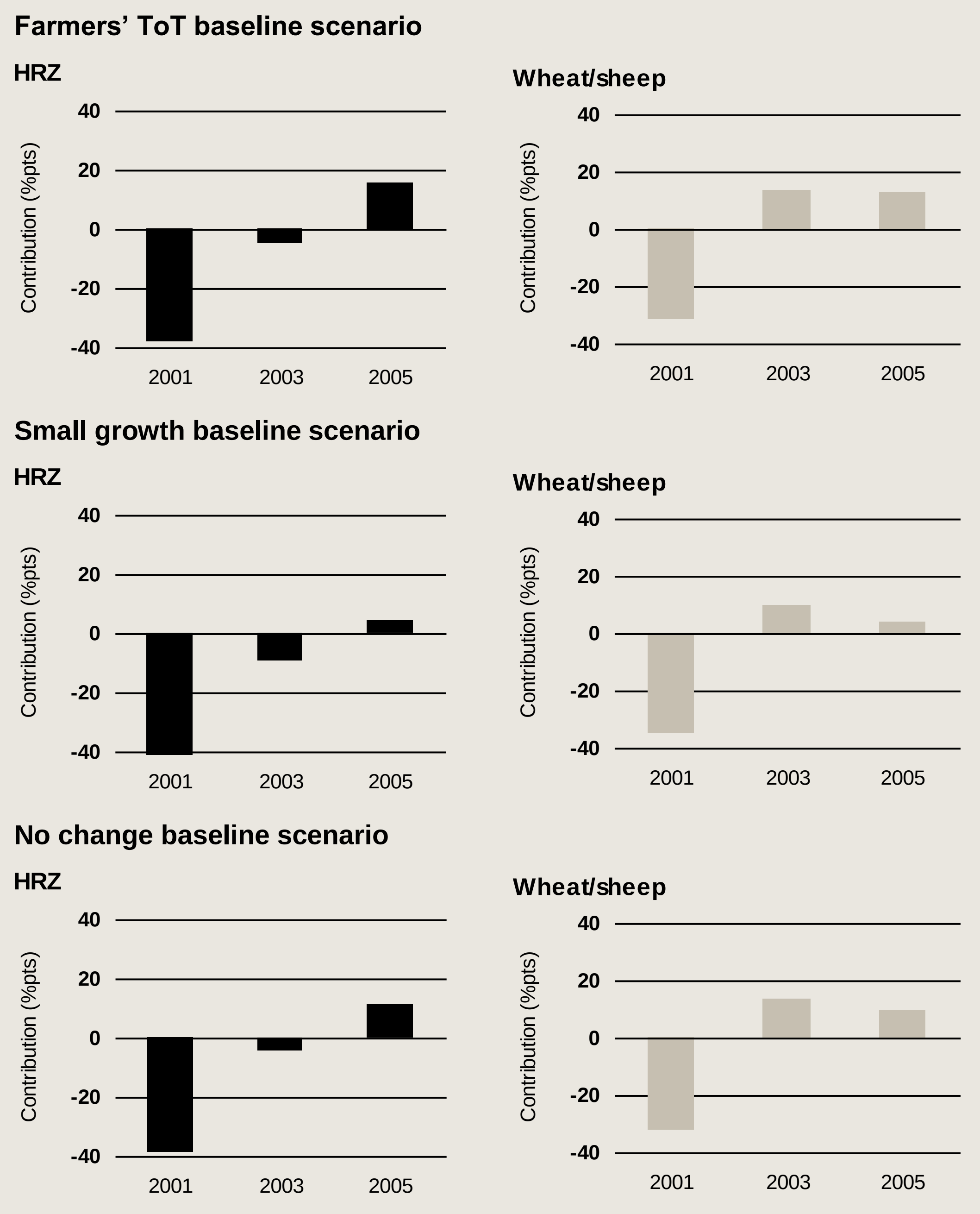
Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.6 **Excluding stock — contribution profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.

F.7 **Piping water — contribution profile**



Data source: ABARE 2008, 'Farmers' Terms of Trade Index', *Australian Commodity Statistics*, table 17, p. 17; ABARE 2000, *1998-99 Natural Resource Management Survey*; ABARE 2001, *Sustainable Grazing Systems (SGS) Survey*; Solutions Marketing and Research 2003, *Producer R&D Awareness and Adoption*; Axiom Research 2005, *LPI Awareness and Adoption*; and CIE calculations.