

SYDNEY'S
AGRICULTURAL
LANDS
AN ANALYSIS

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Abbreviations

ACRONYM	Full Name
ABN	Australian Business Number
ABS	Australian Bureau of Statistics
ABR	Australian Business Register
CALD	Culturally and Linguistically Diverse
EVAO	Estimated Value of Agricultural Operations
GIS	Geographic Information Systems
GST	Goods and Services Tax
LGA	Local Government Area
RIRDC	Rural Industries Research and Development Corporation

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EXECUTIVE SUMMARY

As indicated in the 2005 Metropolitan Strategy and subsequent 2007 Draft Sub-regional Strategies, comprehensive data on Sydney's agricultural lands are key to effective planning on Sydney's urban fringe. With the five year review of the Metropolitan Strategy in 2010, the need for relevant data is even more pressing. Despite the need for clear and coherent data, however, previous studies of Sydney's agricultural land have consistently failed to create a coherent picture of Sydney's agricultural industry and its changing nature and extent.

To examine the state of knowledge on the area, number and value of Sydney's farms in more detail this paper undertook an historical analysis of ABS and non-ABS reports on the Sydney region, including the LGAs of Gosford and Wyong, from 1992 to 2009. This report illustrates that the current debates around the value and size of Sydney agriculture can be traced to concerns about the perceived undercounting of Sydney Agriculture in the ABS agricultural census. While the ABS is widely acknowledged as the most reliable source of data on Australia's agricultural industry in general this has not been true in relation to Sydney's agriculture. Since at least the early 1990s the validity and reliability of ABS census findings for small scale agriculture that takes place around urban areas have been brought into question by many non-ABS reports. Disappointingly low ABS estimates of the area and number of farms and of the value of the Sydney fresh vegetable industry, in particular, have been pointed to as evidence of ABS data inaccuracy. Characterised by small scale farms run by culturally and linguistically diverse groups, Sydney's vegetable farms have been seen to belong to a class of agriculture – peri-urban farming – which has been systematically under-recognised by an ABS data collection methodology focused on broad scale agriculture. The perceived undercounting of Sydney agriculture by the ABS agricultural census resulted in the development of numerous non-ABS reports seeking to readdress the apparent data gap.

The non-ABS reports had an important role in improving the accuracy and reliability of ABS collection data for Sydney, leading to a substantial increase in ABS estimates on the value, area and number of Sydney farms. Changes made to the ABS collection methodology in the 2005-6 agricultural census saw a significant shift in results between the 2000-1 and 2005-6 ABS agricultural census findings. The capture of a larger number of small farms because of the revised methodology led to substantial increases in estimates of the area and number of Sydney farms in 2005-6. That this increase in area and number of farms was particularly evident in the vegetable industry indicates that many small-scale, culturally diverse Sydney farms had indeed been left out of previous ABS census surveys. Furthermore, our report indicates that confidence in post-

2005-6 ABS data collection techniques relies substantially on the independent report by Malcolm and Fahd (2009). The non-ABS reports have contributed to much-needed debate on the accuracy of data on Sydney's agricultural lands and have provided important qualitative understandings about what actually goes on across these lands.

This report also highlights, however, the need for more up-to date and methodologically consistent data on the area, number and location of Sydney's farms for land use planning. Our analysis indicates that data from the majority of non-ABS reports should be used with caution due to definitive figures on agricultural land use and value due to methodological and technical limitations. One key issue is the specificity of data-sets due to methodological differences and the resulting lack of comparability between reports for longitudinal analysis. Another concern is that the failure to clearly outline the methodologies, data sources and the bases for various calculations, also make it difficult or impossible to now verify or reproduce the results from many reports. As a consequence of this lack of transparency, it has been difficult for policy makers and industry groups alike to have confidence in many of the estimates produced or for longitudinal analysis to be undertaken. Differences in their estimates have led to conflicting accounts of, among other things, the relative decline or durability of the agricultural industry and of its composition. Data disparities highlight the importance of transparent and replicable methodologies for up to date, reliable data on Sydney agriculture.

In examining the reliability of the various data source and estimates, the principal finding of our analysis is that, contrary to popular criticism, ABS statistics from the 2005-6 agricultural census provide relatively trustworthy data on Sydney Basin agriculture. The improved accuracy of ABS data is demonstrated by compliance between updated 2006-7 ABS census statistics and the results of the most recent non-ABS ground-truthed study of Sydney Basin vegetable farms by Malcolm and Fahd (2009). Our report confirms current ABS data as the most consistent and comprehensive data set on agriculture in the Sydney Basin. It does however indicate that much research still needs to be done to provide a comprehensive picture of the state of Sydney agriculture.

As a result of the problems identified in both non-ABS and ABS data-sets, the report indicates that the question of the area of land under agricultural production in Sydney has yet to be satisfactorily answered. This is a critical data gap as it speaks to questions of productivity and land use and potential future requirements for the industry. The report does, however, point to a number of trends and issues in Sydney agriculture that

will be provide a useful guide in planning for its future. These trends includes evidence that Sydney agriculture is increasingly intensive in nature while at the same time decreasingly soil reliant. While the exact amount of land under production is not known, the changing nature of Sydney's agricultural industry suggests that the key planning issue may no longer be the preservation of prime agricultural land per se but rather the absolute amount of land available for agricultural production. The report's findings indicate the dynamic and adaptive nature of Sydney's agricultural industry and provide additional options for urban planning beyond the housing versus farmland debate. These findings also, however, emphasise the need for more detailed data on Sydney agriculture. This is particularly in the area of land actually under agricultural production to provide more accurate picture of the state of Sydney agriculture. The report also indicates the need for attention to, and further research on, the future economic, and social, viability of Sydney farms to compliment the necessary research into land use.

In confirming the improved reliability of the ABS agricultural statistics for Sydney our report indicates that the post-2005-6 ABS statistics should be supplemented by remotely sensed data and ground truthed collection and surveys. The commissioning of complementary information collection is important for two reasons. The first is that such exercises can provide an important accuracy check for ABS data on Sydney. The second is that the use of GIS technology, remote sensing and ground truthing in non-ABS surveys can also provide detail of the location and size of area under production and thereby provide more conclusive information for planning purposes than currently offered by the ABS census. Conducting complementary surveys and data collection exercises can improve understandings of Sydney Basin agriculture and allow for the development of longitudinal data sets to determine long term trends. Such detailed longitudinal data are vital for planning for Sydney's agriculture into the future.

SYDNEY'S AGRICULTURAL LANDS: AN ANALYSIS

Along Australia's east coast the growth of cities such as Sydney has seen the spread of houses into the semi-rural lands on the urban fringes. This process of peri-urbanisation has created concern about the future viability of the agricultural industries in these areas and their contribution to urban economies and food supplies (Low Choy et al. 2008). Yet while there is now a rising public interest in the food production capacity of these peri-urban regions, urban agriculture has been historically overlooked in both urban planning and agricultural policies. Alongside a prevailing view that agriculture in Australia existed primarily in the 'interior', farming in and around urban regions has largely been considered an insignificant and transitional land use (Kennedy 1993; Knowd, Mason & Docking 2005). A consequence of this apparent neglect of urban agriculture has been a failure to collect comprehensive and reliable up-to-date data on the nature, volume and value of agriculture in these regions. In the case of the Sydney region's agricultural lands, which include the LGAs of Gosford and Wyong (see Figure 1), on which this report focuses, the current body of knowledge is piecemeal and contradictory, and presents only an incomplete picture of the industry. The lack of accurate data makes it difficult to plan for the future of agricultural lands in the Sydney region.

This report assesses the available data and information on the number of farms, area and economic value of Sydney's agricultural lands by reviewing the findings and limitations of existing studies. In comparing and contrasting the conclusions of various ABS and non-ABS reports, this report traces the development of knowledge about Sydney's agricultural industry. It also seeks to identify, from the perspective of current innovations in technology and expanded data sources, which findings provide reliable data for use in planning processes, and which findings may now need to be revised.

The review and analysis comprises of three stages. In the first section this paper offers an analysis of ABS data from 1992 to 2008 as the first stage of the review of existing knowledge on Sydney agriculture. This section outlines the data provided by the ABS agricultural survey and reveals that the ABS data have much to offer in generating a more holistic picture of the current state of Sydney's agricultural lands. The analysis also examines the criticisms that have been made regarding the accuracy of ABS data and indicates the caveats that should be applied to any use of ABS data, especially for longitudinal analysis.

The second section outlines the principal reasons for the contested state of knowledge about Sydney's agricultural lands. As the section explains, this contestation stems primarily from the claim that ABS statistics represent an undercount of Sydney agricultural activity. Arguably, it was

this claim of ABS inaccuracy which led to the development of numerous alternative non-ABS reports on the state of Sydney's agricultural industry. Following the release of these non-ABS reports, published by various groups including the NSW Department of Primary Industries (previously NSW Agriculture) and consultant and academic groups, the ABS data collection methods were changed resulting in a post 2005-6 increase in ABS estimates of the number, size and value of Sydney's small-scale peri-urban farms. The various and often disparate methods and findings of many of these non-ABS reports, however, have also fuelled debate around the size and value of Sydney's agricultural land.

The third stage of this paper examines non-ABS reports on Sydney agriculture from 1993 to 2009 as the second part of the review of existing knowledge. In this section an analysis is made of the clarity and transparency of the methodology used in each report in order to assess the validity and reliability of their findings. To allow for ease of examination, each of the reports is described in terms of aim, method, findings and limitations. In assessing the limitations of each report, the extent to which these findings can be compared against those of other reports is also examined. As a consequence of the different methodologies utilised it is argued that many findings cannot be used to construct a longitudinal analysis of trends in Sydney's agricultural industry.

Analysis of ABS and non-ABS reports on Sydney agriculture in this paper brings into question both pre-2005-6 ABS and certain non-ABS data sets that have featured within debates over Sydney's agricultural land. While the non-ABS reports appeared to have played a pivotal role in improving the accuracy and reliability of ABS collection methodologies in relation to small-scale peri-urban agriculture, our analysis identifies a critical gap of reliable data on the area, number and location of Sydney's farms that still needs to be addressed. In the face of piecemeal and inconsistent approaches to measuring and mapping Sydney's agricultural land, however, there are a number of non-ABS reports that offer a certain level of reliable comment on the state of Sydney's agricultural industry. In addition to providing detailed ground-truthed data on Sydney's vegetable farms, Malcolm and Fahd's (2009) recent research challenges established knowledge in arguing for the accuracy of current ABS data. Our analysis in this paper also reveals, however, that the continuing data gap, including the lack of longitudinal data, requires a more consistent, methodologically sound approach to identifying Sydney's agricultural lands over time. The production of comprehensive, reliable and longitudinal data is critical if we seek to understand long term trends in Sydney's agricultural industry and what can (or should) be done in planning for its future.



Figure 1: The Sydney Region by Local Government Area¹

¹ Sydney's agricultural land, in the context of this paper, comprises of the area on the metropolitan fringe utilised for agricultural production. The greater Sydney Metropolitan area, outlined in Figure 1 according to Local Government Area (hereafter LGA), is defined in this report according to the ABS definition. It is bounded by Wollondilly LGA in the east, the Blue Mountains LGA in the west and Gosford and Wyong LGAs in the north.

SECTION ONE: ABS DATA

This section provides a detailed analysis of the findings and limitations of ABS agricultural census data from the 1992-3 to the 2007-8 censuses. ABS agricultural census data represent the only data set on Sydney agriculture that has been gathered by the same organisation over a long time period. The agricultural census comprises of a survey to every business the ABS determines to be an agricultural enterprise. It is now taken every five years with sample surveys in the intervening years to update findings (Australian Bureau of Statistics 2007). It is from the findings of these surveys that the ABS generates data on the area, value and quantity of Australian agricultural production.

The ABS agricultural census covers land uses and production data across a large range of agricultural enterprises. The measurements of land uses include area of holding and the area under production of individual crops. The ABS uses this commodity data to produce estimates on the value of agricultural production. This production and land use data is available at different scales, including state, statistical division and statistical local area. Information on inputs to production such as water and fertiliser are also collected and disseminated through this process. Estimates on agricultural employment are not included in this census but are derived from the ABS population census data.

There are certain aspects of the ABS methodology, however, that bring into question the usefulness and reliability of ABS statistics in drawing conclusions about the state of Sydney's agricultural lands. These include the way in which land use is measured; the margins of error given for statistical inferences; and changes over time in the ABS agricultural survey collection methodology. These concerns and the implications they have for the use of ABS statistics on Sydney agriculture are considered below.

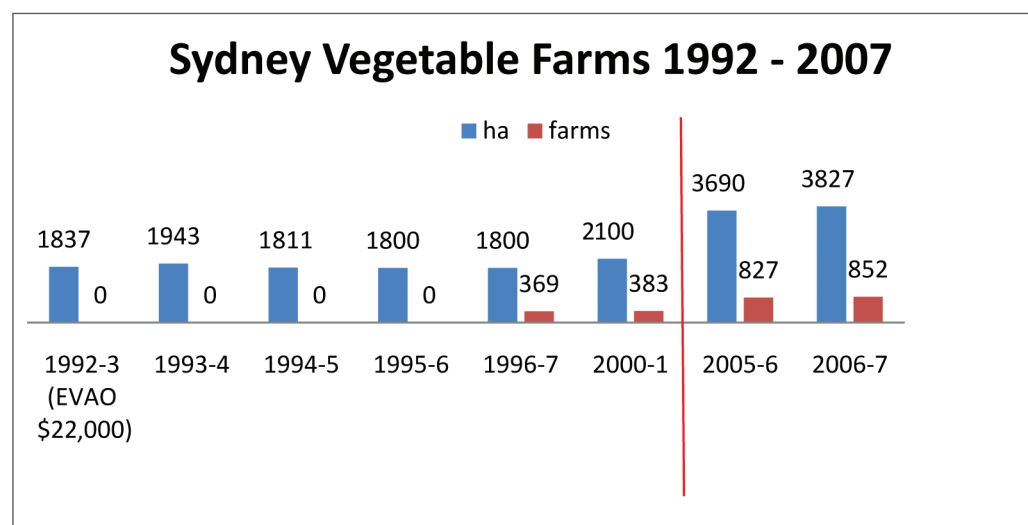
One potential problem with the use of ABS data on the spatial area of Sydney's agricultural land is that ABS data on land use does not always correlate to the physical area in hectares of land in farming. Malcolm and Fahd (2009) argue that in some instances and particularly for intensive horticulture, that the ABS data often represent a 'double-counting' of actual farmland and therefore cannot be taken as an accurate representation of the physical area being farmed in Sydney. There is validity to this argument. Analysis of ABS methodology indicates the ABS actually provides two sets of data under the category of land use, due to a two part method of counting farmland. The first method of counting is the 'area of holding', representing the number of physical hectares of farmland. The second form of counting is the 'area under crop'. In contrast to the physical area of farms, this count refers to how many hectares are farmed of a particular crop; for example, tomatoes. As one

physical hectare can be planted with a number of different crops (for example tomatoes, lettuce and cucumber) over a year, the estimated area under crop can be much larger than the physical area of farms. Different plantings on the one hectare can in effect be counted as 2 or 3 hectares of farmland. This variation in counting methodology means that the different land use estimates of 'area of holding' and 'area under crop' should not be directly compared in analysing changes in land use over time.

A further qualification of ABS figures on agricultural land use involves the measurement of 'area of holding'. While the 'area of holding' represents the only ABS data that indicate physical hectares of farmland, it actually represents the total area of each farm property. This means that the estimate of farm or 'holding' in hectares may include land assigned to houses or other non-productive land within the farm boundaries. In broad-acre farming this is probably not a great concern given the relatively small size of houses compared to total property size. For small scale farming in the Sydney Basin, however, measuring an entire farm including non-productive areas is likely to lead to a substantially higher estimate of land area than a measurement of area under actual production. This difference in methods of measuring agricultural land also means that direct comparisons cannot usefully be made between non-ABS studies which measure area under production and ABS 'area of holding' estimates. Effectively there are no ABS data that reliably indicate the exact number of physical hectares under agricultural production in a region.

Another aspect that should be considered in the use of ABS data is the large statistical errors attached to a number of ABS estimates for Sydney agriculture. These error margins range from between 10%-25% to between 25%-50%. Data with error margins beyond 50% are presented with a cautionary note that the estimates should not be relied upon. Obviously as sample sizes vary so do the ranges of possible errors. The fact that the ABS indicates the possible errors for certain estimates, however, arguably increases the reliability and validity of ABS findings.

Finally, a further problem raised about the use of ABS data for longitudinal analysis has been changes over time in ABS collection methodology (Kelleher, Chant & Johnson 1998). In particular, changes in methodology have affected which farms have been included in ABS counts. Two changes have occurred in the period under study, the first in the 1993-4 census and again in the 2005-6 census. Prior to the 1993-4 agricultural census the minimum estimated value of agricultural operations (hereafter EVAO) for an agricultural enterprise to be included in the survey fluctuated up and down. In 1992-3

Figure 2: Sydney Vegetable Farms 1992-2007²

Source: Urban Research Centre calculations from ABS data (1994, 1995, 1996, 1997, 1998, 2003, 2008a, 2008b, 2008f)

the minimum EVAO for inclusion was \$22,000 per financial year. From the 1993-4 agricultural census, however, the EVAO base rate has been fixed at \$5000, meaning that agricultural enterprises earning over that amount would be counted. The lower EVAO from 1993-4 meant that the agricultural census was more likely to include smaller scale horticultural businesses like those on Sydney's fringe.

In 2005-6, in a response to continued criticisms about the perceived undercounting of small farms, the ABS made further changes to the way in which the ABS counted agricultural enterprises. Rather than draw its farms only from the ABS database of agricultural enterprises, based primarily on land ownership, the 2005-6 agricultural census drew on the Australian Business Register (ABR) for its list of farms. The ABR lists all businesses with Australian Business Numbers (ABNs). While only businesses that earn over \$75,000 are required to be listed on the ABR, as they must register for an ABN to pay Goods and Services Tax (GST), many other smaller businesses also register for ABNs and so appear on the ABR as well. This change represents a further break in ABS data collection methodology making comparisons between pre- and post-2005-6 ABS data highly unreliable.

The consequence of these changes in ABS definition and collection methodologies is that they hinder longitudinal analysis of Sydney agriculture using ABS data. Yet the

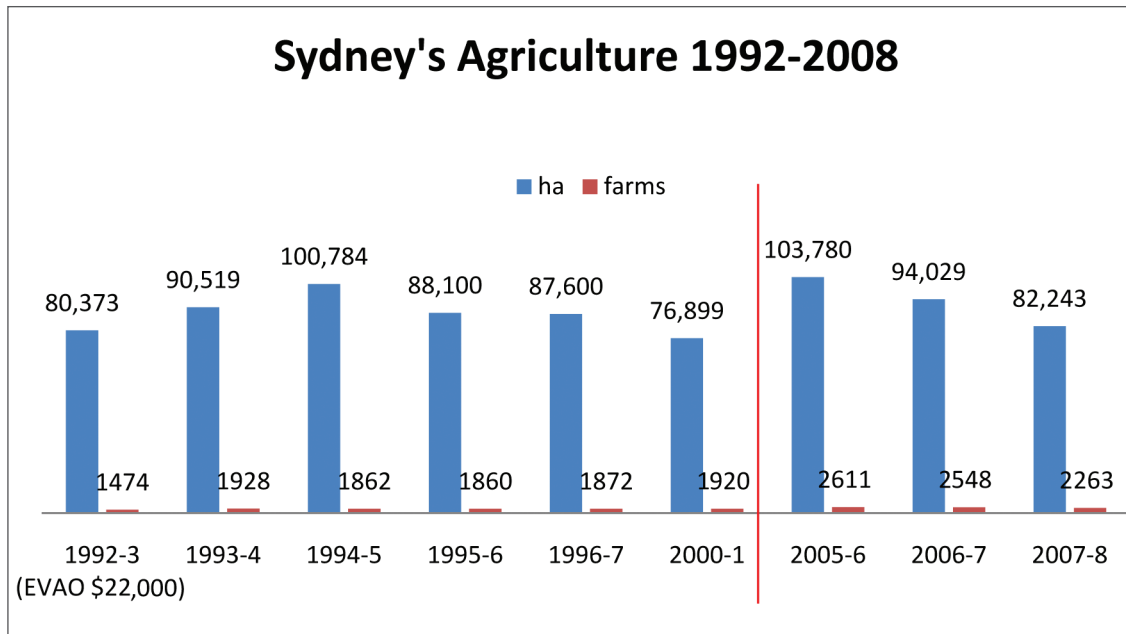
changes to methodology were intended to provide better data coverage of small scale farms such as those in Sydney. In the context of this paper it is important to consider how effective each of the changes were in improving coverage of Sydney's farms. Figures 2, 3 and 4 serve to illustrate the changes in ABS data on Sydney as a result of these methodological changes. These figures illustrate that the methodological changes in the 1993-4 ABS agricultural census had a mixed result in terms of improving accuracy of farm numbers. The change in the 2005-6 census, denoted by the red line in figures 2, 3 and 4, made a considerable difference however. While the ABS suggests that, overall, the change to the use of the ABR for farm listings did not really change agricultural statistics at a national scale (Australian Bureau of Statistics 2007), it has had a significant impact on Sydney's statistics.

Figure 2 illustrates the changes in the number of farms³ and area under production (in hectares) in the Sydney vegetable industry between the 1992-3 and 2006-7 ABS agricultural censuses. In this period the EVAO required for inclusion in the census remained at \$5000 except for the 1992-3 census data (as indicated) which was provided for comparison. The data in this figure indicates a sharp rise the number of vegetable farms and hectares under vegetable production in Sydney between the 2000-1 and 2005-6 census data following the changes to ABS collection methodology in 2005-6.

² The red line on Figures 2, 3 and 4 indicate the shift in ABS collection methodology in the 2005-6 agricultural census collection methodology.

³ The numbers of farms in Figure 2 are only given for the 1996-7, 2000-1, 2005-6 and 2006-7 census periods as this was the information publicly available on the ABS website.

Figure 3: Sydney's Agricultural Land Use 1992-2008

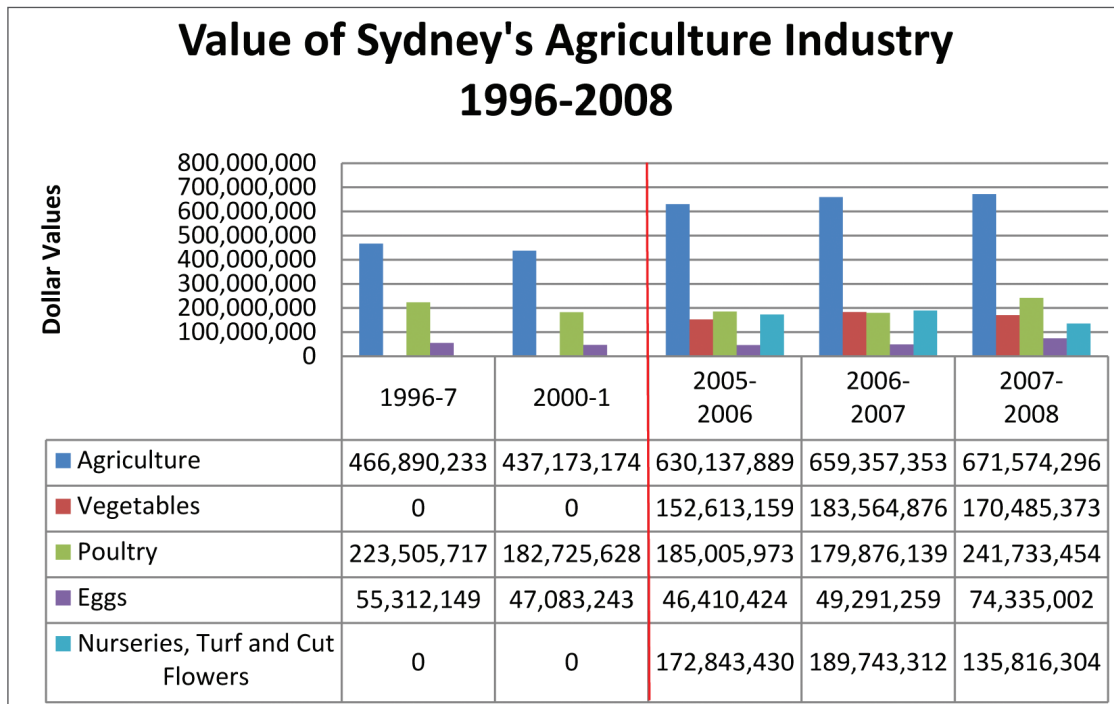


Source: Urban Research Centre calculations from ABS data (1995, 1996, 1997, 1998, 2003, 2008a, 2008b, 2008d, 2009a)

Figure 3 represents Sydney agriculture between 1992-3 and 2007-8. The figure indicates the area under agricultural production and number of farms rising and falling over time, with a particular low in farm area in hectares 2000-1. The trends suggested by this graph are not conclusive, however, due to the methodological changes in the time period represented, as explained above.

The final graph, in Figure 4, represents the changes in the value of Sydney's agricultural industry over time. It also compares the changes in the values of the most profitable sectors of the industry: vegetables, poultry, eggs and nurseries, turf and cut flowers. Figure 4 indicates a significant rise of approximately \$200 million in the estimated value of Sydney's farms between the 2000-1 and 2005-6

Figure 4: Value of Sydney's Agricultural Industry 1996-2008⁴



Source: Urban Research Centre calculations from ABS data (2003, 2008c, 2008e, 2009b)

⁴ The 0 figure in the graph indicates that the relevant value was unavailable.

agricultural censuses, following the changes in ABS collection methodology in 2005-6.

In comparing Figures 1, 2 and 3 the change in the 1993-4 ABS agricultural census from a minimum EVAO of \$22,000 to a minimum EVAO of \$5000 does appear to have made a substantial difference in the number of Sydney farms included in the census. The increase of over 400 farms registered after the change to the lower minimum EVAO of \$5000 indicates a much greater capture of peri-urban farms in Sydney than had occurred previously. The change in the minimum EVAO did not appear to have made a significant difference in terms of the inclusion of vegetable farms in the 1993-4 ABS census data, however. The increase of about a hundred vegetable farms or so after the change in the 1993-4 census collection methodology, indicated in Figure 2, represents an initial rise in vegetable farm numbers. As the number of farms then decreased to below the 1992-3 census count in the subsequent 1994-5, 1995-6 and 1996-7 ABS census data it would appear that the methodological changes did not greatly increase the representation of Sydney's vegetable farms in ABS data. The increase in vegetable farm numbers in the 1993-4 census could potentially be attributed to fluctuations in farm numbers rather than methodological change.

The 2005-6 ABS agricultural census figures, however, indicate significant increases from the 2000-1 data on all indices: the estimated value of agricultural operations, the number and area of Sydney farms generally, and the number and area of vegetable farms specifically. These increases would suggest that the change in the 2005-6 ABS collection methodology led to a much greater representation of agricultural operations of Sydney Region. The increase in all data-sets also indicates that the ABS agricultural data prior to 2005-6 undercounted the number, value and area in hectares of Sydney farms. Most telling perhaps is the increase in over 400 vegetable farms and 1500 hectares of land under vegetable production between the 2000-1 and the 2005-6 agricultural census counts. As vegetable farms have been used as the indicator of ABS undercounting the significant increase in this sector perhaps best indicates the apparent increased accuracy of ABS collection methodology from the 2005-6 census.

SECTION TWO: THE DEBATE

This section describes and analyses the debate around the value and size of Sydney's agricultural land largely generated by what can now be seen as the inaccuracy of ABS data prior to the methodological changes in 2005-6. While the debate over the value of peri-urban agriculture and the accuracy of ABS data has been on-going in Sydney since at least the early 1990s, it is a report on the issue at a national level by Peter Houston in 2005 that perhaps best outlines the facts and assumptions in dispute. Through analysis of ABS data, Houston (2005) argued that peri-urban agriculture made up to 25% of the value of Australian agricultural production. This substantial figure, he argued, challenged a long standing neglect of peri-urban agriculture relative to non-urban areas of agricultural production such as the Murray Darling Basin. As a consequence Houston (2005) argued that urban agriculture should be given greater official recognition in agricultural and urban planning policy.

Houston's (2005) report did not simply present a reinterpretation of existing ABS data. The report went further to argue that even its significant findings from the analysis of ABS estimates were probably an undercounting of the true value of peri-urban agriculture. Through a comparison of the findings of consultant and governmental reports on peri-urban agriculture with relevant ABS data Houston (2005) showed that ABS estimates were consistently below the estimations contained in non-ABS reports. This disparity, he asserted, following the claims of authors of the non-ABS reports he referenced, was due to the focus of ABS methodology on the broad acre farming more commonly associated with Australian agriculture. The application of this methodology to peri-urban areas, Houston suggested, meant that ABS data failed to capture accurately the small scale farming in urban fringe areas. Houston's conclusion was that the neglect of urban agriculture meant that official statistics did not adequately represent its size and value. This concern about an alleged absence of correct data led to the proliferation of non-ABS reports on Sydney's agricultural industry between 1993 and 2009.

In Sydney, the perceived undercounting of small scale farms by the ABS agricultural census was also seen to be exacerbated by the cultural diversity of its farmers. The majority of the city's vegetable farms, in particular, are considered to be run by culturally and linguistically diverse (hereafter CALD) growers (Parker & Jarecki 2003). According to Kelleher et al. (1998), the number of CALD growers was unlikely to be counted correctly due to the small area of their vegetable farms (estimated at 2-4 hectares) as well as the existence among CALD growers of a substantial cash economy, literacy constraints and a resistance to providing information to government agencies. If they comprise the majority of Sydney's vegetable producers,

an under-representation of CALD farmers would result in a corresponding under-counting of the overall agricultural production of the Sydney Basin. It is for this reason that data on Sydney's vegetable farms in particular have consistently featured as a point of reference in claims to the inaccuracy of ABS agricultural statistics in general.

SECTION THREE: KEY NON-ABS REPORTS⁵

In seeking to provide an alternative and ostensibly more accurate reading of the state of Sydney Basin agriculture than given by ABS data, non-ABS reports have deployed both on-ground and desk top analysis based on a variety of methodologies, scopes and scales. Despite the critique of ABS data, however, the findings of the non-ABS reports on the number of farms, area and value of Sydney agriculture have also been inconsistent due to the diversity of data produced and used. Some reports are particularly open to criticism regarding the accuracy and reliability of their data. In analysing the current state of knowledge on Sydney agriculture this section examines the aims and methods of the non-ABS reports on Sydney Basin to determine the validity and reliability of their findings and outline any limitations they may have.

Data disparities across the non-ABS on-ground field studies and the desk-top reports highlight the importance of transparent and consistent methodologies in producing reliable data on Sydney agriculture. In on-the-ground field studies by consultant and government agencies disparities in findings can be attributed to variations in methodologies, and to inconsistencies in the deployment of technologically based data analysis techniques including GIS (geographic information systems). Many reports have covered only certain sections of the metropolitan area, generating insufficient results for an extrapolation of Sydney-wide trends. Other reports from governmental and consulting groups have been primarily desk-top studies or studies drawn from in-house NSW Department of Primary Industries estimates. Irrespective of data collection methods, though, the findings of these departmental and consultant reports – such as the \$1 billion dollar value of Sydney agriculture – have been much quoted publically. The failure in many reports to clearly outline their methodologies, data sources and the base for various calculations and estimates, make it difficult or impossible to verify or reproduce results. As a consequence of this lack of transparency it has been difficult for policy makers and industry groups alike to have confidence in many of the figures produced.

Another limit of non-ABS report findings is the way in which certain figures have been carried forward within public and governmental discourses exacerbating confusion over the size and value of Sydney agriculture. One consistent problem in the apparent repetition of data across different reports has been a critical slippage in exactly what certain figures represent. This slippage has exacerbated confusion about what is actually

happening on the ground and provided further challenges for those seeking to plan for the future of Sydney agriculture. The process of repetition has also involved a stripping of the context in which claims were originally made. An outcome is that various stylisations of data and claims have become privileged as ‘fact’ in media and public debates.

Relatedly, this report also draws attention to the specificity of each data set in the non-ABS reports as a limitation of its use in the production of knowledge about Sydney’s agriculture. A critical analysis of the differing results of non-ABS studies and their comparability requires asking what exactly is being examined and why. This question is particularly important when undertaking longitudinal analysis to determine trends in Sydney agriculture over time. The relevance of each report for planners and policy makers is not simply in the validity of the data within the reports, but, as other authors have noted, in the applicability of findings to particular research or policy concerns (Malcolm & Fahd 2009). If it is the economic importance of the industry that is being considered, then the production value and employment estimates are the most important measures. If it is the capacity of the city to feed itself then tonnage per product category is probably the best measure. If it is land use pressures then area of land used is a key measure. There are also social and cultural values associated with peri-urban agriculture which would require more qualitative measurements (Bayrante et al. 2003; Knowd, Mason & Docking 2005).

Data on each aspect of Sydney’s agriculture can only speak to certain issues and thus should be used with caution. For example, as a number of studies note, land area is not necessarily a strong indicator of industry output or number of farms (Johnson, Kelleher & Chant 1998). Land area, therefore, does not directly correlate to the durability or productivity of the Sydney agricultural industry. In short, comparisons cannot be made with accuracy across most available studies particularly for longitudinal analysis due to the specificity of each data set involved. Moreover, without an understanding of how each data set is produced for each study and what exactly is being measured there is a risk of data being used as evidence for more than is actually substantiated.

The following section presents an annotated bibliography of the various non-ABS reports covering the period 1993 to 2009. The primary focus of this bibliography is, as noted in the introduction, an analysis of the reliability and validity of the

⁵ In addition to the key non-ABS reports detailed in the main body of the report there have also been a number of other reports published on aspects of Sydney’s agricultural lands. As they do not offer new data on the area or value of Sydney’s agriculture or substantially contribute to the debate they have been listed in the Appendix 2.

various reports through an examination of the transparency and rigour of the methodologies utilised. This analysis also highlights the issues of the repetition of data and the specificity and/or incomparability of findings discussed above.

KENNEDY (1993)

Agriculture in the Sydney Region: A Fringe Activity Critical to the Regional Economy

Aim

This paper was published by Andrew Kennedy of NSW Agriculture. It sought to draw attention to a perceived neglect of the significance of agriculture on Sydney's urban fringe, a neglect exacerbated by inaccurate ABS statistics.

Method

This paper used data from the 1991 ABS Agriculture Census and estimates from NSW Agriculture advisory staff to indicate the estimated value of Sydney agriculture.

Findings

Kennedy argued Sydney agriculture was more economically valuable than ABS data suggested and therefore should be given greater attention in the city's urban planning. From estimates supplied by NSW Agriculture advisory staff, this paper placed the farm-gate value of Sydney's agricultural land at \$850 million, compared to the \$461 million estimated by ABS 1991 census data. Kennedy argued that ABS statistics for Sydney agriculture were likely to be an undercount due to the small size of the farms on the peri-urban fringe. Kennedy also argued that arable land in Australia such as that found in peri-urban Sydney is in short supply. As Sydney agriculture was highly valuable and limited arable land was seen to be at risk by the analysis, the paper argued that more attention should be paid to the protection of urban fringe agricultural land.

Limits

This report does not describe how the NSW Agriculture estimates were determined, apart from indicating they came from NSW Agriculture advisory staff. As will become evident through the examination of subsequent reports this lack of methodological transparency is common in reports based on non-ABS estimates, leaving little or no way of verifying the methodology used or results obtained.

NSW AGRICULTURE (1995)

Sustainable Agriculture in the Sydney Basin

Aim

This paper was prepared by NSW Agriculture to provide estimates of the value of Sydney's agricultural land and to show that this land should be preserved and protected into the future. To this end the paper drew attention to the impacts of social, economic and environmental pressures on Sydney Basin agriculture and outlined the need for a strategic planning process to ensure its protection.

Method

The report used data collected by NSW Agriculture 'through contact with the [agricultural] industry' to estimate the farm gate value of Sydney agriculture. The report also noted (in bold), however, that these figures are estimates based on data collected with limited resources.

Findings

This report estimated the value of Sydney agriculture to be approximately \$940 million (p.16). This is an increase of \$90 million dollars on the \$850 million value estimate from NSW Agriculture reported in Kennedy (1993). In addition to an overall value estimate, the report also provided individual estimates for the value of different agricultural sectors and an analysis of their productivity and number of people employed. The report estimated that Sydney vegetable production was worth \$99 million and comprised of 1300 growers (p.19). Mushrooms, in particular, were identified as a strong crop type, with a separate estimated value of \$26 million (p.21). Nurseries were estimated to be worth \$200 million, fresh cut flowers \$100 million and turf \$50 million (p.20-21). The most rapidly expanding agricultural industry at this time was considered to be poultry, with combined meat and egg production valued at an estimated \$298 million (p.16). According to these estimates the dominant agricultural industries in the Sydney Basin in 1995 were vegetables, poultry, nurseries and turf.

In terms of other agricultural sectors, the report indicated that the increasing intensification of farming in the Sydney Basin had led to the decline of certain other industries such as piggeries. At the time, cattle and dairy, which are also extensive industries, were relatively stable in terms of production although grower numbers had declined. The report argued that as land prices increased and urbanisation expanded, intensive, high-value crops such as Asian vegetables would be increasingly focussed on by growers. The continued strength of the vegetable industry in Sydney illustrated by the ABS data in section one supports this prediction.

Limits

Due to the use of industry estimates and a failure to clearly define how these estimates were compiled the accuracy of the data in this report cannot be now verified. That the report clearly acknowledges the limitations of its approach to estimating values signals that the reader should use the value estimates given with caution.

JOHNSON, KELLEHER AND CHANT (1998)

The Future of Agriculture in the Peri-Urban Fringe of Sydney

Aim

This report was an analysis of longitudinal trends in Sydney agriculture based on ABS data. It was undertaken by a team of researchers from the University of Western Sydney and was presented at the Australian Agronomy Conference in July 1998. The analysis of ABS data in this report compliments the empirical study of Sydney's agricultural lands by these researchers examined subsequently.

Methods

The authors compared the 1984-5 and 1993-4 agricultural censuses.

Findings

In comparing the ABS census data the authors noted a number of trends between the 1984-5 and 1993-4 census years. These trends included an overall decline in area under farming in the Sydney Basin and a corresponding decrease in the profits of many agricultural sectors. The authors also noted an increasing intensification of certain industries during the period. In terms of the specific sectors, vegetable farming was found to have maintained its value but to have declined in area and operator numbers over time, as did the dairy industry. For other agricultural sectors such as piggeries, fruit and poultry, however, a significant decline in both the area under production and value of production over time was noted by the authors. Turf and cut flower production remained steady, the authors stated, but sites of production for both sectors had moved significantly westward over the period of the study.

Overall the authors argued that Sydney agriculture had a decreasing reliance on soil resources due to intensification of industries and the growth of non-soil reliant sectors such as poultry. As a result of this finding the authors question the apparent focus in planning policy on protecting 'prime agricultural land', suggesting it is not the key issue on the urban fringe. What is needed, the authors argued, is the development of planning policies that better address the needs of present and developing agriculture.

The authors argued that different sectors of the agricultural industry would require different approaches in planning for their land use needs. The authors raised the possibility of agricultural zones for intensive production areas, similar to light industry zones, to ensure farms did not run into conflict with urban neighbours. Industries such as cattle grazing or horse breeding, however, provided open space and visual amenity for the broader community and thus might be acceptable in low residential areas. They believed that Sydney's agriculture would become increasingly polarised between the intensive industry segments and marginally viable or hobby farming segments including grazing.

Limits of Research

The main limitation of this research is that the authors did not provide actual figures from the ABS census in 1984-5 to 1993-4 to allow for verification of their findings. The early ABS data they refer to are not available via the ABS website making reproduction of their findings now very difficult. The comparisons they make are further limited by the fact that the report does not acknowledge the changes in EVAO in the 1993-1994 census, the final year included in their analysis. As the actual ABS data used by the authors are not provided it cannot be conclusively stated as to whether this EVAO change was accounted for in their analysis.

KELLEHER, CHANT AND JOHNSON (1998)

Impact of Rural Subdivision on Agriculture

Aim

This report was undertaken by the same team of researchers from the University of Western Sydney and was published by the Australian Federal Government's Rural Industries Research and Development Corporation (RIRDC) in October 1998. The aim of this research was to identify how much land was being used for farming in the Hawkesbury, Wollondilly and Mudgee Local Government Areas (LGAs). The authors had three related aims: to identify the value of the agricultural land identified; determine how much farmland was actually best quality agricultural land; and then examine the effect of urban subdivision on the quality agricultural land in these LGAs. The authors argued that attempts to analyse trends in agricultural land use over time had been subverted due to a lack of comparable and reliable data sets over time. They specifically argued that the changes in baseline value in the ABS agricultural census had made ABS data unreliable for such comparisons. The findings of this report were subsequently presented at the Australian Agronomy conference in 2001 (Kelleher 2001).

Methods

The project used 'MapInfo', a GIS mapping program, in conjunction with Landsat Thematic Mapper (TM) satellite imagery, to calculate the area of agricultural land use by farm lots in the three LGAs. TM imagery is satellite imagery which contains up to 7 multispectral bands. These bands can then be analysed to classify land use based on different colour and thermal-infrared variations. This TM imagery is designed to be used with image analysis software but can also be used, with less precision, through a manual analysis of the image produced. The TM imagery used in this study was from 1993 with a 30 metre resolution. The authors noted that the Landsat TM imagery was available back to 1983 and could therefore be used for historical analysis if time and resources allowed. The authors used 1996 cadastre maps from the Land Information Centre in Bathurst to determine property boundaries and area of farms. Aerial photography was not utilised to complement the satellite imagery due to cost.

While the authors had initially intended to use remote sensing technology to generate their calculations of agricultural land use this was not successful. After initial attempts to analyse the TM satellite imagery through remote sensing with the program 'Farmlmage' failed, the imagery was exported to MapInfo. In MapInfo the different land use categories were manually analysed according to the colour codes provided in the TM imagery. The area estimates derived from this process were used to then calculate an estimated value of production as well as analyse the area of land that fell into different agricultural soil classes. The agricultural land use identified was then verified through ground truthing.

The report is unclear as to the extent of on-ground analysis that occurred. The report initially states that 'windscreen surveys' – in which agricultural experts drive through agricultural areas to assess the extent of agricultural activity – were rejected due to time and research funding constraints (p.9). Elsewhere, however, the report states that land use in the Hawkesbury area was estimated from satellite images and then ground truthed extensively over a five month period in 1996, with a similar process followed in the Wollondilly and Mudgee LGAs (p.13). Perhaps the ground truthing was undertaken through sampling, although there is no indication of what sampling approach was, as would be expected in a GIS land use analysis.

Findings

In the Hawkesbury LGA, the value of agriculture was estimated to be \$211 million, with 33 thousand hectares of farms. The vast majority of this area was found to be grazing land, with mushrooms, orchard, turf and poultry the highest value industries. The authors found that Hawkesbury LGA had 292 market gardens (vegetable farms) occupying an estimated 1758 hectares and, 3500 hectares of class 1 agricultural land. The area and value of agricultural lands estimated in this study is substantially above the ABS data from the 1996-7 agricultural census which ascribed the Hawkesbury with approximately 14,000 hectares of farmland at a value of only \$62 million.

In Wollondilly LGA the value of agriculture was estimated at \$361 million with 55 thousand hectares of farms. The majority of this land was grazing, with poultry and orchards estimated to be the highest value industries. In Wollondilly vegetable production was found to occupy an area of 1036 hectares on 119 farms. The estimated area of farmland for Wollondilly was also considerably higher than the area shown by ABS data which estimated approximately 27,000 hectares of farmland with a value of \$84 million in 1997.

The authors also examined how much land in each of the LGAs could actually be considered 'prime agricultural land'. This was a significant question as the authors had argued in the previous paper that Sydney planning policy placed too great a focus on the loss of prime agricultural land at the expense of other influences on the agricultural industry (Johnson et al. 1998). Determining if there was actually a significant amount of prime quality agricultural land and if it was available for agriculture in the LGAs concerned, allowed the authors to assess how important the protection of this land was to sustaining agricultural industry.

According to the NSW Department of Land and Water Conservation's land capability system, the authors note, soils classes 1 to 4 are considered good soil for agricultural production (p.14). Class 1 soil is considered the best agricultural soil for cultivation while class 4 land is not considered suitable for crop production at all. The report found that in the two Sydney LGAs examined only a small percentage of land qualified as prime agricultural land, with Class 1 agricultural land only comprising 1.25% of the Hawkesbury LGA and 0% of the Wollondilly LGA.

Of this limited quality agricultural land, the authors found that the majority had already been affected by urban subdivision. In the Hawkesbury LGA, in particular, there had been extensive subdivision of class 1, 2 and 3 lands, especially between 1960 and 1990. The only exception was flood prone Class 1 land which had not been greatly subdivided. The study found that in Wollondilly LGA there was less subdivision of land classes 2 and 3 relative to the Hawkesbury LGA. Overall, however, the intense subdivision of class 1, 2 and 3 lands in both LGAs was considered to pose a substantial threat to the availability of prime agricultural land to agricultural industries.

The authors concluded that agriculture in Sydney was increasingly intensified and increasingly independent from soil quality, confirming the findings from their previous report (Johnson, Kelleher & Chant 1998). On the basis of this conclusion the authors argued that the case for protection of prime agricultural land is better made on the grounds of open space or amenity rather than agricultural production. The threats to certain industries such as dairy, they suggest are due to broader structural issues such as deregulation rather than loss of prime agricultural land. They also stated, however, that urban encroachment is still a concern in the Wollondilly and Hawkesbury LGAs and represents the greatest threat to the higher value but less soil-reliant agricultural industries of poultry and mushrooms. The overall issues, this report suggests, is the loss of land for agriculture rather than the loss of prime agricultural land per se.

Limits of Research

This report represents the most in-depth and innovative study into agricultural production in the Sydney Basin undertaken at this time. The authors undertook to address what was, and continues to be, a significant data gap in this area through the use of the methodologies available to them. There are a number of factors, however, that limit its usefulness in contemporary analysis of the area and value of the Sydney Basin agricultural industry. The first, and perhaps most obvious, limitation is that the report only covers the Hawkesbury and Wollondilly local government areas. While these LGAs are key agricultural areas in Sydney, the selective approach means that the report cannot provide a baseline measure for longitudinal analysis of the area and value of agricultural production for the whole of Sydney. The results are also presented without an accuracy measures (such as the ABS's calculations of margins of error) to provide an indication of reliability for the user.

As the authors utilised GIS through the program MapInfo they were unable to undertake digital analysis of the satellite

data. In effect, the satellite data were used as an image and manually analysed rather than analysed as a full set of digital information. While very time consuming, the methods used mean the findings are likely not to be of the accuracy obtainable from digital analysis. Further, as the authors were in fact measuring land use by cadastre lots they were measuring the area of farms rather than the area of land being farmed. While the authors do provide estimates of the areas under production, these were based on the estimates of NSW DPI staff and agricultural industry represented rather than actual measurement. It is likely that such a measurement was not undertaken due to technological limitations. The risk of analysis based on estimates rather than accurate measurements, as discussed in subsequent sections is that it could well have led to an overestimation of the size of land actually under production and subsequent estimates of the value of production.

CITY OF CAMDEN COUNCIL (2000)

Camden Council Rural Lands Study

Aim

As part of its rural land study, Camden Council had an analysis of their agricultural industries undertaken by the NSW Agriculture (2000). The report was commissioned primarily to address the perceived inaccuracies in ABS data for the LGA.

Method

The NSW Agriculture analysis of Camden's agricultural lands comprised of data drawn from 'industry estimates, the expert opinion of NSW Agriculture staff and their industry records'.

Findings

The NSW Agriculture analysis put the value of Camden's agriculture at \$44 million, well above ABS estimates of \$34 million. The NSW Agriculture report also compared the Council's rating return records of 288 farmers to the ABS statistics which found 97 farms. The report concluded that the ABS statistics significantly underestimated the number of farms in Camden and the value of their agricultural production.

Limits

There is little information on the methods used to generate the estimates presented in this report. As the methods cannot be interrogated or the calculations examined the findings on the value of the different sectors of Camden's agriculture cannot be verified and are potentially unreliable.

PARKER AND SURIYABANADARA (2000)

The Safe Use of Farm Chemicals by Market Gardeners of Non-English Speaking Background: Developing an effective extension strategy for the Sydney Basin

Aim

This report was undertaken by researchers from the University of Western Sydney and published by the Federal Government's

RIRDC program. The report was not intended as an analysis of the area or economic value of Sydney Basin agriculture per se; rather it sought to draw attention to CALD growers working in the vegetable industry and their chemical use practices. This and subsequent reports by Francis Parker and associated authors draw attention to the social and cultural contexts of market gardening in Western Sydney. While these issues cannot be examined in detail here, the report provides estimates on the number of CALD growers in Sydney which, as noted in section two, is a central issue in the debate over the size of Sydney agriculture.

Methodology

The data on Sydney Basin agriculture presented in this report is derived primarily from the 1991 ABS agricultural census data.

Findings

The report presents ABS data from 1991 indicating that there were 2027 people from non English speaking backgrounds working in the agricultural industry in Sydney (p.24). The report states that it is unclear whether this figure in fact represents the number of workers or the number of enterprises. The data, as presented, also did not distinguish whether the term 'agricultural worker' was intended to indicate only those who ran or owned a farm or if it also included seasonal workers. Elsewhere, the report stated that there is an 'estimated' 2000 vegetable growers in Sydney of whom 80-90% are CALD (p.22). The data sources are not given and it is unclear as to whether workers or enterprises are being referred to.

Limits of Research

The limitations of this report primarily lie in its confusion about exactly what the given data represents. The report indicates it is unclear whether the ABS figure of 2027 is intended to represent farmers or agricultural workers or indeed farms. It is also unclear, however, whether the figure of 2000 vegetable growers given subsequently is intended to represent farmers or farms. While the authors use the term 'growers' the ambiguity as to what this defines has led to an apparent conflation of farmers and farms, if not by the authors of this report, then by those subsequently using the estimates. The figure of '2000' vegetable farmers/farms (also referred to as market gardeners/gardens) is one that appears in many subsequent reports without adequate referencing, exacerbating confusion around the size of Sydney's vegetable industry.

BAGINSKA AND RUFFIO (2001)

Assessment of Diffuse Sources of Pollution in the South Creek Catchment – A GIS Approach

Aim

This study was prepared for the NSW Environmental Protection Agency to assess sources of pollution in the South Creek Catchment. The South Creek catchment encompasses 620 sq kms and most of the Cumberland Plain of Western Sydney. The measurement of agricultural land within the catchment was only a by-product of the overall aim of the report. Agricultural production was included in the report as it represents a

potential source of pollution in the South Creek Catchment. The report has been included in this review primarily because it provides an example of a study with a very detailed and transparent methodological process. The extensive methodological discussion provides a useful reference for future studies undertaking remote sensing analysis of Sydney Basin agricultural land.

Method

To estimate the area of the various land uses in the catchment, the study analysed Landsat TM satellite imagery (at a resolution of 25 metres) from 2000 through the GIS program, ArcView. Similar to the Kelleher et al. study, the TM imagery was manually analysed rather than analysed through remote sensing software, probably as a result of technological limits at the time. Differing from Kelleher et al. (1998), however, this study only measured land under production rather than cadastre lots, resulting in a more accurate assessment of the amount of land actually being farmed. The analysis of the TM imagery was compared with aerial photography from 1998 at a 1 metre resolution, as the aerial photography provided a much more detailed image than the 25 metre resolution of the TM imagery. The findings were further ground truthed through sampling of approximately 224 points in the study area to determine accuracy (p.19), which was estimated at 76.4% (p.24).

Findings

This report found that there were approximately 10,428 hectares under agricultural production in the South Creek Catchment, with an estimated 1098 hectares in market gardening (p.13). In terms of overall land use, agriculture was found to comprise of 16.7% of land use in the catchment compared with urbanised land comprising of 21.9% and cleared land comprising of 34.1% (p.12). While these area measurements do not incorporate the entire Sydney region they are presented here as the report had a thorough and rigorous methodology and accuracy measure, indicating their reliability as a data source.

Limits

The authors noted that an initial attempt to classify land through remote sensing failed to indicate all land uses due to a lack of detail in the satellite imagery. Satellite imagery is now available at much finer resolutions than the 25 metres used in the Baginska and Ruffio report, allowing for more effective use of remote sensing mapping of Sydney agriculture in the future. Acquiring accurate field-based data through ground truthing also proved difficult for the authors, increasing their reliance on photographic interpretation and visual analysis. The use of visual analysis as the primary means of analysis is potentially problematic as it elevates the risk of human error. If automated remote sensing programs had been available/used to analyse the data the risk of human error would have been minimised. A further limitation of this study in the context of this review is that it only covers the South Creek catchment and not the Sydney Basin as a whole. The fact that it covers a catchment and not an LGA is also a limitation as results cannot be compared with ABS data and other non-ABS report based on LGAs as has been done with reports such as Kelleher et al. (1998).

SINCLAIR (2003)

Western Sydney Rural Lands Study

Aim

This study was commissioned by the NSW Department of Infrastructure, Planning and Natural Resources to examine the rural lands of Western Sydney. The aim of the study was to undertake 'a land use survey and lot size analysis to determine the relationship between land uses, fragmentation, pressure and conflicts in peri-urban regions'.

Methodology

The land use survey covered the Western Sydney LGAs of Baulkham Hills, Fairfield, Hawkesbury, Liverpool, Blue Mountains, Camden, Penrith, Campbelltown and Blacktown. In undertaking the land use survey Sinclair used a number of land use classifications including: rural residential housing, intensive plants (market gardening, protected cropping such as greenhouses, orchards, vineyards), extensive agricultural (grazing, horse studs, fodder crops), intensive animals (non-natural grazing – piggeries and poultry mainly), vacant cleared land, native vegetation, extractive industries, public use and village (urban areas).

The land use in the study area was analysed initially using aerial photography to identify different land uses according to the author's classifications. The land uses identified were then field checked between April and July 2003 through a 'windscreen survey' of roads and properties in the rural parts of the LGAs. Land uses determined by this process were then coded and entered into property databases obtained from councils. The survey classified each lot according to the primary use of the property. Where there were multiple uses the dominant use was chosen. A lot size analysis was also carried out to provide details on the amount of fragmentation in the study area.

Findings

This study presented a comprehensive, ground truthed assessment of the different land uses within the aforementioned LGAs. A total of 42,377 rural lots were counted within the rural lands in this survey. The report found that 78.3% of these lots had a residential use as the main use of the property (p.3). The second highest dominant land use was intensive plants at 6.8%, with vacant land as the third highest land use at 4.9% of total area. For agricultural land use specifically, the survey found 2226 lots of intensive plants, 994 lots of intensive agriculture and 276 lots of intensive animals (p.4). The author found that the number of agricultural lots, when all three types of agricultural land use were combined, was highest in the LGAs of the Hawkesbury (610) followed by Liverpool (491), Penrith (366), Baulkham Hills (359) and Camden (243) (p.5).

Sinclair also found that the majority of lots in Western Sydney's rural lands – excluding the native vegetation and village land use areas – were between 0.8 and 3 hectares in area, with most averaging around 2 hectares (p.7). Sinclair also found that over 50% of land lots fell within the 0.8-3 hectare range and only 13% of lots were larger than 8 hectares, indicating

considerable land use fragmentation. This fragmentation, the report stated, was evidence of a decline in agricultural land due to increased rural residential development.

Limits of the study

This study did not estimate the exact area in hectares of land under agriculture which means the study could not provide a comparison to the estimates of agricultural land use in hectares given in previous and subsequent reports. If it had provided an estimate in hectares, however, the designation of an entire lot according to its primary use may have resulted in an overestimation of land use, as discussed in relation to the Kelleher et al. (1998) findings. The report is also potentially limited in terms of comparisons with other reports and longitudinal analysis, as it did not provide an economic analysis of the value of agricultural land use as found in Kelleher et al. (1998).

GILLESPIE AND MASON (2003)

*The Value of Agriculture in the Sydney Region: February 2003 (Draft)*⁶

Aim

This report was undertaken by the Sydney office of NSW Agriculture. It sought to address more comprehensively what NSW Agriculture had identified in previous studies as an undercounting of Sydney agricultural production by the ABS agricultural census (Council of Camden 2000; Kennedy 1993). To provide an alternative and ostensibly more representational estimate of the value of Sydney agriculture, estimates from various non-ABS sources were collated to gain an alternative overall value estimate.

Methods

This study was undertaken through a 'desk top' analysis. The authors used existing information from the decade prior to 2003 to generate estimates of the value of Sydney Basin agriculture and levels of employment in the Sydney agricultural industry. The three main sources of information were agricultural or rural land studies conducted by the various local governments as part of their planning process; published agricultural statistics from the ABS 1996-7 agricultural census; and NSW Agriculture specialist field advisory staff estimates. The report states that the NSW Agriculture staff estimates of the values of different agricultural sectors were derived from a series of calculations. First, the area used by each sector was multiplied by average yield per hectare to gain an estimated yield for the sector. This yield estimate was then multiplied by indicative market prices for the various agricultural products to obtain a value estimate. The final estimates, then, represent a combination of the estimates from various sources, although they are primarily from NSW Agriculture staff estimates. The ABS data from 1996-7 were used as a comparison for the value estimates calculated by the authors.

Findings

The study estimated the value of the Sydney agricultural industry at over \$1 billion. This estimate was more than twice the \$467 million value attributed to Sydney agriculture by the ABS in the 1996-7 agricultural census (p.12). According to the author's calculations the value of Sydney's intensive horticulture alone, incorporating vegetables, fruit, flowers and turf, was \$537 million (p.12). This contrasted starkly with the value of \$100 million attributed to Sydney horticulture by the 1996-7 ABS agricultural census.

The report also states that there are approximately 2000 people employed full time in the vegetable industry in the Sydney Region, a figure which was referenced to NSW Agriculture agricultural extension officers (p.6). This '2000' figure is also the same number that appears in the Parker and Suriyabanadara (2000), although that report used the descriptor 'vegetable farmers' rather than 'people employed' in the vegetable industry. Whether the figure in the Gillespie and Mason paper was intended to represent farm workers or farm owners, however, remains unclear. The repetition of the '2000' figure – in this report in a slightly different context – illustrates how the apparent small slippages in data representation repeated across various reports generate confusion about the state of Sydney Basin agriculture.

Limits of the study

The principal limitation of this report is that its estimates are difficult to verify due to the variety of sources they are attained from. This is particularly the case in relation to the use of estimates from NSW Agriculture field staff. The study indicates that it used the size of land under production as a primary source of its estimates of the value of Sydney production. The report, however, provides neither estimates of the area of agricultural land or the calculations used to generate value estimates for the majority of values given.

Another limitation of this report is that the comparisons made between the value estimates generated by this report and the 1996-7 ABS data are potentially unreliable as the data are between various points in time. As the unit value of Sydney's agricultural production has generally increased over time, as illustrated by Figure 4 in Section One, the estimated value of production in 1996-7 is likely to be less than value estimates for 2001 or 2002. While the temporal disparity of the data used is noted in the report, it is not taken into account in the calculations of value data or in the comparisons undertaken on the basis of these calculations.

⁶ While this report has been marked as a draft it has been circulated and referenced by the authors in the draft format (Knowd, Mason & Docking 2005). This suggests that it is valid to use the report in this format and that there is possibly no 'final' report.

GILLESPIE (2003)

Agricultural Trends in the Sydney Region 1996-2001: Census Comparisons

Aim

This report was undertaken by the Sydney office of NSW Agriculture with the aim of examining longitudinal trends within Sydney's agricultural industry relating to land use, employment and value of production using ABS data. The report was released as a companion report to the Gillespie and Mason (2003) report examined previously.

Method

The report compared and contrasted data from two consecutive ABS agricultural censuses, 1996-7 and 2000-1. While restating the position that ABS data represented an undercount of Sydney's agricultural industry, the author argued that the ABS's consistent approach to data collection was useful for analysing agricultural trends over time. It was argued that any errors in data collection would be consistent due to the consistency of ABS methodology in this period. The author also used Gillespie and Mason (2003) data for estimates of the value of Sydney's agricultural industry.

Findings

The report found that between the 1996-7 and 2000-1 census years the number of agricultural holdings actually increased in the Sydney region by 3.1% (p.4). In the same period, however, the author noted a 10.5% decrease in the area of land used for agriculture in Sydney and a 5% decrease in employment levels (pp.4-5). Gillespie suggested that these shifts indicated an intensification of agricultural production coupled with a decrease in soil reliant production, following the trends noted by Johnson et al. (1998) (p.34).

The report also indicated a decline in certain agricultural sectors and the growth of others. The report noted a decline in the piggeries, eggs, cattle, dairy and certain fruit sectors (p.34). Poultry meat, vegetables, and horse industries among others, however, were considered to have experienced strong growth over the study period (p.34). The relative strength of the vegetable production industry within the Basin follows the trend indicated in Johnson et al. (1998). The strength of the poultry industry, however, appears to be a reversal of the decline noted by Johnson et al. (1998).

Limits of the study

The findings of this study were limited to the extent that the study only drew on data from two agricultural censuses. As a result, the report did not necessarily present an accurate reading of trends over time as production can vary significantly from year to year. The comparison of ABS data in Section One suggests that a more longitudinal land use analysis is needed to indicate conclusively that there are long term changes not observable in year on year fluctuations. While the comparisons of over 15 years of ABS data in Section One were not conclusive due to methodological changes, they do bring into question the downward trend in area under agricultural production suggested by this report.

The use of Gillespie and Mason's (2003) data for the value of the various agricultural sectors was also problematic for the clarity and reliability of the report's conclusion. The amalgamation of data from the two reports involved statistics collected using very different methodologies. This had the potential to confuse the reader as to the origin of the various estimates including their attribution to ABS data. The use of data sources should have been acknowledged within the report as a caveat to the statistics generated from the Gillespie and Mason (2003) report.

NSW AGRICULTURE (2003)

Regional Review of Sydney and the South-East Region

Aim

This report was published by NSW Agriculture to present the data on the state of agriculture in Sydney and the south east region of NSW.

Method

The paper reviewed existing information rather than presenting original data. While there is little reference to the data sources for much of the information given, many of the figures correspond with the Gillespie and Mason (2003) report. This would suggest that much of the data came from that report, which was also published by NSW Agriculture.

Findings

The report repeated the Gillespie and Mason (2003) estimate of the \$1 billion value of Sydney Basin agriculture (p.5). It also stated that Sydney has 6550 hectares of vegetable farms with a value of \$215 million a year (p.27). No sources were given for this area estimate; but the value of vegetable production again reflected the value claimed in the Gillespie and Mason (2003) report. Vegetable grower numbers are said to have exceeded 2000 and farms to have exceeded 1000 in number. The figure of 2000 vegetable farmers again replicated Gillespie and Mason's (2003) findings. The clear differentiation here between the number of vegetable growers and vegetable farms, however, would suggest that the estimate of 2000 vegetable farmers in Parker and Suriyabanadara (2000) does represent farmers rather than farms. As neither the Gillespie and Mason (2003) report or the NSW Agriculture (2003) report indicate the sources of their information, however, it cannot be confirmed that they are indeed referring to the same figure as Parker and Suriyabanadara.

Limits of the study

As the report did not give references to the sources of its data its findings cannot be verified. To the extent most of the estimates corresponded with Gillespie and Mason's (2003) findings, the estimates they would appear to have been derived from this report. It is therefore suggested that the cautions given on that report would apply to these estimates as well.

BAYRANTE ET AL. (2003)

Progress Report: The Sydney Market Garden Project

Aim

This report was authored by the working group of the Sydney market garden project. The working group comprised of representatives from both government agencies and academic institutions that were working with CALD market gardeners. The aim of the project was to improve service provision to these growers by improving the level of information in the partner agencies and institutions about these farms. The report was therefore not intended specifically as an analysis of the area and value of the Sydney agricultural industry. It did, however, provide estimates on the number of CALD farms in Sydney.

Methods

The authors used estimates from the University of Western Sydney's Integrated Pest Management Project (UWS IPMP) (2001-2003) for market garden numbers. It also used ABS data from 2001 for comparative data in the report.

Findings

Data from the UWS IPMP put the number of market gardens run by CALD growers at over 1500.

Limits of the study

The reliability of the estimates in this study is limited as they are derived from another project with no description of the methodology used to obtain them. Furthermore, while the paper discusses 'market gardens' this term is used to represent a variety of farming practices. And while the farms are primarily listed as vegetable farms, the list of 'market gardens' also included turf farms, cut flower production and orchards within this category. The report did not clarify how the number of market gardens was determined and what exactly the term 'market gardens' represents in relation to previous reports that have defined vegetable farming separately to other agricultural production such as cut flowers. The lack of clarity on these issues makes it impossible to compare these findings with previous estimates on the number of farmers in the Sydney vegetable industry, such as those in Gillespie and Mason (2003). This weakness further exemplifies the incomparability of many reports on Sydney agriculture due to their different methodologies and subjects of analysis.

SINCLAIR ET AL. (2004)

From the Outside Looking In

Aim

This report was funded by a regional and community grant from the University of Western Sydney. The aim of the report was to outline concerns about the impacts of peri-urban development on rural lands in Western Sydney, with a particular focus on the agricultural industry.

Methods

The report arose out of a series of workshops with representatives from the Sydney agricultural industry, Western Sydney community and academia which sought to address the challenges facing peri-urban lands and generate suggestions for what might be done to confront the threat of urban encroachment. The authors drew on other reports for data sources. Land use estimates were drawn from Sinclair's 2003 report on land use in Western Sydney and from previous local council land use studies. Value calculations were largely derived from the reports by Gillespie and Mason (2003) and Kelleher et al. (1998). While not cited as such, estimates of the number of market gardens would appear to have been drawn from Parker and Suriyabanadara (2000).

Findings

As noted most findings were replicated from other reports and these have already been assessed in this report. One figure, however, is worthy of mention. That is the estimate in the report of 2000 market gardens in Sydney (p.35). This is a significant shift in the representation of figures on vegetable farming from a claim of 2000 vegetable *growers* in the Parker and Suriyabanadara (2000) report to a claim of 2000 *market gardens* in this report.

The report also argued the \$1 billion estimate of the value of Sydney agriculture from Gillespie and Mason (2003) is likely to be an undercount (p.26). The authors argue that as the Kelleher et al. (1998) findings only represented two of Sydney's LGAs but accounted for half of the \$ 1 billion estimate, agricultural production in Sydney as a whole must in fact have a much higher value.

The report also made use of data from the 1997 agricultural census to indicate that Sydney contributes the majority of NSW's production of poultry meat and eggs, nursery, cut flowers and turf, and a number of perishable vegetable items.

Limits of the study

The paper provided no further reference to the source of the 2000 market gardens estimate. As a result it is not clear whether it represents a slippage in figures or is a new figure from an unnamed source. Whether the data in fact represents farmers or farms or indeed workers on farms has a significant implication in terms of the known size of the vegetable agricultural industry. Stating that there are 2000 market gardens suggests a potential increase in 100% of the number of vegetable farms from many previous reports, except Bayrante et al. (2003). As there can be at least 2 people identifying

as farmers per market garden, as market gardens are often a family business (Parker and Suriyabanadara 2000), the estimate of 2000 market gardeners given in previous reports would equate to only around 1000 farms. This estimated ratio of farmers to farms is supported by the findings of the NSW Agriculture (2003) report discussed previously. While the term 'market gardens' is slightly ambiguous, as illustrated by the Bayrante et al. (2003) report, it appears that this report intended to use the term to refer to vegetable farming. The apparent shift or slippage between farmers and farms, and the different descriptors of farms, exacerbates the general confusion about the size and extent of agricultural land use in the Sydney Basin across the various reports.

Additionally, a further potential limitation of this report is the replication of value estimates such as that of the Gillespie and Mason (2003) report. The difficulty of validating these estimates is discussed previously.

AGRIBIZ CONSULTING (2007)

Report on the Current Agricultural Capability and Use of the Rural Lands in Liverpool City Council LGA and Their Potential Future Agricultural Use

Aim

This report was commissioned by Liverpool City Council to examine the state of the agricultural industry in the Liverpool LGA as part of the council's rural lands study.

Method

An agricultural land use survey was undertaken to update a land use survey AgriBiz had undertaken in 1994 for Liverpool City Council. The study only examined certain sections of the Liverpool LGA; covering only 68% of the land surveyed in 1994 which itself did not encompass the entire LGA. The land examined was further divided into primary and secondary study areas, which were situated in the least urbanised sections of the LGA on the assumption that these best represented 'rural lands'. The primary study area was the greatest distance from Liverpool's CBD with the secondary study area closer to the CBD and urbanising areas. Further narrowing the scope of the study, it appears that the survey only included properties that were 2 hectares or more in size.

The agricultural properties were identified by the authors through the use of aerial photos taken in March 2005. The identified properties were then ground truthed through a 'windscreen' survey of the identified properties from the road. The authors also interviewed a number of agricultural land users in the Liverpool area.

To assess economic value, the 2000-1 ABS agricultural census data was used to calculate the relative contribution of Liverpool agriculture in the context of the overall value of Sydney's agricultural production.

Findings

The survey found only a small number of farms in the study areas. This included 22 market gardens and 22 sites of 'controlled environment plant production' which included hydroponics and polyhouses and could represent either vegetable or cut flower production (pp.13-15). Total agricultural land use in hectares was only calculated for the primary study area, and was estimated at 843 hectares (p.4). The authors note, however, that 542 of these hectares were accounted for by a single dairy producer, the Leppington Pastoral Company. From these findings the report concluded that agriculture in the LGA was in decline, with many farms operating only to 'run-off' current stock or property-based investment. The authors attribute the decline to the high land costs in Liverpool relative to low returns from agricultural produce.

Significantly, the survey found more commercial agriculture in the 'secondary study area', the section closer to the urbanising sectors of the LGA, than the primary and more 'rural' study area located a greater distance from Liverpool CBD. That there was more agriculture in the secondary study area suggests that the urbanising area of Liverpool not included in the study could also have contained a significant amount of agriculture.

Limits

As this report only covered a section of Liverpool LGA it probably presented an incomplete account of agricultural activity within the LGA. The conclusion of the report that agriculture in Liverpool LGA is in decline is therefore brought into question.

MALCOLM AND FAHD (2009)

Ground Truthing of the Sydney Vegetable Industry in 2008

Aim

This paper was commissioned by Horticulture Australia Limited and the NSW Department of Primary Industries. The aim of the report was to undertake a comprehensive ground truthed study of the area under vegetable production in the Sydney region to address the inadequate state of current knowledge on the issue. The Malcolm and Fahd (2009) report represents the most up to date report on Sydney Basin vegetable farming. It contains a clearly defined methodology with ground truthed findings. The report is therefore discussed in greater detail than previous reports.

Methods

Malcolm and Fahd (2009) used satellite imagery from Google Earth Data Pro to identify land under vegetable production. The land use identification was then verified using on-ground physical inspections in which Global Positioning Software was used to accurately map the locations of farms. Malcolm and Fahd also used a laptop computer with 2008-2009 satellite imagery on Google Earth Data Pro as well as SIX cadastral maps in their ground truthing to check their data while in the field. The collected data was then mapped through the GIS program ArcGis 9.2. The vegetable farms identified were broken down into three categories: in-ground vegetable farming

greenhouse production and hydroponic farming; to provide a more accurate picture of the state of vegetable farming in Sydney.

Findings

The study counted 1052 sites under vegetable production in the Sydney Basin (p.3). The area under vegetable production was calculated to be 2025 hectares and the average size of plantings was estimated to be 1.9 hectares (p.3). The report also found that Sydney's vegetable production is undertaken on very small areas of land, as most were under 2 hectares. In finding that 52% of vegetable farms are within Sydney's nominated Growth Centres and 42% in the South West growth area alone, this study also highlights the threat to current vegetable farms from planned urban development (pp.53-55).

The number of vegetable farms indicated by the Malcolm and Fahd survey falls substantially short of the 2000 vegetable farms mentioned in some earlier reports (Sinclair et al. 2004). This, the authors suggest, brings into question some of the larger estimates about the level and value of production in the Sydney Basin. Conversely, however, if it were to be assumed that there were two farmers to every farm, the estimates given in Mason and Gillespie (2003), NSW agriculture (2003) and Parker and Suriyabanadara (2000) of 2000 market *gardeners* or vegetable *farmers* could actually be seen to be similar to Malcolm and Fahd's findings. As has been noted throughout the paper the lack of clarity around the use of the '2000' figure makes it difficult to determine conclusively how previous estimates compare to those of Malcolm and Fahd.

Given the relatively small size of farms, Malcolm and Fahd also question whether some of the farms should be considered 'hobby' farms rather than commercial properties (p.53). The report acknowledges, however, that it is beyond the scope of its findings to speak definitively to these issues as the report did not measure the productivity or value of the farms.

One of the most significant findings of the Malcolm and Fahd report is that the ABS census data from 2006-7 can be seen to be relatively accurate. In comparing the 852 vegetable farms indicated by the 2006-7 ABS agricultural census (Figure 3) to the 1052 vegetable farms found by Malcolm and Fahd it is evident that the ABS data closely resembles those obtained from the on-ground survey. These comparable results contrast with the comparison in the Kelleher et al. (1998) study with 1996-97 ABS agricultural census data for Sydney, in which the figures from the two sources were substantially different.

Our view is that the 2006-7 ABS estimate of 852 vegetable farms in the Sydney Basin could still be seen something of an 'undercount' being below that of the 1052 vegetable farms estimated by the authors. It should be noted, however, that the 2006-7 ABS agricultural census only counts businesses with annual production valued at \$5000, as discussed in Section One. As Malcolm and Fahd indicated, a number of the farms captured in their survey could have been non-commercial, personal farms or farms with an annual output valued at less than \$5000. The authors suggest that if they were to subtract those farms that had outdoor vegetable plantings smaller than

one hectare, and therefore unlikely to meet the ABS criteria for inclusion, the number of farms would be approximately 835 and so similar to the ABS figures (p.38). The authors also noted that some land owners owned and/or farmed on more than one title. Other survey methods would count such businesses as one farm/farming enterprise, thus further reducing the number of farms involved. However due to lack of data Malcolm and Fahd were not able to quantify the numbers affected.

Limits to Study

While the Malcolm and Fahd study is clearly the most up-to-date and detailed study of the size and location of Sydney's vegetable farms, it has a number of limitations in respect to enhancing an understanding of the state of Sydney agriculture. The most obvious limitation perhaps is that the report only covers vegetable farms. Such a limitation was clearly justified as the area and number of vegetable farms in Sydney seems the most contentious element of debates on the accuracy of ABS data on Sydney's agricultural industry. A study with a broader scope, however, would be necessary to deliver a full picture of agricultural land use in Sydney.

There are two other ways in which the methodology used limits the usefulness of this study for analysing Sydney's agricultural industry. The first relates to the capacity for historical analysis. Needless to say, the ground truthing methodology utilised in this report cannot be undertaken retrospectively. As a result this study doesn't talk to changes over time in Sydney agriculture. While Malcolm and Fahd make comparisons with the work of Kelleher et al. (1998) this comparison is limited by differences in scope of studies and methodology. Understanding the need to compare studies over time, one of the key recommendations of the authors is that a study like theirs be repeated on a regular basis in order to build up reliable data on land use change in Sydney.

The second limitation relates to creating consistent datasets into the future. The field based analysis undertaken by the authors, while comprehensive, is very labour intensive. Its demand on time and human resources is, the authors' note, a reason why such studies have not been undertaken with greater regularity. Exploring remote sensing techniques, as previously attempted by Kelleher et al. (1998) and Baginska and Ruffio (2001), with advanced current technology is one option for reducing the labour intensive nature of repeat studies in creating longitudinal data.

In addition, it should be noted that while this report found that the 2006-07 ABS statistics were a reasonably accurate representation of Sydney Basin agriculture, this observation does not indicate that previous ABS data were also accurate. While the findings in Section One show that data from the 2005-6 census onwards has been collected by the same methodology, data prior to 2005-6 cannot be relied on to show the same consistency. It should also be noted that it is only ABS estimates of vegetable farm *numbers* in Sydney and not the extent or value of production that can be verified by the Malcolm and Fahd (2009) findings. Despite this caveat, however, ABS estimates of farm numbers for Sydney provide more reliable estimates for these farms in general

especially since users are provided with clear statements of methodologies used and error margins for understanding estimates provided.

LOCAL GOVERNMENT RURAL LAND STUDIES (1997-2009)

Aim

This section represents rural land studies or agricultural surveys from Sydney's fringe Local Government Areas (hereafter LGAs). It incorporates reports from Baulkham Hills (2003), Penrith (2001), Wollondilly (2003), Hawkesbury (1997; 2008), Liverpool (2007), Wyong (1998), and Camden (2000) LGAs and the Central Coast Plateau Chamber of Commerce (Central Coast Plateau Chamber of Commerce). There were earlier versions of reports from some of these councils, such as a 1993 report from Wollondilly LGA, but this could not be obtained for this report. Other councils such as Blacktown and Blue Mountains indicated to us that they do not have equivalent reports, as did WSROC and MACROC. The status of rural lands or agricultural industry reports of a number of Sydney councils recorded as having agricultural activity in ABS data including Hornsby Shire, Campbelltown, Fairfield and Warringah Councils could not be determined. Of these LGAs, only Hornsby Shire is recorded as having significant agricultural production in the ABS agricultural census. While the reports examined have been undertaken over a number of years they are grouped together here to provide an overall picture on the data utilised by Sydney's local councils.

Findings

While number of studies that provided new data (and these have been discussed separately), the majority of reports utilised snippets of either ABS data or data from NSW Agriculture. Wollondilly and Hawkesbury (1997, 2005) also utilised the Kelleher et al. (1998) study of their LGAs. Penrith, Baulkham Hills and Hawkesbury councils also had agricultural lands analysis undertaken by Ian Sinclair of *Edge Land Planning* consultancy (Edge Land Planning 2001, 2003; Hawkesbury City Council 1997). As the Sinclair data are summarised for the whole of Sydney in the aforementioned 2003 *Western Sydney Rural Lands Study* and the 2004 report *From the Outside Looking In*, they are not detailed again here. Some councils such as Camden and Wyong also drew on rural rebate information to garner farm numbers, as noted in the Camden council study discussed previously (Council of Camden 2000; Wyong Shire Council 1998).

While most reports at least referred to ABS data they also consistently asserted its inaccuracy, citing NSW Agriculture or Kelleher et al. (1998). The majority of reports, however, only reference pre-2005-6 ABS data which, as established in Section One, was indeed likely to be an undercount. Only the 2009 report commissioned by the Central Coast Plateau Chamber of Commerce utilises the 2005-6 ABS data, and so can be considered reasonably correct in the estimates it presents from this source. The report does, however, make a comparison between the findings of the 2000-1 and the 2005-6 ABS agricultural censuses to estimate that the value of agriculture in Gosford had expanded by 83% between the

two census years (p.13). Given the increases created in all ABS measures of Sydney agricultural data in the 2005-6 census it is likely that a large percentage of this increase is due to the ABS methodological change rather than changes in the industry itself.

The analysis of these local council studies and reports are particularly useful as they illustrate the extent to which a select few non-ABS reports have been privileged in official discussions regarding Sydney's agriculture.

Limits

The reports that used snippets of NSW Agriculture or pre-2005-6 ABS data, overall, do not add further information to our discussion of Sydney's agricultural lands. The limits of both ABS and NSW Agriculture data have been discussed separately in this paper and therefore will not be discussed again here.

DISCUSSION

This review began by illustrating that a perceived undercounting of Sydney's farmland in ABS statistics generated numerous alternative reports on the size and value of Sydney's agriculture. The increase in the estimates of both the area and value of Sydney production after the methodological changes from the 2005-6 ABS agricultural census indicates that concern about ABS undercounting was warranted. The methodologies used to produce alternative estimates by government agencies and consultants, however, were not always transparent or replicatable. This lack of methodological rigour brings into question the reliability of these non-ABS estimates and renders them, in most cases, relatively unusable for an accurate and longitudinal analysis of the state of Sydney's agriculture.

Overall this review reveals a rather patchy picture of reports on Sydney's agricultural industry, full of inconsistencies and contradictions in respect to the current state of Sydney agriculture and its changes over time. Many reports have criticised ABS data and some, like Gillespie and Mason (2003), offered estimates well above ABS estimates for the value of production. The Malcolm and Fahd (2009) report, conversely, suggests that current ABS data, albeit of land under production, are quite accurate. The conflicting findings of the various reports illustrate that the lack of a reliable comprehensive data set has created a high level of confusion and uncertainty regarding the area, value and significance of Sydney agriculture.

The lack of methodological transparency has been a key reason for this confusion as it has resulted in a lack of detail about the way in which certain estimates were produced and the replication of unverifiable estimates. The privileging of a few select findings created accepted 'facts' about the Sydney agricultural industry that were not necessarily accurate or reliable. This confusion was exacerbated when estimates shifted and changed with each repetition. This analysis paper has shown that as it was repeated in a number of reports the '2000' figure slipped from vegetable farmers or farm workers to farms. It is unclear whether these were indeed references to the same or different data as the figures were presented without any clear evidence as to their source. Whether the various reports referred to 2000 vegetable farmers or farms, depending on how it was interpreted, could have effectively doubled the number of market gardens estimated to be within Sydney. While either figure represents a substantial number of vegetable farms, the significant disparity between the two figures highlights the need for more accurate and reliable estimates of agricultural land use and value in the Sydney Basin. A consequence of this ambiguous repetition of data is that a wide range of estimates of the number of vegetable

farms in Sydney were then created and referenced, further clouding public debate.

Another potential problem created by the methodological inconsistency across studies of Sydney's agriculture industry is the resulting specificity of data-sets. This specificity means many of the data sets are potentially incomparable for determining longitudinal change. Data produced on the value of agricultural production and data on the area of agricultural land from different years, for example, cannot be directly compared as they represent different modes of analysis. Even when studies have been undertaken on the area of agricultural land use, whether area under farm or area under production was measured can limit the comparability. Malcolm and Fahd (2009), for example, were able to make comparisons with the Kelleher et al. (1998) study on the number of vegetable farms in the Wollondilly and Hawkesbury LGAs. In making comparisons on land under production, however, they had to rely on estimates from Kelleher et al. (1998) derived from the total area of vegetable farms with which to compare with their exact measurements of area under production. The varying methodologies, technologies and modes of analysis mean such comparisons cannot be as definitive, and therefore as useful for longitudinal analysis, as they would be with methodologically consistent data.

Our analysis indicates that data on longitudinal trends in Sydney's agricultural land use is also inconclusive as a result of comparisons between narrow time periods, potentially due to insufficient additional data. In his analysis of ABS data from the 1996-7 and 2000-1 agricultural censuses, Gillespie (2003) found a 10% decline in agricultural land. In contrast, however, the examination of ABS data from 1992-3 to 2007-8 in Section One suggested fluctuations in the area of agricultural land use over time rather than a consistent trend of decline. This analysis, undertaken with the benefit of data from subsequent ABS agricultural censuses, brings into question the claims about the absolute loss of farmland in Sydney. Such a trend cannot be confirmed conclusively due to the changes in ABS methodology between 1992-3 and 2005-6. This comparison does highlight however that an accurate analysis of land use changes across the Sydney Basin requires a methodologically consistent data set covering an extended time-period.

As a result of the limitations identified in both ABS and non-ABS sourced data, our analysis indicates the extent of Sydney's agricultural land use is a question yet to be satisfactorily answered. Key here, as with the comparative analysis, is the issue of how land is measured. The ABS 'area of holding' data represent entire farm lots rather than the number of physical hectares farmed, as noted in Section

One. The Kelleher et al. (1998) findings also appeared to have been derived using the same method of lot measurement. In broad-acre farming the distinction between farms and area being farmed is, as noted, perhaps unimportant and would not produce a significant disparity in final acreage data. In small scale farms like those around Sydney, however, the percentage of a property that may be taken up by non-productive land is much larger. An unpublished finding of the Malcolm and Fahd survey was that on some farms agriculture represented the entire area of the farm while on others as little as 10% of the farm constituted land under production (Peter Malcolm pers com. 07-07-10). These findings indicate that data on the area under production in Sydney is critical in planning for the future of the industry. While the Malcolm and Fahd (2009) and Baginska and Ruffio (2001) studies mapped various aspects of the area under crop, a study on the area being used for both general agriculture and intensive cropping for the entire Sydney Basin still needs to be undertaken.

In noting the need for more reliable data on trends in Sydney agriculture, it is also important to question whether a loss of agricultural land, particularly prime agricultural land, is the only issue to consider in terms of the future of the industry. The intensification of Sydney's agricultural industry indicated by many reports suggests that the industry has undergone substantial change over time and is now less reliant on land quality for production. The intensification of the vegetable industry combined with an increase in its unit value, noted in ABS data in Section One and in comparison studies (Johnson et al. 1998; Gillespie 2003), suggests that while there has been a noted fragmentation of prime agricultural land in areas such as the Hawkesbury and Wollondilly (Kelleher et al. 1998), productivity in many sectors of Sydney agriculture would appear to have increased. Such findings point to the dynamic nature and high productivity of Sydney agriculture. These findings also bring into question whether it is principally prime agricultural land that needs to be protected through planning policy or the absolute availability of land, albeit with sufficient water and access to market, for agriculture in Sydney?

In terms of the long term future of Sydney agriculture concern might also, and arguably more appropriately, be expressed about the decline of certain agricultural industries, particularly food producing ones, rather than only the decline of agricultural land. Most recent ABS data on the value of Sydney production outlined in Figure 4 indicates that Sydney produces a substantial amount of turf and cut flowers which are a high value product but do not contribute to food supply. As Malcolm and Fahd (2009) note, a great deal of formerly food producing agricultural land in the Hawkesbury LGA has now been turned into turf farms due to the better return on and reliability of the crop compared to vegetable production. This trend points to the need to assess the relative viability of farming in terms of costs of production and costs of land, an issue highlighted but not addressed in detail in the non-ABS reports on Sydney agriculture examined in this paper (Agribiz Consulting 2007; SJB Planning 2006). The question of economic, and social, viability, in addition to the absolute availability of land, are key factors in the on-going feasibility of the Sydney Basin agricultural industry. Further consideration

and detailed analysis of these issues in detail is an important topic for further research.

In undertaking research on the economic viability of small-scale farms in the Sydney Basin, however, it must be recognised that it is a complex and dynamic issue. There are many factors to be taken into account as farms are often family-run and reliant to varying degrees on off-farm income. Other industry-wide factors such as the increasing costs of and low returns on agricultural production also have a significant impact on Sydney growers. A cost-effective way of securing insights into the issue of economic viability would be an in-depth case study approach, targeting specific sectors of the industry. Due to the diverse and disparate nature of Sydney's agricultural industry, undertaking a comprehensive industry-wide survey would be costly and carry a high risk of failure.

CONCLUSION AND RECOMMENDATIONS

The report has found that the ABS data from the last agricultural census date of 2005-6 is the most up to date and reliable data on the area, number of farms and production value of Sydney agriculture, apart from the Malcolm and Fahd (2009) report on Sydney's vegetable farms. This statement is made with the understanding that there are still a number of deficiencies in the ABS data set. One area of concern is that there are still possible data gaps regarding CALD growers on Sydney's fringe as many of the reasons previously raised in relation to the undercounting of these groups, including the difficulties of completing ABS agricultural censuses still remain. There may also be agricultural businesses that fall under the ABS criteria of an EVAO of \$5000 and therefore aren't counted in the ABS agricultural survey. The close alignment, however, of the number of vegetable farms found by the Malcolm and Fahd (2009) study and that of the 2006-7 ABS agricultural survey would suggest that the ABS data is now relatively reliable. This comparison is particularly relevant in addressing criticism of the inclusion of CALD growers in ABS data as the vegetable industry is estimated to be composed of 80% to 90% CALD growers. Another deficiency of current ABS data is the lack of comparability with previous census periods. The ABS data also doesn't provide data on the area of land under production in the Sydney Basin, a critical data set for urban planners in understanding the land use needs of this industry. Understanding these deficiencies enables the use of this data with confidence, however, rather than prohibits its use.

Despite noting the limitations of data produced by certain non-ABS reports, this analysis report has also illustrated that such independent reports can also provide useful data on Sydney agriculture. This review found the Malcolm and Fahd (2009) report to be the most comprehensive and detailed ground truthed study of the area under production and number of farms in Sydney's vegetable industry in at least the last 15 years. The findings of this study illustrate the need for independent ground truthed studies to be undertaken on a regular basis. The role of the Malcolm and Fahd study in confirming the validity of current ABS data indicates such studies are necessary to provide a comparison to and constant check of ABS findings. The Malcolm and Fahd study also illustrates that independent studies have the capacity to provide much more detailed data on the size, location and area under production of the individual farms than are available from ABS statistics.

A comparison between the findings of Malcolm and Fahd report and the AgriBiz (2007) report illustrates, however, that the methodology of non-ABS studies by consultant, government or academic groups must be closely scrutinised. As our analysis indicated methodological limitations, including the scope and

scale of studies undertaken, risk under-estimation as much as an over-estimation of the area and number of Sydney farms. The difference between the 22 vegetable farms (or 44 if polyhouses are included) counted in the AgriBiz (2007) survey and the over 300 vegetable farms counted by Malcolm and Fahd's (2009) survey in the Liverpool LGA is substantial. The gaps between the two findings also suggest that the nature of Sydney's small scale urban agriculture serves to challenge and confound attempts to define it on the same terms as conventional broad-scale agriculture. By setting aside assumptions that agriculture will only be found in the most rural areas, a comprehensive mapping of all of Sydney's peri-urban land would provide a much more accurate analysis of the city's agricultural land.

To address the identified need for up-to-date and reliable data on Sydney agriculture, this report recommends that remote sensing technology be used in combination with GIS technology to determine both the area of land under production as well as the area of farmland in the Sydney Basin. This mapping should represent all land uses on the urban fringe – including urban development, waterways and national park – in addition to agricultural land uses. Such a comprehensive mapping is important for understanding the extent and change over time of other land uses, particularly in relation to housing development. Identification of existing land uses also provides an opportunity for the identification of areas for potential future agricultural development.

Remote sensing and GIS analysis are recommended as the preferred methodologies for this land use mapping for a number of reasons. The first is that the replication of field based surveys using a combination of GIS and ground truthing surveys of Sydney's agricultural lands would require the same kind of labour intensive effort undertaken for the Malcolm and Fahd report. The nature of such surveys makes them difficult to repeat and is likely to be the main reason such studies have not been undertaken regularly. The use of automated remote sensing technology combined with GIS programs and selected ground truthing would allow for future mapping to be undertaken via a less labour and time intensive method. Furthermore, as remote sensing software allows for an automated image analysis process, the potential for human error that exists (especially in visual/manual classification) is minimised.

The technological advances in remote sensing technology and the improved resolution of satellite imagery since the Kelleher et al. (1998) and Baginska and Ruffio (2001) reports, also mean it is now a much more effective way of measuring the specific number of hectares under agricultural production in Sydney.

Remote sensing analysis also enables the broad-scale mapping of all land uses on the urban fringe through the use of satellite imagery. Overall, conducting complementary surveys and data collection exercises can improve understandings of Sydney Basin agriculture and allow for the development of longitudinal data sets to determine long term trends. Such detailed longitudinal data is vital for planning for the future of Sydney's agriculture into the future.

The primary step for the application of remote sensing technology is in an initial survey of Sydney's agricultural land which would have to include access to satellite imagery and use of verifiable techniques for the interrogation of remotely sensed data. Having established the data sources, techniques and undertaking of initial analysis, repeat analysis would be able to be completed annually or bi-annually with reasonable efficiency. It is recommended that a mapping be completed at least every five years to coincide with the ABS agricultural census. Before proceeding with the initial survey of agriculture by remote sensing, however, a technological and economic audit and planning processes would need to be undertaken.

APPENDIX 1: REPORTS EXCLUDED FROM ANALYSIS

Gibson and Lawrie (2003)

Effluent reuse in the Hawkesbury Region – Issues and Land Suitability

This study used estimates of land under irrigation from Bill Yasoumi, NSW Agriculture. This suggests that agricultural land in the Hawkesbury Region was 12,127 hectares. The methodology for obtaining these results is unspecified and is therefore not examined in this report.

Strong and Lee (2006)

Chinese Women Working in Market Gardens Across the Sydney Basin

This report addressed issues faced by Chinese women market gardeners in Sydney and was commissioned by the NSW Area Health Service. It uses the 1991 ABS statistics presented in the Parker and Suriyabanadara (2000) report which are examined in this paper.

SJB Planning (2006)

Rural Resource Lands Study

The aim of this study was not to measure Sydney's agricultural land but rather provide an analysis on planning options for its future, as part of Sydney's rural resource lands. This report offers no original data and little secondary data on Sydney's agricultural lands. Its use of the Gillespie and Mason (2003) data is a further example of the almost ubiquity of these figures despite the lack of transparency around their calculation.

This report argued that there were many underlying factors in the viability of agricultural production on Sydney's fringe that were interconnected with land use availability. Of particular relevance, they surmised, was the return from production relative to the increasing value of land. The increasing pressure from urbanisation on the fringe is seen to also create challenges for farmers in terms of neighbour conflict.

Rae (2007)

Water Management in South Creek Catchment: Current state, issues and challenges

This report was undertaken for the Irrigation Futures CRC. As part of an analysis of water management issues the report examined land use in the South Creek Catchment area. The data given in report is from Baginska and Ruffio (2001) and have been discussed in the main body of the report.

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