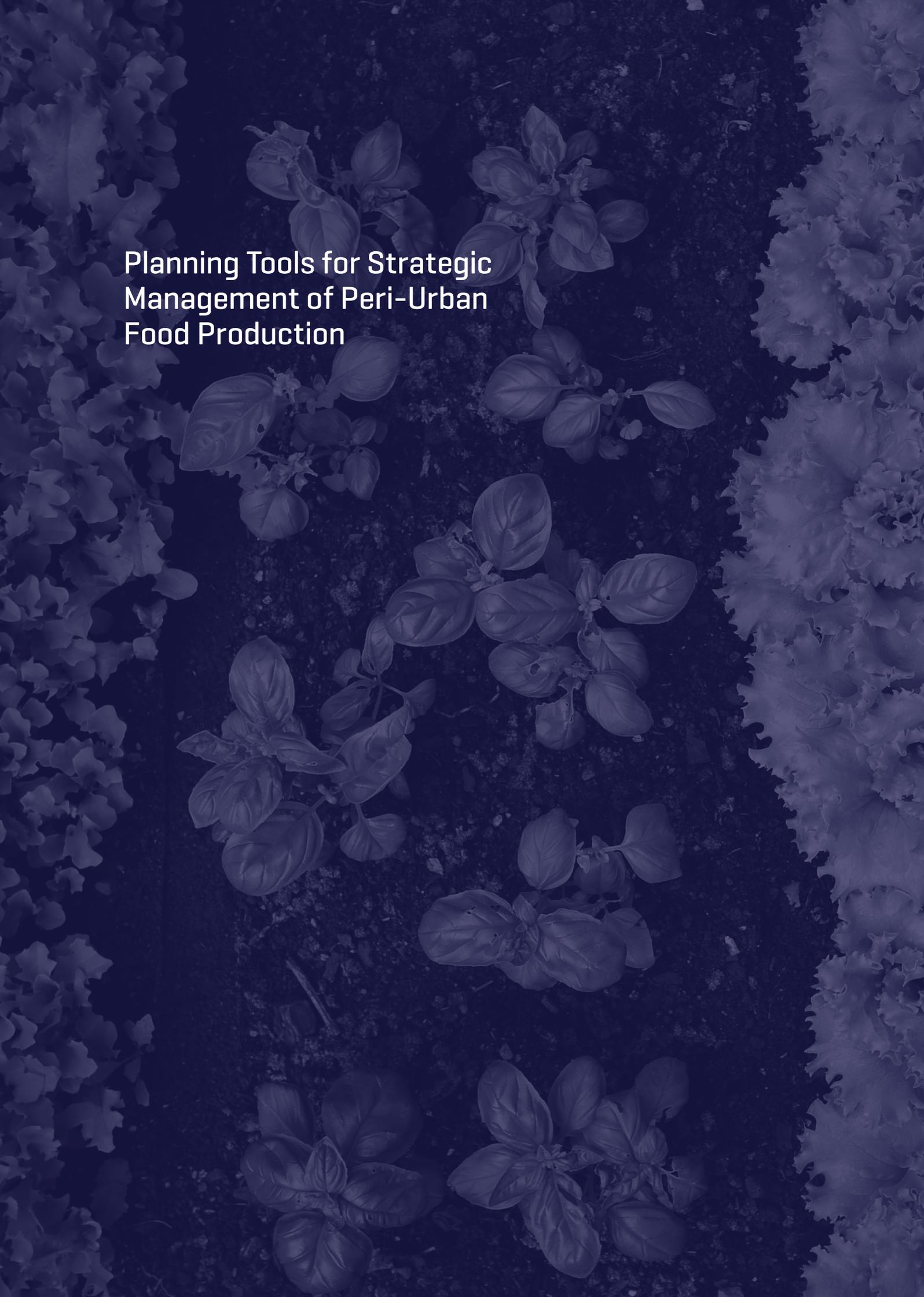




September 2016

Planning Tools for Strategic Management of Peri-Urban Food Production





Planning Tools for Strategic
Management of Peri-Urban
Food Production

Report for Royal Institution of Chartered Surveyors

Report written by:

Laura Wynne

Dr Dana Cordell

Joanne Chong

Dr Brent Jacobs

Institute For Sustainable Futures
University of Technology Sydney
PO Box 123
Broadway, NSW, 2007
Australia
www.isf.edu.au

RICS Research team

Dr. Clare Eriksson FRICS

Director of Global Research & Policy
ceriksson@rics.org

Amanprit Arnold

Global Research and Policy Manager
aarnold@rics.org

Published by the Royal Institution of Chartered Surveyors (RICS)

RICS, Parliament Square, London SW1P 3AD

www.rics.org

The views expressed by the authors are not necessarily those of RICS nor any body connected with RICS. Neither the authors, nor RICS accept any liability arising from the use of this publication.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Copyright RICS 2016

Study sponsored by :



The RICS Research Trust, a registered charity established by RICS in 1955 to support research and education in the field of surveying.

Contents

Executive Summary	5
1.0 Introduction	7
1.1 What are peri-urban areas?	8
1.2 This report	9
2.0 Challenges for Peri-Urban agriculture	10
2.1 Land-use pressures	10
2.1.1 Land-use change	10
2.1.2 Land-use conflicts.....	11
2.1.3 Fragmentation and biosecurity.....	12
2.2 Global pressures	13
2.2.1 Climate change impacts.....	13
2.2.2 Resource scarcity	14
2.2.3 Other threats to global food security	14
2.3 Future scenarios for Sydney agriculture.....	15
2.3.1 2011 production	15
2.3.2 Urban Sprawl scenario.....	16
2.3.3 Limited Sprawl scenario.....	18
2.3.4 Agriculture Prioritised scenario	18
2.4 Engaging stakeholders	19
2.4.1 Feedback on scenarios and maps	19
2.4.2 A collaborative vision of a resilient food future for Sydney.....	19
3.0 Planning tools and responses	20
3.1 Strategic planning	22
3.2 Zoning.....	23
3.3 Transferrable development rights	25
3.3.1 Success factors for TDR schemes	25
3.3.2 Challenges for TDR programs.....	26
3.4 Right to farm policies and legislation.....	28
3.4.1 Coming to the nuisance – protecting pre-existing activities ...	29
3.4.2 Preference over existing land uses.....	29
3.4.3 Changes in use and activities.....	29
3.4.4 Compliance with particular practices.....	30
3.4.5 Impacts and implications.....	30
4.0 Valuing benefits of peri-urban agriculture	32
4.1 A framework for identifying the benefits of peri-urban agriculture	32
4.2 Emissions and waste benefits	36
4.3 Socioeconomic benefits.....	36
4.4 Food security benefits.....	37
4.5 Ecosystem benefits.....	38
4.6 Urban liveability.....	38
5.0 Conclusion	39
6.0 References	40
7.0 About the Authors	41

Executive Summary

Peri-urban areas around the world have traditionally been the food bowls of our cities. Increasing urbanisation is threatening the existence of peri-urban agriculture, paving over the soils that have fed global city populations.

Peri-urban agriculture provides important benefits to our cities. Indeed, it underpins the resilience of our cities by:

- Buffering against climate change; Sydney's rainfall and soil fertility means it may have a comparative advantage over other more sensitive foodbowls like the Murray Darling Basin
- Reducing emissions and waste generation, due to locally-produced food being transported shorter distances, stored for less time and therefore associated with less food waste than food produced further from markets
- Providing socio-economic benefits associated with employment and economic benefits, including supporting farmer livelihoods and associated industries such as food processing and agro-tourism
- Increasing food security, through factors such as shorter transport routes being less vulnerable to disruption, and potential affordability benefits in the event of future oil price shocks (which may result in higher costs for imported food)
- Assimilating urban organic wastes by recycling municipal food waste and wastewater in agricultural soils
- Providing ecosystem benefits, such as provision of green open space which can both cool the urban heat island effect and support for biodiversity, and
- Improving urban liveability, including the potential to support urban cooling and flood mitigation.

Increasing conversion to commercial and residential uses, fragmentation, land-use conflicts and global challenges such as climate change pose a threat to the viability of food production in peri-urban areas.

Policy responses are needed to ensure that these threats are not realised and that our cities do not lose valuable food-producing lands.

This report considers responses that might emerge from the planning system to address threats to peri-urban agriculture. The report focuses on the experience of peri-urban planning and food production in the Sydney Basin, in New South Wales, Australia. Cities around the world will have local permutations that will make the findings of this paper more or less relevant for their context, however we believe that the findings will likely be relevant to policy makers and practitioners in a range of contexts.



The report reviews a range of planning responses to managing peri-urban areas for resilience and sustainability. These include strategic planning measures, financial incentives, property rights protections and improved methods for valuing the benefits that peri-urban agriculture provides to cities.

The review finds that, if cities truly aim to effectively manage and support agriculture in peri-urban areas, they will be required to implement a several-pronged approach. Achieving positive outcomes for peri-urban agriculture will require at least some of the following components, likely several in combination:

- A transferable development rights scheme (a planning-system based incentive scheme) to provide additional income for farmers and improve economic viability, as well as recognise the true cost of development and density in urban areas,
- More rigorous zoning and buffer zones to prevent the rezoning of agricultural land,
- Right-to-farm legislation that balances the rights of neighbours with farmers' right to operate their businesses profitably, recognising that changes in activities will occur over time, but preventing significant infringement of neighbour's amenity,
- Modelling of likely changes to land use and food production in peri-urban areas to assist farmers in understanding the impacts of conversion of lots to alternative uses,
- Recognition in strategic plans of agriculture as a priority land use and the inclusion of an explicit intention to preserve agricultural land in peri-urban areas,
- Reconsideration of the doctrine of 'highest and best use' that prevails within the planning system, to recognise the full range of benefits provided by peri-urban agriculture,
- Strategic planning measures such as an urban growth boundary or green belt, and
- A framework, as suggested in the following section, to more fully value the benefits of peri-urban agriculture to allow more informed assessment by planners in considering rezoning applications.

Other important measures that sit outside of the planning system (and hence outside the scope of this) are likely to include:

- Data collection and development of modelling programs to understand landscape changes over time, areas most in need of protection, and future scenarios for likely land use change.
- Market protections to protect farmers within Australia's duopoly-dominated food retail market. Measures may also be required to recognise the environmental externalities associated with transporting food long distances.
- Food waste policies and campaigns are needed to reduce the proportion of food in the system that is produced but never consumed. This will have benefits for food security as it will reduce overall demand for food by increasing efficiency of consumption.

Given the multi-faceted nature of the problem of peri-urban agriculture loss, a multi-faceted solution is likely required. Simply providing a property right protection such as a right-to-farm, while effective in ensuring a farmer's right to operate their business, will not necessarily prevent the conversion of neighbouring land to urban uses, nor will it necessarily guarantee the viability of the farming operation. Similarly, while strategic planning measures such as urban growth boundaries can be effective, they will likely be unsuccessful if not supported by strong zoning and explicit protections for agricultural land uses. A multi-faceted approach with long-term objectives is required to address the many challenges faced by peri-urban areas.

For many cities, perhaps including Sydney, a large proportion of peri-urban food production has already been lost, converted to residential use and supporting infrastructure. For that which remains, and for those cities that have sustainably managed their peri-urban agricultural lands, policy and initiatives are required to ensure that food production on the urban fringe can continue to contribute to urban resilience in the future.

1.0 Introduction



The world is rapidly urbanising, placing pressures on our cities to house and employ many billions more people than ever before. As our cities swell to accommodate this growing population, they place pressures on the natural systems upon which they depend for food and resources. In particular, peri-urban areas—those areas that border our cities and have traditionally supplied fresh food to city populations—have come under threat as cities have sprawled progressively outwards.

As trade flows become ever more international, market forces encourage the purchase of our food from overseas markets that may be cheaper or more efficiently produced than that from domestic producers. However, relying on these simple calculations of efficiency ignores the serious risks that we may introduce by allowing our food supply to become increasingly exposed to international transport and geopolitical relations and changing climate. Supporting food production in peri-urban areas may prove an important means to mitigate these risks.

There are many wide-ranging benefits that are unique to peri-urban agriculture and cannot be provided to cities by agriculture in more remote rural areas. These benefits include environmental services such as emissions and waste reduction potential, socio-economic benefits related to employment, food security outcomes, ecosystem benefits and improvements to urban liveability.

Historically, urban agriculture was important to the cities, though production appeared to decline throughout the 20th century, likely due to innovations in transport and storage technologies, allowing food to be brought greater distances to market. Recent concerns about economic and food instability has increased interest in bringing food production back to city hinterlands within many developed countries including the USA (Russo, Tomaselli, & Pappalardo, 2014). The multiple benefits provided by peri-urban agriculture are discussed in detail in Section 4.

As cities increasingly recognise their vulnerabilities to a range of economic and environmental changes, they will require tools and methods to protect—and, in some cases, restore—their city's peri-urban agricultural base. Improved policy measures and strategic planning are required to ensure that the role of peri-urban agriculture in supporting city resilience is recognised and protected.

This report considers responses that might emerge from the planning system to address threats to peri-urban agriculture. The report focuses on the experience of peri-urban planning and food production in the Sydney Basin, in New South Wales, Australia. Cities around the world will have local permutations that will make the findings of this paper more or less relevant for their context, however we believe that the findings will likely be relevant to policy makers and practitioners in a range of contexts.



1.1 What Are Peri-Urban Areas?

Peri-urban areas are the dynamic interface between our cities and rural areas. In developed country contexts, these regions usually comprise a mix of urban and rural uses, such as residential dwellings (often on large ‘rural lifestyle’ blocks), small-to-medium-scale agriculture such as horticulture, and semi-rural uses such as the horse industry, as well as the occasional town centre, often concentrated around a transport hub. Peri-urban regions tend to share many characteristics with urban regions, however they serve distinct functions that support the urban area to which they are adjacent. In developing country contexts, peri-urban areas often include proliferations of informal settlements and informal industries interspersed with agricultural lands, often family-owned smallholder farms producing foods that are transported daily to market.

Due to their close proximity to markets and populations, peri-urban areas play an important role in providing food for urban populations—especially in supplying food that is perishable and cannot travel long distances to market, such as coriander or eggs. However, peri-urban regions are also the areas into which our cities tend to grow as they expand over time, making them vulnerable to being subsumed for housing and infrastructure.

Burnley and Murphy (1995, p245) argue that, in the Australian context, peri-urban areas have been defined as ‘the urbanised edges of cities plus the spaces into which they expand, both physically and functionally’ [emphasis added]. This definition has allowed for a conception of a city that ‘constantly absorbs its fringe area and creates a “new” fringe further from the city centre’ (Golledge 1960, p243).

The Sydney metropolitan area, however, is topographically constrained. With national parks to the north and to the south, the ocean to the east and the Blue Mountains to the city’s west, the city is unable to exponentially expand and move its fringes ever outwards. Thus, measures are required to respond to the current expansion of the city into its peri-urban areas.

Innovation and opportunities often arise at the fringe or intersection of systems, and the same is true of peri-urban regions. As the interface between urban and rural, they present us with opportunities to capitalise on the unique features of those two land types—for example, recycling a city’s food and green waste for use as a quality compost in agriculture. Additionally, such areas arguably require special consideration in planning systems. Urban planning mechanisms, intended to deal with the fabric and form of the city, are often not sufficient in their ability to protect land uses such as agricultural production. However, the processes and systems applied in rural and regional contexts may also be unsuitable, as they may be unused to dealing with population growth pressures (Australia, like many other nations, is suffering a decline in its rural population, with regional areas suffering from out-migration, rather than population growth pressures). This paper argues that a number of measures are required to ensure that planners are adequately equipped to consider peri-urban regions as having different fabric and form to both cities and rural areas.



1.2 This Report

This paper draws on the findings of two research projects relating to peri-urban agriculture. The two projects have recently been conducted—the Mapping Sydney’s Foodsheds project, funded by the Building Resilience to Climate Change fund in NSW, and research focused on planning system responses to peri-urban agriculture, funded by the Royal Institution of Chartered Surveyors. Together, these projects undertook a range of research methods to understand challenges, opportunities and best practice responses for peri-urban agriculture, including:

- A literature review regarding the benefits, challenges and opportunities for peri-urban agriculture
- A literature review and stakeholder engagement regarding best practice land-use planning for peri-urban areas
- A series of stakeholder engagement events that sought to understand the challenges faced by peri-urban agriculture in the Sydney Basin, and possible responses to these challenges
- Development of a framework for capturing the total value of peri-urban agricultural land and risks associated with its loss
- Evaluation of a series of interactive scenario maps that were communicated to a broad audience.
- Development of a modelling approach to project a range of scenarios for land-use change, and their impact upon food production. This also included a number of demand-side scenarios that modelled the implications for a range of population dietary choices upon the city’s ability to meet demand for food from within the Basin.

This report outlines the findings of the research undertaken for the Royal Institution of Chartered Surveyors, however draws also on the work undertaken through the Mapping Sydney’s Foodsheds project.

The first section of this report addresses challenges facing peri-urban agriculture, both in the Sydney context and in other jurisdictions. This section is followed by an overview of the results of a scenario modelling exercise to understand the implications of these challenges for the future of peri-urban food production in Sydney, as well as an evaluation of the usefulness of these maps for stakeholders. The following section provides an overview of common planning system responses to the loss of peri-urban agriculture, including an assessment of the strengths and drawbacks of these responses as reported in the literature. A key finding of this review is the need for a framework for valuing the various benefits provided by peri-urban agriculture so that such values might be fully accounted for in land-use change assessments. Thus, Section 4 of this report provides a framework for capturing the various benefits that peri-urban agriculture might provide to adjacent cities.

2.0 Challenges for Peri-Urban Agriculture

Our modelling has shown that, in the Sydney context, the growing population (or, rather, the geographic pattern of the city's accommodation of this population growth) poses a threat to the future of peri-urban food production. However, urban systems are complex ones, and the relationship between population change and peri-urban farming involves a number of interactions that relate to varied pressures. Capturing all of these diverse interactions in one report would no doubt be challenging, and so we make no claim to do so. Rather, here we summarise some key pressures that are being experienced by peri-urban agriculture across three key themes that emerged throughout our discussions with stakeholders—land-use pressures, fragmentation issues and global and economic factors.

The findings in the section are drawn from the series of stakeholder engagement sessions, as well as interviews with key stakeholders, and a literature review. As mentioned previously, many of the findings may be relevant for other cities, though many will be subject to regional variations.

2.1 Land-Use Pressures

A key challenge for peri-urban agriculture in the Sydney Basin—and in most expanding peri-urban regions of the world—is the conversion of agricultural land for residential, commercial or other non-agricultural uses. There are two key, interrelated, elements of this, which are discussed below. The first of these is the loss of productive land suffered through the conversion of lands to non-productive uses, and the second is the conflict that arises as a result of the increasing proliferation of non-agricultural uses (particularly residential uses) neighbouring farms, which have impacts upon the ability of farmers to operate their business.

2.1.1 Land-Use Change

The increasing urbanisation of land is a global phenomenon. In Europe, at least 2.8% of all land experienced a change in use between 1990 and 2000, the majority of which was an increase in urban areas (La Rosa, Barbarossa, Privitera and Martinico, 2014). In Sydney, as in other Australian cities, a significant proportion of food-producing land has already been converted to other uses—primarily, residential—due to 'poor planning, haphazard development and a lack of environmental oversight of land use practices' (Choy and Sutherland, 2008). Our modelling indicates that around 60% of Sydney's remaining agriculture is likely to be lost if current plans are implemented and sprawl allowed to continue at current rates.

Numerous stakeholders are affected by, or influence, land-use change. These include farmers, residents, developers, environmental managers, planners, water managers and health service providers.

While many stakeholders consulted as part of this project were quick to blame planners at both the state and local government levels for this widespread conversion of lands, the web of factors that contributes to this change of use is far more complex—and, quite often, starts with the farmers themselves. Farmers who wish to retain agricultural production in peri-urban areas often feel that planners are waging a war against their existence, ushering in residential subdivisions around them. The reality, however, is messier.

In general—and certainly in the Sydney Basin—the value of agricultural property increases when it is rezoned for residential uses. Thus, for some farmers, peri-urban properties can be regarded as property investments or 'capital nest eggs' (Cook and Harder, 2013). For some growers, selling land at a premium and shifting operations



to areas with lower land values is a real strategy to sustain their businesses, and may provide their main opportunity for survival. For others, it provides a retirement strategy—often, their only option for retirement after years of declining profitability. The resultant conversion of land to residential uses has significant impacts on those farmers who are not interested in converting their land to new uses, and who would prefer to retain their land as productive agricultural land for future generations. These farmers consequently face increased land-use conflicts and fragmentation (discussed further below).

The incentive to subdivide at the grass roots is often matched by political support for rezoning land at the state government level in NSW, where pressure to house a growing population is felt most keenly (Cook and Harder, 2013). In the short term, this may be mitigated by a small number of farmers shifting to rural areas where they are able to operate more profitably. The cumulative effect of this conversion, however, tells a different story. As more farmers sell their land for residential sub-division, fewer and fewer farms remain on the city's fringe, and those who do are increasingly subject to the land-use conflicts discussed in greater detail below. In the long term, the total loss of agricultural land may be significant – indeed, as the modelling conducted by this research team determined, in Sydney it will reduce local food production to only 6% of total food supply by 2031, down from 20% in 2011.

The steady conversion of agricultural land to residential uses has fuelled a widespread perception by many community members and decision makers of peri-urban areas in Australia as 'suburbs-in-waiting', and agriculture land as simply latent, waiting for investment interest to convert it to residential use (Rothwell, Ridoutt, Page, & Bellotti, 2015).

Planners at the local government level reported frustration with farmers about the blame apportioned to the planning profession for the loss of agricultural lands. They noted that local government planners are generally only empowered to consider and assess applications from farmers to rezone and subdivide their land, rather than themselves being active in facilitating the shift from agricultural to residential uses, as they are often perceived to be. However, the criteria that local government planners are required (by regulation, legislation and conventional planning practice) to use to assess such applications may be to blame for the conversion of land. Local government planners are required to weigh the application against a range of factors, including identifying the 'highest and best use' for that parcel of land (calculated, at present, on economic values alone, usually weighing the annual productivity of that parcel as agricultural land against its saleable value as residential land) and the broader state government plans for that area. Given that, in the Sydney context, the current state government plans involve significant expansion of the city into peri-urban areas to the city's north west

and south west, as well as overheated property prices across the city, such assessments generally result in the conversion of land to residential uses.

A market-driven process, rather than planned process of urban consolidation, is likely to deny the possibilities for restoring food production to urban areas (Gleeson, 2013). In NSW, where the planning system could be described as strongly market-driven, strategic plans tend to favour residential sprawl over alternatives uses or growth patterns, and the absence of protective measures tend to fail to provide a means by which to prevent the conversion of lands to residential use. Further, resistance and opposition to increased densities throughout the city has fostered reluctance on the part of planners to push for increased densities in 'middle ring' suburbs.

2.1.2 Land-use conflicts

In addition to the absolute loss of available agricultural land, concerns abound about a loss in agricultural production, farmer livelihoods and commercial viability associated with fragmentation and rezoning or subdividing of agricultural land. The increase in residential neighbours as a result of sub-divisions in peri-urban areas can lead to increased conflicts between farming and 'lifestyle' landowners. The resolution of such conflicts has, in many cases, been detrimental to farmers, who have consequently faced declining profitability due to restrictions on their operations. In the Sydney context, many of these farmers have reportedly been forced to relocate outside the Basin, or have simply sold their land for residential uses and retired.

Agricultural activities involve impacts such as noise—tractors, trucks and other machinery, smells—manure, fertiliser, organic waste; impacts that are at odds with the peaceful, rural lifestyle that many 'tree-changers' seek when they move to peri-urban areas. These impacts have led to a rise in nuisance complaints from new residents seeking to limit the activities of neighbouring agricultural businesses (Houston, 2003). This has, in turn, led to councils applying restrictions on agricultural operations that have been subject to complaints, such as limitations on hours of machinery operations or constraints on the types of fertilisers used. These restrictions often impinge upon farmers' abilities to operate profitably. In particular, intensive animal industries, such as shed-based poultry, that have remained present in peri-urban areas, have frequently come into conflict with new residents.

A common way to protect farmers from nuisance complaints that might impede their ability to operate their business is through the introduction of a 'Right to Farm'. 'Right to farm' laws ensure that agricultural operations are protected uses in particular areas, and that the normal operation of their business cannot become subject to nuisance complaints. As discussed in Section 3.4, legislation to this effect has recently been tabled in NSW.

2.1.3 Fragmentation and biosecurity

Concessional lots, or large residential lots allowed on portions of land zoned 'Rural', are seen by many planners as a compromise to the wholesale subdivision and development of agricultural land. Such lots usually take the form of 'lifestyle lots' that involve a small number of livestock such as poultry, goats or horses as well as (usually small) vegetable gardens or hobby farms. Due to these lots being relatively 'rural' in appearance, planners often see them as less damaging to surrounding agricultural industries than other forms of development. However, there are several implications for farmers when this type of development occurs.

Firstly, the residential neighbours on such lifestyle lots are commonly the source of nuisance complaints. Many occupants of lifestyle lots are 'tree changers' – residents (often retirees) who move to peri-urban areas for a quieter lifestyle than the city offers. These residential newcomers may not be accustomed to the noises and smells of agriculture, and may find that these disrupt their enjoyment of their property, resulting in nuisance suits against farmers which seek to prohibit the use of certain inputs or to limit particular types of activities, as noted in Section 2.1.2. These types of challenges and responses to them are discussed in Section 3.4 on right-to-farm laws.

A second major implication of this fragmentation of agricultural lands is the potential impact on biosecurity. While most commercial farmers operate in ways that minimise biosecurity risks, many hobby farmers or lifestyle lots are unaware of the ways in which their practices might compromise the biosecurity of adjacent farming operations. Stakeholder engagement conducted for this project identified key potential challenges, including:

- Risks posed by poor maintenance of assets such as dams, which may attract wild ducks that carry pathogens such as avian influenza;
- Risks posed by inadequate weed removal regimes can compromise the containment of invasive species which may spread to adjacent farms and affect crops and horticulture;
- Risks posed by poor health of livestock such as goats and pigs, who may carry diseases that remain untreated and could be transferred to humans or other livestock, if poor livestock management practices are in place;
- Risks posed by any poor practices relating to livestock feeding, such as feeding meat to pigs, who may contract contagious diseases.

The close proximity of residential neighbours also increases the potential number of receptors for contagious diseases, multiplying the potential health risk posed by farming operations.

In Sydney, these risks to biosecurity presented by subdivision and fragmentation of peri-urban lots have only recently been recognised. A new program has been established by the Department of Primary Industry to address the challenge, which is growing in scale as fragmentation continues apace. These challenges likely exist in many peri-urban areas undergoing similar changes, yet few planning regulations appear to require planners to consider the biosecurity implications of concessional lots and residential subdivisions in peri-urban areas.

At present, planners in the Sydney Basin reportedly do not consider biosecurity risks when assessing applications to develop parcels of land for residential use—indeed, there is no regulatory requirement for them to do so. However, environmental and public health has traditionally been a key domain for the planning sector, and perhaps it is time for planners to consider such implications when rezoning land. Of course, such considerations would best be included in conjunction with a right-to-farm protection that recognises the rights of existing agricultural operations, so that these agricultural activities themselves do not become deemed unacceptable biosecurity risks in peri-urban areas, but rather that we recognise the risks posed to agriculture by semi-urban land uses.



2.2 Global Pressures

Agriculture has had a profound impact on people and the planet. At the same time, emerging global challenges like climate change and resource scarcity are threatening the viability of food systems and there is a strong need for planned adaptation.

While the rise of agriculture thousands of years ago has enabled the global population to grow, cultivating land for the production of food has been the cause of many of the drastic changes to our landscapes that we have facilitated over the last several hundred years. Producing food has a profound impact on our environment—over 30% of the Earth's total land coverage has now been altered to support livestock, according to a report by the UN Food and Agriculture Organisation.

2.2.1 Climate change impacts

Schmidhuber and Tubiello (2007, p19703) found that 'essentially all quantitative assessments show that climate change will adversely affect food security'. Changed rainfall patterns and increasing temperatures will make it more difficult for farmers to produce the same amount of food that they have produced historically. However, unlike the rest of NSW and much of Australia, the Sydney Basin is not expected to become less suitable for agriculture under a changing climate meaning that its relative importance for Sydney's food security will increase over time.

Australia's extreme weather of droughts and floods is set to become even more extreme under climate change (CSIRO & Bureau of Meteorology, 2015). Australia's climate is naturally variable, with rainfall patterns influenced by yearly and ten-yearly fluctuations making alternating periods of drought and floods common. Such variability makes food production challenging—and this will be exacerbated as our climate continues to change over the coming years. The El Niño weather patterns that bring drought to Australia are likely to become more frequent as our climate changes (Yeh et al., 2009), meaning more regular droughts, making it more difficult for farmers to produce crops and sustain livestock.

The changes to temperature and rainfall affecting plant growth and yield can also have less obvious impacts on agricultural systems by exposing soils to erosion and changing the flowering times of some plants. Increased climate uncertainty and less reliable production in many of our major agricultural regions, may compromise our ability to feed ourselves.

However—unlike the rest of NSW and much of Australia—the Sydney Basin is not expected to become less suitable for agriculture under a changing climate. As the impacts of drought, increased extreme events and temperature extremes take hold, it is likely that the role of the Sydney Basin in securing NSW's food supply will become ever more important. With its reliable rainfall, the Basin is likely to play a central role in the future of food production – assuming that agricultural land, the soil and other natural resources that make agriculture in the region viable are preserved.

With a decreasing proportion of Australia's landscape being suitable for food production over time, it will be critical to better utilise the fertile land in our coastal regions for supplying food to our population. In order to do so, we need to ensure that this land is appropriately protected, both now and into the future.

In addition to being a sector that will firmly feel the impacts of climate change, agriculture is also responsible for contributing to greenhouse gas emissions, emitting a vast amount of carbon dioxide emissions—in Australia, agriculture is thought to be responsible for around 18% of all carbon dioxide emissions, and a further 58% of its methane emissions and 76% of nitrous oxide emissions.¹ Large-scale, industrial agriculture is argued by some to be particularly damaging to the environment (for example Jackson, 1998), as it is associated with livestock production, long-distance transport, extensive use of herbicides, pesticides, chemical fertilisers and genetically-modified organisms, as well as massive alteration of landscapes and diversion of waterways for irrigation. Others, however, such as Avery (1995) have argued that high-yield agriculture may have a relatively beneficial environmental impact due to its ability to reduce the area required to support the global population.

2.2.2 Resource scarcity

In addition to water and energy, phosphorus is a crucial resource for food production. Phosphorus is an essential nutrient in fertilisers to ensure crop yields are high, yet Australia and the world's phosphorus supply come from finite reserves largely controlled by Morocco. The security of future supply and accessibility is uncertain. While all farmers need access to phosphorus, the world's supply of phosphate rock reserves is becoming more scarce, expensive and controlled by only a handful of countries. In 2008, the price of phosphate spiked 800%. This affected farmers from Australia to Ethiopia who could not access fertilisers, leading to farmer riots and suicides in some countries. At the same time, inefficient use of phosphorus from mine to field to fork is polluting our rivers and oceans, causing toxic algal blooms.

The good news is phosphorus can be recovered from local organic sources such as crop waste, manure, human excreta, food waste. Diversifying sources away from imports to include phosphorus recycled from such renewable sources can buffer against geopolitical risks, extend the life of the world's finite reserves, and reduce phosphorus pollution of our rivers and oceans.

In the Sydney Basin, the potential phosphorus supply is fifteen times more than crop demand due to phosphorus availability in poultry manure, food waste and wastewater. This presents an opportunity to meet both Sydney and part of NSW's agricultural demand for fertilisers in the future.

2.2.3 Other threats to global food security

It is beyond the scope of this report to comprehensively investigate global threats to food security, as this report is primarily interested in city-scale challenges and responses. However, it is worth noting that global food security faces a number of challenges and threats, which include but are not limited to:

- **Soil degradation and desertification**, which is resulting in the declining fertility of soils globally, threatening the productive capacity of agricultural lands across all continents.
- **Biosecurity risks** due to the increasing transport of food, people, inputs and products across borders and between continents. This increasing movement of goods and people introduces potential risks to biosecurity, inadvertently transporting diseases and pests.
- **Economic and financial threats** due to the increasing consolidation of food producing entities with a small number of large multi-national companies, rather than with a diversity of smallholders. This creates vulnerability relating to economic shocks and crises.
- **Threats related to lack of genetic diversity**, as the food sources over 75% of its food from only 12 plant species and 5 animals.² This creates vulnerabilities globally, as this means a single disease or pest has the potential to decimate a large proportion of the global food supply.

¹ [http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1370.0-2010-Chapter-Sector%20\[6.5.2.3\]](http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1370.0-2010-Chapter-Sector%20[6.5.2.3])

² <http://www.fao.org/docrep/007/y5609e/y5609e02.htm>

2.3 Future Scenarios for Sydney Agriculture

A number of land-use change and urban growth scenarios and their implications for peri-urban food production in the Sydney Basin have been developed and modelled. This involved using projections of population growth, local government area growth targets, current food production data and geospatial land-use data to identify current production, patterns of future urban growth and the impacts of these various growth patterns upon food production. The NSW Government has set growth targets (or projections) for local government areas through its recent *Plan for Growing Sydney*. This includes suburbanisation of peri-urban areas.

Food demand was calculated using data regarding Australian diets obtained from the CSIRO, and population data from the Australian Bureau of Statistics.

The resulting maps illustrate food production under the current and three future scenarios:

- Current production (2011)³
- Urban sprawl scenario 2031
- Limited sprawl scenario 2031
- Agriculture prioritised scenario 2031

The evidence base resulting from this research was an important platform from which to engage stakeholders in feasibility and desirability of such scenarios and discuss potential measures to support desired pathways. Each of these scenarios and the associated projected implications for food production are discussed in further detail below.

2.3.1 2011 production

The modelling found that, in 2011, the Sydney Basin produced half a million tonnes of food – enough food to meet 20% of its demand for food (Figure 1), including 40% of its demand for eggs (Figure 2), 10% of vegetables, 38% dairy (Figure 3), 55% meat and 2% of fruit.

The modelling shows that, despite meeting only a fifth of Sydney's total demand for food, the Basin supplies a significant proportion of certain foods such as eggs and dairy.

This modelling was intended to show 'current' food production, however data for 2011 was the most recent available. Given the significant expansion of Sydney's urban areas in the past five years, especially around the former agricultural area of Leppington, where a new train station has just opened to support the booming suburban population, it is anticipated that losses against this 2011 production level have already been incurred.

³ The most recently produced data available is from 2011. Future work is planned to update the scenarios to reflect 2016-17 production and demand.

Figure 1

Sydney's food supply in 2011

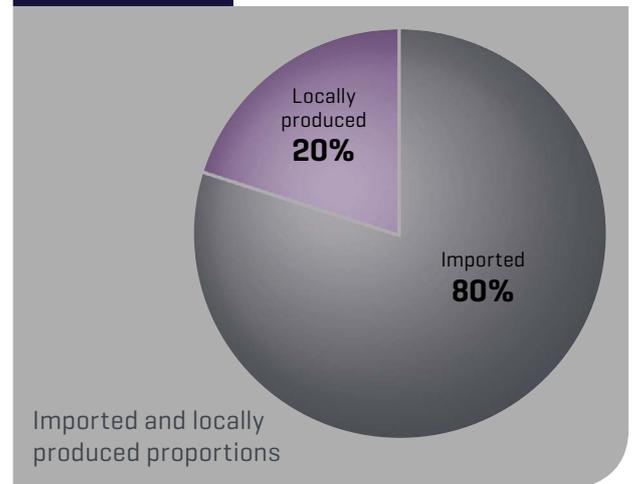


Figure 2

Sydney's dairy supply in 2011

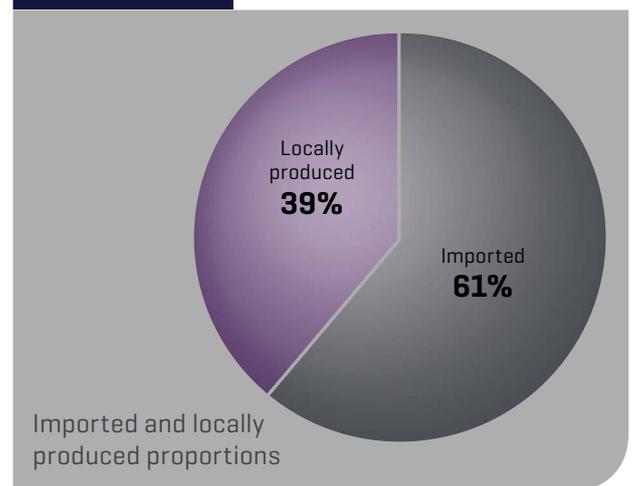
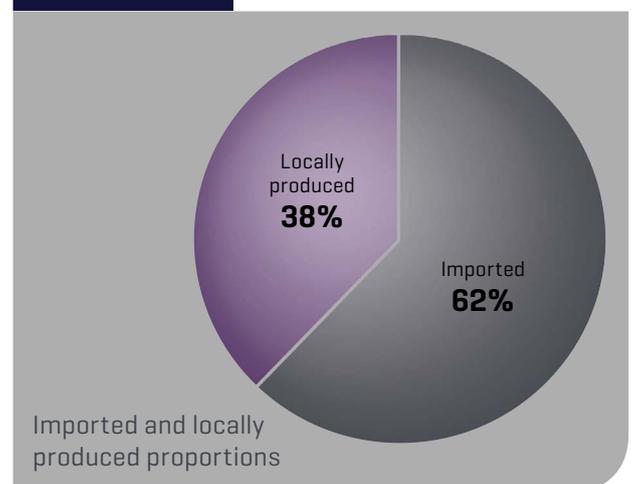


Figure 3

Sydney's dairy supply – current



2.3.2 Urban Sprawl scenario

This scenario asked: *What if Sydney's agriculture was not protected and the proposed population growth under the Plan for Growing Sydney occurred in an unconstrained way?*

This scenario assumed that population growth to 2031 occurs along the lines indicated in the Plan for Growing Sydney, including the local government area population growth targets. Under this scenario, the model projects that Sydney stands to lose approximately 60% of its total food production by 2031, compared with 2011 (see Figure 4). Vegetables, meat and eggs will be hardest hit: 92% of Sydney's current fresh vegetable production could be lost,

as well as 91% of meat and 89% of eggs produced compared with 2011. This is due to urban sprawl into peri-urban areas. This scenario is based on Sydney's metropolitan strategy, *A Plan for Growing Sydney*, which allocates new population growth to each local government area, and, concentrates urban growth around North West and South West Growth Centres. The spatial impacts of this decline are shown in Figure 5.

The comparison between 2011 production and the Urban Sprawl scenario is shown in Figure 6, starkly illustrating the potential loss of agriculture if growth occurs as proposed by current strategic plans.

Figure 4 Projections of future food production in the Sydney Basin

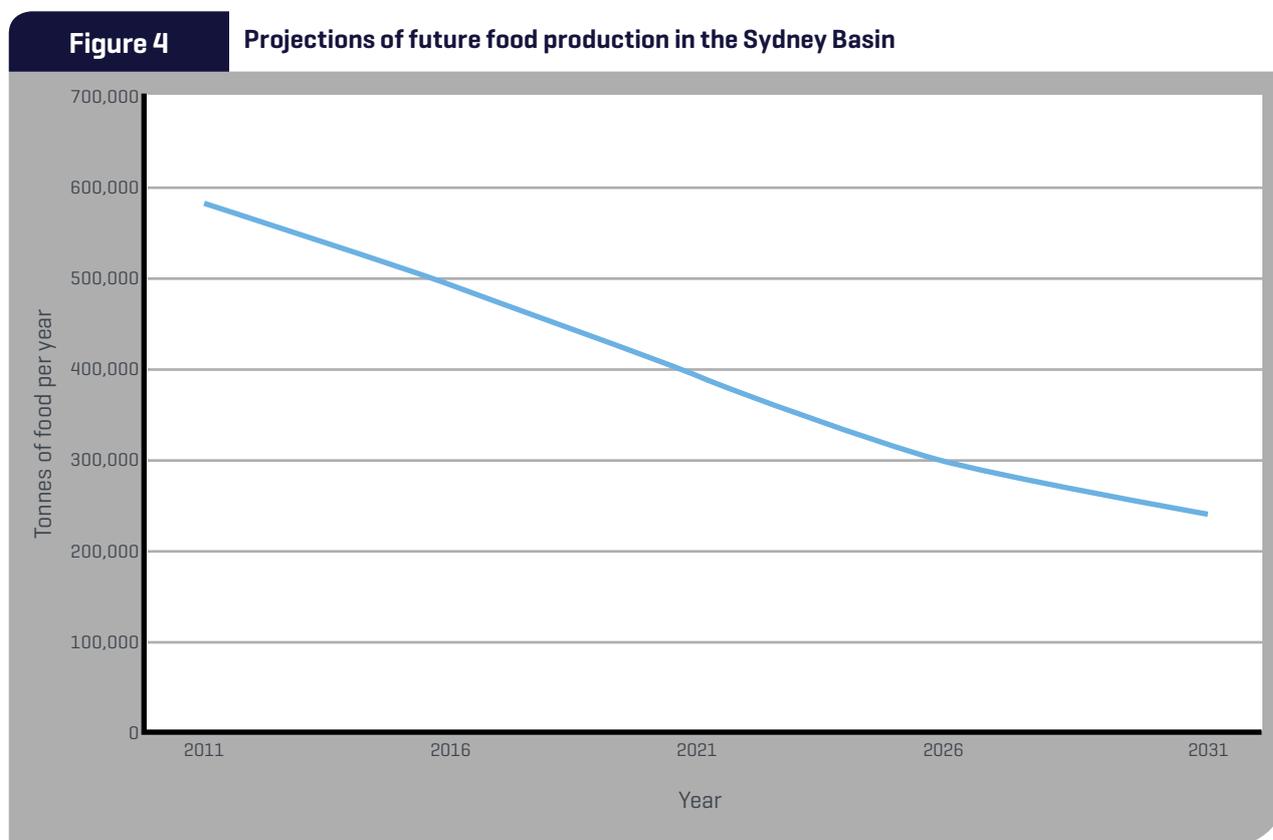


Figure 5

Loss of agricultural production by local government area across the Sydney Basin

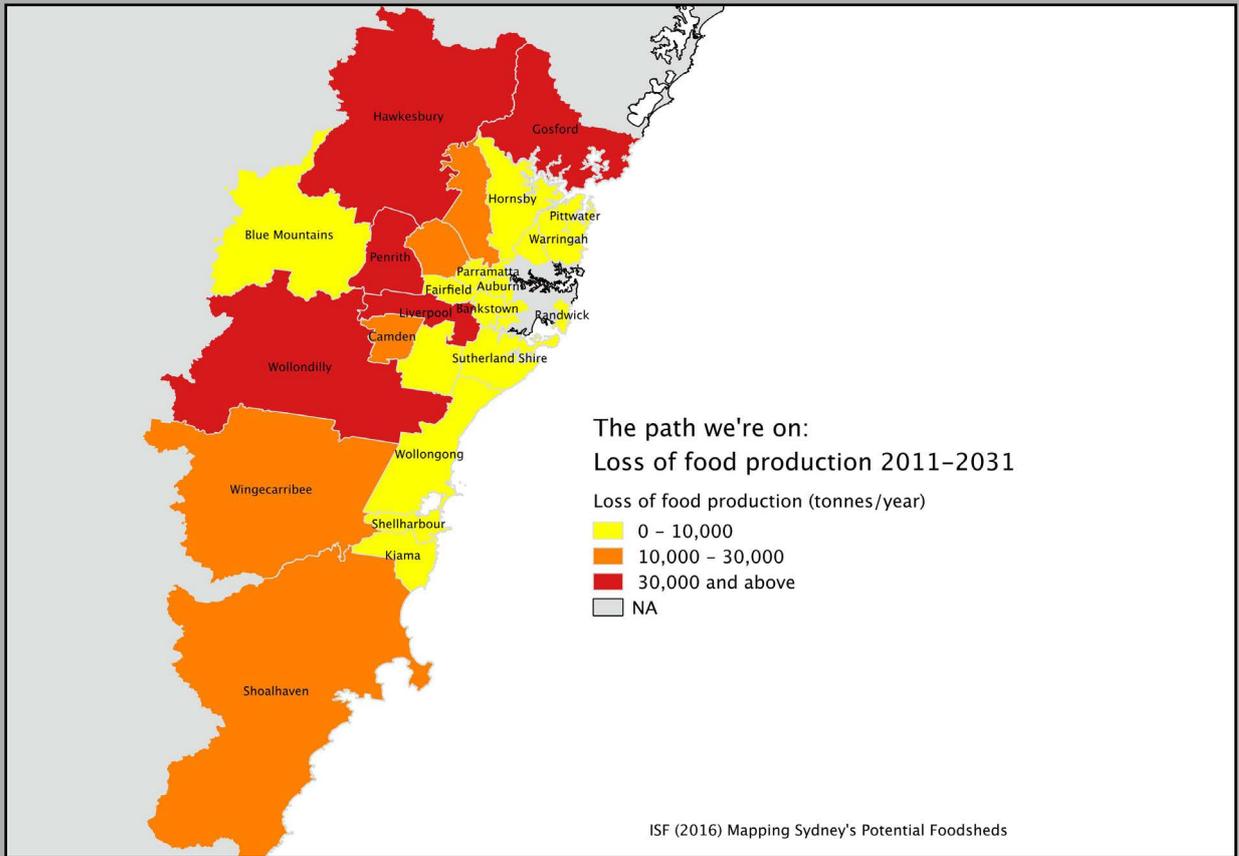


Figure 6

Figures showing food production in the Sydney Basin in 2011 and the projected production in 2031



Source: sydneyfoodfutures.net

2.3.3 Limited Sprawl scenario

This scenario posed the question: *What if urban development occurred on existing urban land or lower priority agricultural land?* This scenario would prevent sprawl onto peri-urban farmland that was of high quality (calculated based on soil fertility and land capability data), but would allow some growth onto lower-quality agricultural land. This scenario was developed with consideration to many land assessment methodologies that attempt to classify, catalogue and recommend projection of land that is considered most valuable for peri-urban agriculture.

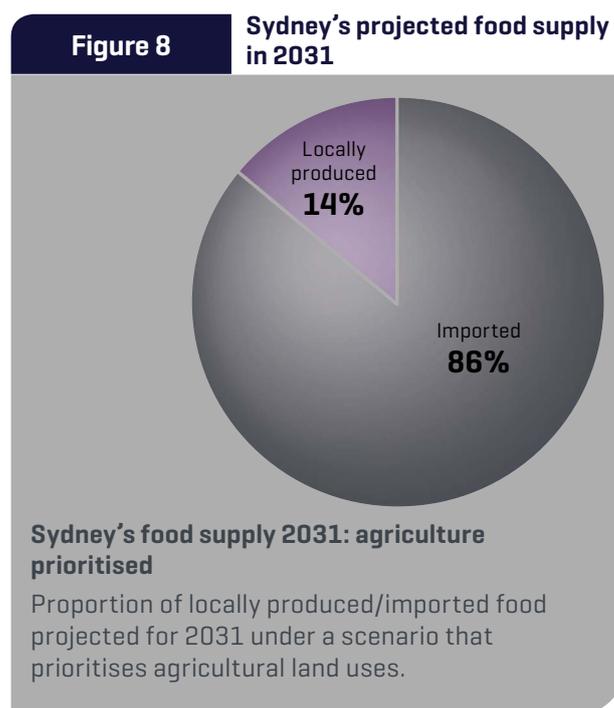
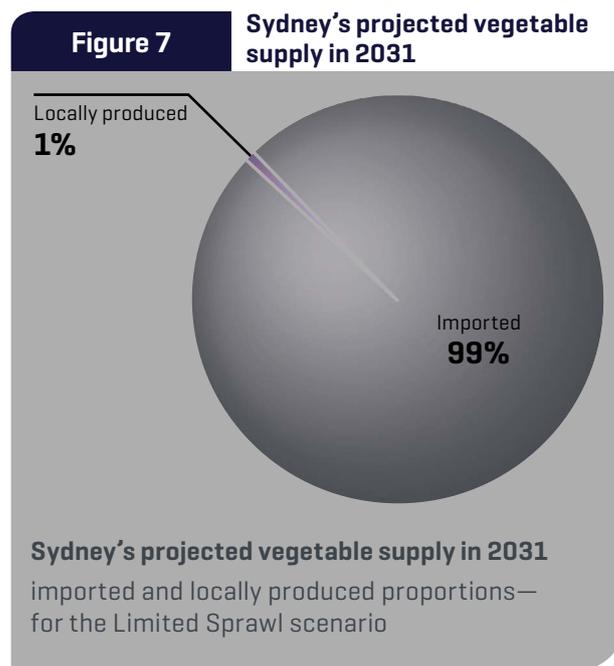
This scenario did not result in much protection of Sydney's agricultural land. That is, the loss of agricultural land is only marginally less than the urban sprawl described above. This is because there is only a small amount of 'high quality' agricultural land in the Sydney Basin, meaning that this scenario would involve very little preservation of existing agricultural production. Production to 2031 declined almost as steeply as under the Urban Sprawl scenario, with Sydney's ability to meet its food demand from local sources declining from 20% to 7% between 2011 and 2031 under the Limited Sprawl scenario. Like the Urban Sprawl scenario, this would result in vegetable production declining to meet only 1% of demand by 2031 (Figure 7).

2.3.4 Agriculture Prioritised scenario

This scenario aimed to understand the potential for Sydney to preserve its current supply of peri-urban agriculture. It asked, *What if the projected population growth under A Plan for Growing Sydney occurred in a constrained way, such that current urban develop could intensify to high density, but not expand onto existing agricultural land?*

This scenario involves protection of the current agricultural base, in terms of production. If Sydney chooses a pattern of urban development that involves densification—that is, utilising the existing urban areas more efficiently, growing up instead of out, we could continue produce around half a million tonnes of food a year.

However, even if absolute tonnage produced is maintained at the same quantity as in 2011, food supply declines as a proportion of Sydney's food demand, to only meet 14% of Sydney's demand (Figure 8). This is due to growing population and therefore growing demand for food, with our projects estimating that Sydney's demand for food will grow from roughly 2,900,000 tonnes/year in 2011 to 4,200,000 tonnes/year in 2031, due to an additional 1.6 million people living in the Sydney Basin by 2031.



2.4 Engaging Stakeholders

Stakeholders were engaged in a number of ways, ranging from communicating and seeking feedback on the scenarios and interactive maps generated in the previous project, for example:

- A website: sydneyfoodfutures.net/interactive-maps
- Stakeholder engagement events, including a workshop for key stakeholders and a high-level policy briefing for key stakeholders in relevant state government departments, and
- Public forums and the media, including a forum at the Sydney Festival and several news articles online, on the radio and in print.

2.4.1 Feedback on scenarios and maps

Feedback was sought from stakeholders on the usefulness of the mapping for addressing peri-urban agricultural loss. Stakeholders indicated that the maps:

- Are likely to be a useful contribution to the body of 'evidence' demonstrating the value of agriculture in the Sydney Basin and implications of not strategically protecting or stimulating agricultural production,
- Have the potential to inform regional planning by providing information to relevant authorities about the implication of land-use change,
- May become a tool for empowering, educating and enabling a consumer voice to advocate for policy change,
- Highlight the broader impact of site-based decision making in the planning system, potentially demonstrating to planners the wide implications of decisions that may appear isolated or inconsequential,
- Provide a clearer overview of the context and value of agricultural land and future vulnerability than has been provided previously,
- Highlight the need for improved awareness about the value of agriculture for the long-term sustainability of Sydney,
- Provide information that may be useful for decision making with planning proposals, helping state government planners determine whether the conversion of a parcel of agricultural land will be appropriate for change of use/sub-division, allowing them to see how that decision fits with the broader picture, and
- Give better profile to the situation, potential loss and implication, useful in advocacy.

In particular, the stakeholders identified that the maps could be a useful tool as part of a larger debate, as the interactive maps allow exploration of options and consequences, clearly displaying the implications of particular courses of action.

Thus, mapping of scenarios for peri-urban futures was well-received by stakeholders as providing important information to enable improved decision making that is able to better take account of the metropolitan-scale implications of site-based decisions.

2.4.2 A collaborative vision of a resilient food future for Sydney

In a second stakeholder workshop, participants revised a statement outlining what a resilient food future for Sydney would look like:

- Sydney's peri-urban agriculture, urban community gardens (including small-scale farms) are **protected, maintained, supported, promoted** and **expanded** to produce high-quality fresh produce, and is included in a coordinated manner in major planning documents created by the State Government in addition to local government
- Sydney sources a **significant portion of its fresh food from seasonal sources within the Basin**, including community urban gardens in addition to commercial peri-urban farms and the remainder from eastern Australia, reducing imports from overseas
- Planners and decision makers **understand** that protecting agricultural lands, farming businesses and employment is **critical to the city's resilience**, and this is reflected in a consistent and strategic way in state and local government policy and planning documents
- Sydney **recovers** and **reuses urban organic wastes (rather than landfills)** locally as inputs to peri-urban agriculture, such as composted food and green waste, wastewater and poultry manure and is considered for energy use
- Consumers have **improved food system literacy**, including knowing where their food comes from (e.g. through labeling), the resources required to produce that food, the wastes generated, the health implications and are aware of and value the substantial importance of peri-urban agriculture and urban gardens
- Sydney's population are **aware** and **educated** of the health and environmental benefits of eating fresh vegetables and fruits and reducing processed food and red meat intake
- Consumers have **access to affordable and healthy** local produce and have the skills to prepare and store meals
- **Transport and logistics infrastructure is in place** (e.g. fast rail, tunnel) to expand opportunities outside or west of the Sydney Basin, beyond 2031.

3.0 Planning Tools and Responses

The previous sections of this report have outlined the challenges facing peri-urban agriculture. Responses at multiple levels are required to address these challenges, including at the international, national, regional and local levels. These responses will need to address the multiple facets of the challenge, including relating to climate and environmental change and degradation, economics and finance, agrobiodiversity, resource scarcity and social challenges relating to equity and affordability, as well as relating to the use of land.

The remainder of this paper is interested in how governance of land use, through the land-use planning system, could be improved to address challenges to and capitalise on opportunities for peri-urban agriculture. The land-use planning system needs to deliver responses at a range of levels, from strategic planning visions to land-use conflict resolution. This section draws on examples from the Sydney Basin to provide context, however it is expected that this section will contain discussion that is relevant to many other contexts and jurisdictions.

Land-use planning and management is critical to the maintenance and integrity of ecosystem services and sustainable agriculture as it mediates the relationship between human and environmental systems (Clancy & Lesslie, 2013). Importantly, the land-use planning system determines allowable uses of land and shapes spatial patterns of development, having significant consequences for spatially-dependent activities such as agriculture, which are dependent on and affected by geographical factors such as climate, topography, surrounding land uses, biodiversity, infrastructure and proximity to market.

Historically, however, land-use planning systems around the world have struggled to manage competing pressures, including population growth, economic growth imperatives (accelerated in the last four decades by increasingly neoliberal policies), environmental and social challenges including climate change, deforestation and contamination, and increasing urbanisation. Peri-urban agriculture has been on the receiving end of all of these pressures.

Further, agriculture and associated benefits such as food security, have often not been viewed as a priority by planners. Pothukuchi and Kaufman (2000) surveyed the planning departments of 22 communities in the US and found that limited attention was being given to the food system. This was because the food system is not seen as directly linked to the built environment and because it is dominated by the private sector and seen as outside the control of planners (unlike parklands and reserves, for example). Pothukuchi and Kaufman also pointed out that the food system is 'notable by its absence from most planning practice, research, and education' (2000, p113).

Despite these claims, there have been attempts to preserve peri-urban agriculture in various jurisdictions, using a variety of measures. However, land-use planning in the world's peri-urban regions has enjoyed only limited success in offering certainty for ongoing commercial production and the protection of agricultural industries (Butt, 2013). These have spanned a number of different types of responses with the planning system. These various types of responses are discussed briefly below, and elaborated further in the remainder of this section.

Strategic planning approaches attempt to set a broad vision for a city's development. Efforts to protect peri-urban agriculture using strategic planning include identifying agriculture as a priority land use, preserving green belts and diverting urban development to brownfield sites.

Zoning mechanisms are intended to specify a land's development potential. A parcel's zoning indicates its development potential (how dense, what floor area, etc) and intended land use (commercial, residential, industrial etc), but is not necessarily intended to protect or preserve land for particular uses (perhaps despite common assumptions). Zoning can be useful for demonstrating a government's intent for a particular area, however, in the absence of significant barriers to zoning changes, zoning is not necessarily a sufficient mechanism for preventing land-use change in peri-urban areas.

Property rights protections such as buffers and right-to-farm laws aim to protect farmers' rights to utilise their land in a productive and profitable way. Such laws recognise that residential and agriculture uses may not be compatible. Buffers attempt to anticipate and prevent incompatible land uses being located in proximity by preventing construction of incompatible uses adjacent to particular land uses. They may be useful, if appropriately framed and applied, but do not necessarily prevent the fragmentation of agricultural land. Right-to-farm laws aim to establish a prioritised development right to farmers over residential neighbours—they provide protections for farmers on appropriately zoned land against nuisance complaints by residential neighbours. Such laws can protect the rights of farmers to operate, however involve complex legal considerations. Such laws also do not prevent the conversion of agricultural land to residential land.

Incentive schemes such as transferable development rights (TDR) schemes attempt to address both the spatial and economic challenges that are facing planning, and in addressing the key facets of this challenge present a viable option for protecting peri-urban agriculture. Though complex, TDR schemes can simultaneously divert development to designated and appropriate growth areas while providing a supplemental income to peri-urban farmers.

There are few metropolitan governance models across the world's developed cities that can be held up as best practice (Budge, 2013). The remainder of this section discusses the opportunities and challenges presented by the planning system responses described above.

A matrix (Table 1) is used here to indicate which of a selection of tools described in this section address key functions necessary to support peri-urban food systems.



Table 1

Functions addressed by a range of potential planning tools and responses to better manage peri-urban food systems

Appropriateness for managing urban food system challenges		Planning tools and responses				
		Strategic: spatial plans	Strategic: green belts	Zoning	Property Rights Protections: RTF	Incentives TDRs
Important functions for managing food systems	Protects current agriculture from conversion to residential	✓	✓	—*	X	—
	Minimises current land use conflict	X	X	X	✓	X
	Prevents fragmentation	✓	✓	—	X	—
	Stimulates and encourages future increase in food production	✓	✓	X	X	✓
	Addresses urban growth pressure	✓	✓	X	X	✓

* possibly, depending on implementation



3.1 Strategic Planning

Strategic planning refers to the city-level planning that is used by governments to set visions and general plans for a city's growth and development. It tends to refer to the long-term planning that governments are engaged in (as opposed to the site-based proposals that they make determinations regarding). In principle, strategic planning should define how governments react to site-based proposals, and how they make decisions about investments and infrastructure to support development.

There are several different mechanisms that fall under the banner of strategic planning. The most prominent of these is the strategic spatial plan, often called a metropolitan plan. Such plans are usually developed by a city or provincial government, and set medium- to long-term visions at a high level. Such plans are usually intended to inform local plans and ordinances that sit below them, such as local zoning maps and planning controls. They tend to specify the amount, direction and characteristics of future growth and development, including the extent of sprawl or urban densification. In this way, they are crucial to the protection (or otherwise) of peri-urban agriculture.

Strategic planning has been used to protect peri-urban agriculture through green belt provisions that have placed limitations on city sprawl. Green belt provisions prohibit development within a specified zone around the city limit, providing a firm limit on urban sprawl. Green belts are likely to be most effective when enshrined in legislation, as London's Metropolitan Green Belt was in the Town and Country Planning Act (1947), which included provisions to compensate local authorities for incorporating green belt proposals in their development plans. In Portland, Oregon, and neighbouring Vancouver, Washington, limits on urban growth applied across four counties over several decades allowed the area to retain the majority of its agriculture, with areas outside the urban growth boundary losing less than 7% of their agriculture in the 40 years to 2006 (Kline, Thiers, Ozawa, Alan Yeakley, & Gordon, 2014).

London's green belt, despite being apparently remarkably successful in preserving peri-urban green space and agriculture, has faced recently criticism for its reported role in inflating the cost and suppressing and availability of housing in England's capital (Amati & Yokohari, 2006). Given Sydney's inflated property market, any efforts to implement a green belt in the Sydney Basin would likely meet similar criticisms.

A key criticism of the green belt concept is that, at a regional scale, it may fail to produce a compact urban form. Development may 'leapfrog' the green belt, sprawling out onto other farmland beyond the zone of the green belt's protection (Amati & Yokohari, 2006). In the Sydney context, as with other geographically constrained areas, such drawbacks may present reduced cause for concern, as the ocean, mountains and national parks bordering Sydney would likely serve to limit such leapfrogging. In other contexts, avoiding such flow-

on effects would entail restrictions on the amount and type of development that occurs in non-urban councils neighbouring the external limit of the green belt. Such restrictions may be politically fraught, as many regional local governments rely upon the in-migration of residents who plan to commute through green belts to reach employment in major urban centres for the income that such new development will bring.

In addition to spatial planning, strategic planning provides an opportunity to set general principles and objectives that guide decision making at subsequent levels of the planning system. Strategic plans thus provide an opportunity for policy makers to prioritise peri-urban agriculture as a key land use within an urban area, requiring processes and decisions at all other levels to give due consideration to impacts that proposals might have upon this protected use.

Principles such as these are clearly most effective when enshrined in legislation, obliging the courts, as well as all other actors, to give consideration to them in reviewing any relevant decisions. In NSW, the objects of the Environmental Planning and Protection Act have been used to uphold environmental protections (see, for example *SHCAG Pty Ltd v Minister for Planning and Infrastructure and Boral Cement Limited* [2013] NSWLEC 1032). However, the protection of agricultural lands through such means relies upon significant political will (to produce appropriate legislation), favourable judges (to interpret agriculture as crucial to 'ecologically sustainable development', for example), and actors willing to bring such actions to court, and potentially bear the costs of doing so.

Incorporation of such principles into metropolitan plans, which tend to be non-legislative guidance documents, may be politically more palatable and more appropriate for achieving active implementation of those principles (rather than reactive, such as requiring their enforcement by a court ruling). Strategic plans, while not having the weight of legislation, are used to guide local decision making, and thus should provide a useful means of enshrining the protection of peri-urban agriculture into planning processes at all levels.

Metropolitan-scale plans need to be supported by planning instruments that provide mechanisms for effective implementation. Land zoning is often the key instrument utilised for this, captured in local plans that zone parcels of land as appropriate for various uses. However, if zoning instruments and processes are not consistently and rigorously applied, such strategic planning may be subject to partial implementation, eroding larger visions through piecemeal decision making, possibly resulting in the fragmentation of green belts.



3.2 Zoning

Traditionally, zoning has been a key method used by planners to determine allowable land uses for particular parcels. Zoning, enshrined in NSW planning through Local Environment Plans (maps which specify zones for each land parcel, identifying allowable land uses and associated controls) is used across most planning systems in the developed world and stems from planning's origins as a system for maintaining public health through management of risks from land use. Zoning attempts to ensure that incompatible uses (say, heavy industry and residential development) are not located in proximity, and attempts to avoid land use conflicts by anticipating conflicts that could result in nuisance suits and seeking to avoid proximity between land uses likely to result in such conflicts.

Euclidean zoning, named after a key legal case relating to its emergence '*anticipates [land use] conflicts or choices, identifies them, ... reduces them to a limited number of generic cases, and then proceeds to resolve them in the body of the ordinance*' (Reinert, 1998). Thus, zoning is a strategic attempt to avoid co-locating incompatible land uses.

Commonly, zoning has also been used to establish property rights—in particular, the right to develop. Property owners understand that they possess a right to develop a parcel of land in a manner specified by the relevant zone, and can use common law cases to sue for takings that prevent them from developing to the maximum value specified by such zones.

However, zones are not necessarily intended to protect land for particular uses, rather, they are more accurately described as intended to protect property rights (including enjoyment of amenity) from infringement by neighbouring activities and land uses and provide a clear statement of development potential for owners, under which they are free from regulatory intrusion (Rose, 1989). Thus, when stakeholders speak of using zoning to protect and preserve agricultural land (as we found was common throughout this project), they are perhaps misconstruing the underlying purpose and role of zoning laws.

Zoning does not provide a perpetual protection and can be rezoned for different purposes. In Sydney, a 'planning proposal' is the term given to an application for rezoning. These are assessed by the newly-established Greater Sydney Commission, though historically such determinations were made by the Minister for Planning and their department. This rezoning process is the primary means bringing about of land-use change in the Sydney Basin, and in many other regions. In the Sydney context, 'highest and best use' is, at least according to anecdotal reports, often the maxim used to determine whether an application will be successful—that is, an application to rezone a parcel of land (called a 'planning proposal' in the NSW planning system) will be assessed using knowledge of current and potential economic value. In general, the proposal will be successful if the parcel of land will yield a higher economic value if converted to the new use.



Of course, such decisions should, theoretically, result in conversion to a use of higher economic value only when that use does not impinge upon the rights of neighbours (though the extent to which new residential neighbours have interfered with farmers' rights to develop their land raises questions regarding considerations for agricultural neighbours in such decisions).

A key challenge for peri-urban agriculture in the Sydney Basin is the conversion of agricultural lands in Sydney from rural to residential uses, through rezoning and subdivision of land. Many stakeholders wonder why zoning does not in itself afford protections to this land and ensure that it is retained as agricultural land. This review finds that this is likely due to several factors in the Sydney context:

1. Information regarding the total value of agricultural land is not available, thus determinations of 'highest and best use' are conducted with limited information regarding the value of agricultural lands,
2. Strategic plans do not explicitly protect agricultural land, and, indeed in many cases explicitly involve the development of agricultural areas for residential growth,
3. Decisions about land-use change are often handled as stand-alone events, and the city-wide and long-term implications of such decisions are seen as outside of planners' responsibility (Budge),
4. Planners do not consider the ways in which fragmentation of rural zones and conversion of land to residential uses might infringe on farmers' property rights, such as through threats to biosecurity, liability to nuisance cases and other incompatibilities between agricultural and residential land.

The review did not investigate the extent to which such problems are present in other jurisdictions. However, the reported failure of zoning to protect peri-urban agriculture in other jurisdictions suggest that these challenges are present in many contexts. Zoning is only as good as the processes and laws that support it, and a planning system that heavily favours urban expansion and residential sprawl is unlikely to find limitations to such growth in zoning.

In the Sydney context, the use of zoning to protect peri-urban agriculture could be strengthened through a number of key changes:

- Explicit support for peri-urban agriculture in strategic and metropolitan-level plans and strategies, which might requiring the Greater Sydney Commission to consider consequences of rezoning upon agriculture when assessing a planning proposal
- Greater awareness of the potential of rezoning, subdivision and new residential neighbours to infringe farmers' property rights. This may ensure that the Greater Sydney Commission is required to consider the potential impact upon agricultural production that residential neighbours pose—a consideration that currently appears absent in such decision.
- A better understanding is required of the full suite of benefits provided by peri-urban agriculture. At present, such values are not incorporated into a consideration of 'highest and best use', meaning that agriculture is only partially valued as a land use.

3.3 Transferrable Development Rights

Stakeholder consultation conducted throughout our research on peri-urban agriculture has revealed that, in the Sydney context, land-use protections alone may not be sufficient to protect and retain peri-urban agriculture. A key driver for the conversion of land from agricultural to residential uses has been the absence of profitability in the agricultural industries, due to slim margins caused at least in part by Australia's supermarket duopoly,⁴ as well as increasing input costs. These changes have benefited farmers with large operations who can achieve economies of scale, but have disadvantaged smaller operators who cannot return a profit on the limited margins that agriculture yields (Merson, Attwater, Ampt, Wildman, & Chapple, 2010). This, in combination with a number of other demographic and economic factors, has led to a decline in the number of small farming operations in peri-urban Sydney (Merson et al., 2010), with ageing farmers selling or sub-dividing their land for conversion to non-agricultural uses.

Incentive-based approaches for protecting land uses can help address the issue of economic feasibility (La Rosa et al., 2014). These approaches can be utilised to simultaneously protect and preserve land for agriculture while supplementing farm incomes to increase viability of farming operations. Transferable development rights (TDR—also known as transfer of development rights) schemes, provide a 'means by which farmers or other landholders can receive income on their land without it being developed' (Pruetz & Standridge, 2009). TDR schemes can help to redirect development into areas that can handle increased density, while providing economic incentives for agricultural land (or other protected uses) to be retained. TDR schemes can be used to protect land for a variety of uses, including open space or biodiversity conservation. This section focuses only on protection of agricultural uses.

TDR programs are implemented to divert development away from agricultural areas toward designated growth areas (Tripp & Dudek, 1989). Schemes achieve this by allocating permits to owners of agricultural land, who may sell these permits in exchange for preserving their land as food producing land. The permits allow developers who purchase them to receive an increase on development potential of land within a designated area. For example, they might receive a relaxation of height restrictions or floor space limits. In doing so, they are expected to generate greater efficiency, by encouraging increased development in areas with better infrastructure or more suitable for dense development (Pruetz & Standridge, 2009).

This, in effect, creates a two-tier zoning structure—a base-level of zoning that applies to all developments, and a secondary level which applies to land for which a TDR permit has been purchased (Tripp & Dudek, 1989).

TDR schemes can help appease landholders who feel that they are unable to realise the development potential of their land due to zoning. However, such schemes require the existence of a particular legal and institutional context in order to create the right set of incentives. This is particularly the case when schemes are entirely voluntary (that is, when holders of agricultural land can opt in or out of the scheme), as permit prices must be set at a sufficiently high point so as to encourage participation in the scheme.

The owner of the protected land must accept a conservation easement on their property, which will (either permanently or for a given period) restrict the development of their land for other uses.

3.3.1 Success factors for TDR schemes

TDRs have reportedly protected over 350,000 acres across the US in hundreds of TDR programs (Pruetz & Standridge, 2009). However, while the overall concept of a TDR scheme is relatively simple, implementation can be complex. To ensure TDR schemes achieve their objectives, careful planning of institutional, legal and technical details is necessary (Tripp & Dudek, 1989).

Drawing from Pruetz & Standridge (2009) and Tripp & Dudek (1989), as well as stakeholder consultation, the following success factors for TDR schemes were identified in this review:

- **Demand for permits:** TDRs have significant economic value only if the pressure for growth in a region is high—this demand should be higher than the available development rights (that is, the total potential of all land to be developed to its maximum regulatory capacity). Without pressure for growth, developers will not have sufficient incentive to pay for increased development potential. City authorities can artificially create this demand by downzoning (reducing the development potential) of land in the designated growth areas, to ensure that there is demand for developers to purchase permits allowing them to increase this development potential.
- **A low transaction cost:** Low transaction costs will ensure that the permits have economic value. A high transaction cost may outweigh benefits to the developer and may provide a disincentive to participate in the scheme.
- **A simple and equitable method for allocating TDRs:** The scheme must involve a method for allocating TDRs to holders of agricultural land that is both simple and equitable. This may be based on an allocation of rights per hectare, or may involve calculations of land value based on type of land, the quality of agricultural land or its location (Tripp & Dudek, 1989).

⁴ The two major supermarkets in the Australian market, Coles and Woolworths, have 72.5% of the market in terms of total dollars spent on groceries [see <http://www.roymorgan.com/findings/5427-market-share-narrows-between-coles-woolworths-while-aldi-makes-gains-201402120013>]. This has allowed Coles and Woolworths to artificially depress the cost of key food products such as milk, bread, fresh produce and meat, affecting the viability of agricultural operations across Australia.

- **A lack of alternatives for increasing development potential:** Designated growth areas should be governed by development controls that prevent alternative pathways for achieving zoning upgrades. In the absence of other means for increasing the development potential of a parcel of land, developers in a growing market will have sufficient incentive to purchase TDRs. However, in a jurisdiction where developers can achieve increased development potential through negotiation or other means, there is little need for developers to purchase TDRs.
- **A certainty that developers will be allowed to use TDR permits:** The administrative and legal arrangements relating to TDR permits must ensure that developers will be able to use them to realise an increased development potential. Any uncertainty about the application of TDR permits will reduce demand, as the permits will only be valuable insofar as they can be used to upgrade development potential.
- **All jurisdictions with a city/region participate in the TDR scheme:** A TDR scheme will be successful only if *all* parts of a city or region participate in the TDR scheme. If only certain jurisdictions participated, developers would have no incentive to pay to increase development potential in one area—instead, they would be far more likely to transfer their development interests into areas of the city or region where the TDR scheme did not apply and where there was not a fixed cost attached to increasing development potential.
- **Designated growth areas need to be appropriate to accommodate additional growth:** Such areas should be identified through strategic planning and other processes as being suitable for and capable of absorbing growth additional to that allowed by development controls. They should be areas well serviced by infrastructure and employment opportunities, capable of absorbing additional, high-density development.
- **The growth area is large enough to create demand for more TDRs than are generated:** In order to maintain sufficient demand for the TDR permits, the scheme should designate a growth area large enough to receive more TDR permits than are generated (Tripp & Dudek, 1989). In a scheme with a surplus of TDR permits, the price for permits would likely fall, reducing the incentive for owners of agricultural land to take out TDRs on their land.
- **Sufficient regulations exist to retain the protected areas:** Certainty is required regarding the protection of the agricultural land for the stated duration (whether in perpetuity or for a given period). This includes certainty regarding the transfer of restrictions between owners. In most planning systems, easements on the deeds are sufficient to ensure that this transfer of obligation occurs between owners.
- **A sufficiently high price for the TDR permit:** Holders of agricultural land will require a price high enough to incentivise the retention of their land as agricultural land. For example, a price equivalent to (or higher than) the difference between the land's value for agricultural use and its value for residential development would provide an incentive for a land holder to retain their land's current use. A price lower than this could fail to provide an incentive for landholders to retain the current use, as they would receive economic gain through conversion of use. Thus, the permit price must be sufficiently high as to incentivise the retention of land for agriculture. (This, of course, assumes that participation in such a scheme is voluntary. In mandatory schemes, the land holder does not require a price incentive to retain the current use, as they are required to participate in the scheme regardless of economic benefits or costs).

3.3.2 Challenges for TDR programs

TDR schemes, though reportedly successful in the US and other jurisdictions, rely on a set of supportive circumstances in order to achieve the preservation of agricultural land, especially when such approaches are introduced on a voluntary basis.

This section discusses some of the key challenges, including the way these challenges might manifest in the Sydney context. Some of the key challenges faced by TDR schemes include:

- **Vulnerability to development demand:** Housing market crashes or declines can impact the viability of the program by reducing the demand for development rights in growth areas. In a city such as Sydney, where housing growth has been strong for many years, it is difficult to imagine such challenges. However, a forecast glut in apartment supply in inner Sydney⁵ may well depress demand for TDR permits.
- **Flexibility in development controls:** TDR permits need to be the only way to exceed base zoning and controls in order to stimulate demand. If other means are commonly used this may dampen demand for the purchase of TDRs. In the Sydney context, as in others, several other means are commonly used to exceed base zoning. These include Voluntary Planning Agreements (in which councils and developers negotiate monetary payment, gifting of land for public purposes or other concessions in exchange for relaxation of the development controls relating to a particular site) and planning proposals (applications for the alteration of zoning for a particular parcel of land—usually to a higher economic use).
- **Ability of landholders to utilise agricultural land:** Protections need to be in place to allow landholders in agricultural areas to use their land productively.

⁵ <http://www.domain.com.au/news/apartment-bust-to-shock-tens-of-thousands-of-investors-report-suggests-20160307-gnc183/>

Right to farm measures, discussed elsewhere in this report, may be one such mechanism. Without such protections, landholders may be forced to let their land lie unutilised due to nuisance complaints that may prevent them from undertaking profitable production.

- Prices must incentivise protection in a voluntary scheme:** In the absence of a mandatory scheme, prices received for permits must be high enough to ensure that holders of agricultural land choose to participate in the scheme. In an inflated property market such as Sydney's, it may be difficult to achieve a sufficiently high price for permits, given the high returns that can be realised by farmers when converting land to residential uses. Thus, demand for development in the designated growth area must be significantly higher than demand for development in the agricultural area, in order to create the appropriate incentive structure.
- Identifying a suitable growth area:** There is a need to understand the implications of increased densities and other changes to built form upon the receiving area.
- Managing a TDR scheme across jurisdictions:** In Sydney, as in many other contexts, the land to be protected may be governed by a different authority than the land in the designated growth area. In Sydney, the land most suitable for protection—peri-urban agricultural assets—are governed by different local authorities, with different development controls to those who govern various growth areas. Thus, there would be a need to ensure that a TDR scheme is consistently applied across jurisdictions. This would mean that TDR permits would need to be valid and to achieve the same upgrade in development potential as they can achieve in an adjacent jurisdiction. Without such certainty of application, developers would see TDR schemes as inherently risky.
- Equity considerations amongst holders of agricultural land:** A key question for TDR schemes surrounds how to determine which parcels of land are eligible and which are not. If a scheme were to aim to protect peri-urban agriculture, how should peri-urban be defined? Where and how should a line between eligible and non-eligible land holdings be drawn? And what would be the consequences for a TDR scheme being applied to one site, but not the adjacent? In a mandatory scheme, equity considerations are particularly salient, given the inherent limitations on development potential that are implied.
- Alignment with strategic plans:** TDR schemes need to be congruent with—indeed, need to be reflected in—strategic planning documents. This would involve reviewing and updating strategic documents (in Sydney, the Plan for Growing Sydney) to ensure they are reflective of the intentions of the incentive scheme.
- Administrative costs and complexities:** the cost for a developer to participate in the program needs to be minimal in order to incentivise participation. Any transaction cost associated with participation needs to be well below the marginal benefit that a developer would receive from the increased development potential granted by the TDR permit. In other words, the developer will want assurance that there is profit to be associated with purchasing a TDR permit, and will not be interested in purchasing one if the transaction costs threaten to erode that profit.
- Length of preservation:** Covenants and easements placed on parcels of land may remain for a certain period of time or for perpetuity. An important consideration in a TDR scheme is the length of time a piece of land must be preserved. Some schemes set a time period (20 or 30 years, for example) whereas others protect the use for perpetuity. The price and the allowance provided by the TDR should be reflective of this—allowing substantial increases on development potential may not be an efficient response to an easement that only protects an agricultural lot for 20 years.
- Type of concessions that developers receive:** TDR schemes involve providing concessions to developers that allow them to develop a parcel of land in a designated area beyond its statutory development potential. However, determining what form this will take is important. Will it be increased floor space ratio, gross floor area, increase in height allowances, a reduction in green space provision, flexibility with setbacks or in parking requirements? How will these allowances be determined? These kinds of considerations will help determine how attractive participation in the scheme is to developers, as they will be looking for concessions of the type that will allow a greater number of sales (that is, that will allow them to build more units) or a reduction in costs (leeway regarding parking provisions, open space provision etc).
- Avoiding land banking and speculation:** There is a need to ensure that land subject to TDR permits remain active and productive as agricultural land. This will require ensuring that speculators don't buy land zoned agricultural in order to receive income from TDR permits, allowing it to lie fallow and unproductive. Some jurisdictions make TDRs available only on productive agricultural land, and require farmers to provide a business plan to demonstrate intentions for future production.

In summary, TDR schemes provide a fantastic opportunity for cities to address two complex elements of peri-urban agriculture—economic challenges and spatial pressures. However, these schemes are complex and can be administratively burdensome, and careful planning is required to ensure their success. They must be responsive to contextual factors in order to generate the correct incentives for participation.



3.4 Right to Farm Policies and Legislation

Land-use conflicts with neighbours – particularly residential neighbours – are presenting new threats to the ongoing viability of farming operations. Farming, despite its (at times) idyllic appearance, is not necessarily compatible land use with residential subdivision. The smells and noises produced by agriculture, in particular, cause concern for residential neighbours, many of whom move to peri-urban areas for a quieter lifestyle.

Farmers have increasingly become the subject of nuisance complaints, which seek to restrict their activities so as to prevent disturbance of adjacent properties. Such complaints often result in restrictions of the type of fertiliser that can be used, limitations on the hours of operation for particular items of machinery or particular requirements regarding certain farming practices. Many of these restrictions threaten a farmer’s viability and challenge their ability to continue operating their business in that location, often resulting in further subdivision and adding to the loss of agricultural land.

A key response to such threats across many jurisdictions, but particular in the US, has been the introduction of ‘right-to-farm laws’. Most commonly, such laws seek to prevent people using nuisance law to abate activities which are part of farming business activities (Centner, 2007). For example, such laws might prevent a residential neighbour from bringing a nuisance suit relating to offensive odours against a farmer. Such laws were primarily introduced in the US as a means of preserving agricultural land for future generations and protecting the economic viability of existing farming businesses (Centner, 2007), largely in response to the increasing suburbanisation of peri-urban areas and the associated loss of agricultural lands. Hamilton describes laws preventing non-farm operations from moving close to and then challenging the very existence of an indigenous agricultural operation as ‘valid attempt[s] to preserve farms and farmland and a way of insuring fundamental fairness’ (Hamilton, 1998).

In the US, every state has adopted some kind of law or policy to protect farmers against nuisance suits (Centner, 2007), with the introduction of laws of this type beginning in earnest in the 1980s. Recently, NSW in Australia adopted a Right to Farm policy, though this is not yet legislated. Tasmania is currently the only state that has explicit, legislated right-to-farm laws, with the Primary Industry Activities Protection Act introduced to ‘stop the common law action of nuisance being used to prevent farmers pursuing the normal, legitimate and statutorily authorised activities which form a necessary part of good agricultural practices’ (Tas DPIPWE, 1995).

Not all right-to-farm laws are created equal, and the purpose and details of legislation can greatly vary, having varied implications both for the protections afforded farmers and for the burden placed on neighbours. These variations and their implications are described below.

3.4.1 Coming to the nuisance – protecting pre-existing activities

As Centner (2007) notes, the most common approach to providing an anti-nuisance defence for farmers is to incorporate a 'coming to the nuisance' doctrine in a right-to-farm law. A protection against 'coming to the nuisance' means that a nuisance suit cannot be brought against an activity or land use that pre-existed new adjacent land uses or new occupants. This is intended to stop people who elect to move next to objectionable agricultural activities from using nuisance law to abate the existing activities.

Some states, including Minnesota, Mississippi, Pennsylvania, and Texas, in an attempt to balance neighbours' rights with those of farming operators, have adopted statutes of limitation that prevent the bringing of nuisance actions after a specified period. Under the statutory provisions, 'neighbors who fail to file a nuisance claim within a stated time period after the commencement of the offensive activity may not successfully maintain the nuisance suit' (Centner, 2007). Such provisions seek to protect farmers without entirely removing neighbours' right to seek redress for injurious activities.

Some laws, such as the Tasmanian protections, require that the agricultural land use have been continually active for at least one year, providing protections for neighbours against new agricultural activities.

3.4.2 Preference over existing land uses

Laws that prevent nuisance suits where a new neighbour has 'come to a nuisance' are designed to prevent new neighbours objecting to existing activities and land uses. In some cases, however, legislation, whether intentionally or otherwise, provides protection for farmers against nuisance laws being brought by existing land uses and neighbours (Centner, 2007, p98). A number of US states have broadened or strengthened the protection available in the original conception of right-to-farm laws, by, for example, removing any requirement that the agricultural operation exist prior to the complaining activity (Hamilton, 1998).

This has the (possibly unintended) implication of preferencing farming over all other land uses, and can create a burden on existing neighbours who lose their rights to use nuisance suits to protect their amenity. The literature argues that there is no equitable justification for right-to-farm laws that allow people to adopt activities that are offensive to existing neighbours, unlike the 'coming to the nuisance' protections. In the US, these protections have been particularly problematic where they have prevented residential and agricultural neighbours from objecting to industrial pig feedlots that have been introduced to areas where such uses were not previously in place. Such laws are problematic for several reasons, not the least of which is such uses fail to utilise the agricultural lands and soils that the laws are intended to protect, as feedlots utilise land in a manner closer to industrial than agricultural uses, and because they can be associated with significant environmental health concerns.

3.4.3 Changes in use and activities

Though there may be equity implications of allowing significant changes of use to be protected under right-to-farm laws, as described above, many legislatures have recognised that changes will inevitably occur in agricultural businesses due to business imperatives or technological improvements (or, as is increasingly becoming the case, changes in climate necessitating alterations in practices, production techniques or the type of food produced by a farm).

Most right-to-farm statutes do not protect operations that change their production activities, however, as Centner notes, several right-to-farm statutes attempt to include the adoption of new technology within the agricultural operations and activities covered by the law (Centner, 2007). Pennsylvania, for example, includes 'new activities, practices, equipment and procedures consistent with technological development within the agricultural industry' under the definition of a 'normal agricultural operation', allowing farming businesses to make reasonable changes to their activities without risking liability under a nuisance suit. Such protections are important as 'operators need to be able to make changes while retaining the protection of the right-to-farm law if they are to continue their business' (Centner, 2007).

However, the expansion of an existing agricultural operation may be unfair to neighbours, who may be impacted by the change (Centner, 2007). Thus, allowing some changes without infringing on the rights of neighbours is a difficult balancing act for legislators. Some laws do not allow any expansion, others allow limited expansion, and a few are very generous with allowing changes to operations. These more generous laws have proven particularly problematic, given that, as described above, significant changes to use and operations can have major impacts on neighbours. Some laws provide neighbours the ability to bring nuisance suits against changes that result in particular kinds of impacts – for example, the Idaho laws do not offer protection to expanded facilities that altered production inputs resulting in offensive odours. Other states identify a particular size of expansion that is retained protection against nuisance laws – Minnesota, for example, places a percentage on the amount of expansion that qualifies for protection, and any operation that expands by less than 25% the number of a particular kind of livestock retains its protections, but greater expansions would be exempt from protections.

In Tasmania, the only permissible 'significant' changes in activities that allow operations to retain their protections under the laws include those which are due to 'improved technology or agricultural practices', thus significant expansions or variations in practices do not enjoy the protection of the right-to-farm laws (Griffith, 2015). This strikes a balance between the rights of neighbours and those of the farming business, however does not necessarily recognise that farmers may need to expand their operations in order to retain viability.

3.4.4 Compliance with particular practices

Michigan and other states in the US have used protection from nuisance cases as an incentive to comply with certain standards and practices – laws ensure that the protections from nuisance suits do not apply unless the farmers are in compliance with ‘standard practice’. In theory, this sounds as though it may be beneficial by ensuring minimum standards yet protecting farming operations. However, there are several implications of such requirements.

The first is that significant changes in use may be permitted and exempt from nuisance if they comply with standard practices. Centner (2007) cites *Steffens v Keeler*, a case in Michigan in which a vacant dairy farm was converted to use as a piggery. Once the piggery was found to be compliant with ‘standard practices’ for that industry, it was protected under the right-to-farm legislation and neighbours had no right to object to offensive odours despite the significant change in use and activities.

A second implication is that farmers are not necessarily free from judicial intrusion on their activities under laws that operate in this way (Centner, 2007). This may often mean a greater degree of regulation of practices than might be expected under usual environmental protection and food safety regulation laws, thus exposing farmers to even greater regulatory burdens.

Further, by enshrining ‘standard practices’ in law, farmers may be subjected to the very same limitations and restrictions that may have been imposed by successful nuisance suits. Whether such ‘standard practices’ are able to consider regional variations in, for example, input requirements relating to soil types and local climates, or be sufficiently flexible to allow for innovation and the development of new techniques, may have implications for the burden that is placed upon farmers by such laws.

3.4.5 Impacts and implications

Nuisance laws have, historically, been an important common law protection against adjacent land uses that might impact on a property owner’s enjoyment of amenity or property values. Activities that disrupt enjoyment of amenity might include any that are noisy, odorous, unsightly, potentially damaging to health or that compromise a person’s enjoyment of solar access or similar. Nuisance laws aim to protect, for example, residential neighbours from the impacts of adjacent development that might disrupt their quality of life. Thus, they have been an important mechanism for preserving property rights, providing a means outside the zoning system to protect from injurious uses and activities.

Of course, the application of nuisance laws may also have unintended consequences, such as placing additional burdens on farming businesses that might compromise their viability, as described above.

While right-to-farm laws protect farmers from nuisance suits, they also potentially burden neighbours with nuisances against which they have no right of protection. In the US, there is some concern that right to farm laws have burdened neighbours of farming activities in such a way that they should be considered ‘regulatory takings’ – burdens of regulation that are deserving of compensation (Centner, 2007). Right-to-farm laws work by altering the allocation of property rights, experienced by landowners as limitations on their ability to bring a legal action protecting the right to enjoy their property (Hamilton, 1998). This alteration is done in the name of protecting agricultural assets, however the ways in which such laws are written and the types of activities that they protect will have significant implications for sustainability and equity.



The impacts of industrial agriculture are very different to those of traditional agriculture – especially where industrial feedlots are concerned (Centner, 2007), and these forms of agricultural production may have more significant effects upon property values through odours, unsightly structures and health concerns than traditional grazing, cropping or horticulture might yield. Many of these activities do not make use of the underlying agricultural asset – the valuable soils suitable for crops, grazing and horticulture, but rather build barns on these lands for warehousing thousands of livestock. Many states passed RTFs at a time when the conversion of agricultural land to urban uses drew attention (Reinert, 1998), and concern for the loss of productive assets was high. Such laws sought to protect and sustain agricultural assets for future generations, and prevent the irreversible conversion of lands away from agricultural uses. There are, however, implications from such protections, and these may differ in peri-urban and rural areas.

In the peri-urban context, in particular, questions about whether certain agricultural activities are desirable activities for the fringes of our cities. For example, is intensive animal agriculture compatible with peri-urban patterns of development? Do our cities enjoy the purported benefits of peri-urban agriculture if this agriculture is intensive and industrial in form? Feedlots that house pigs and cows are likely to contribute to, rather than alleviate, environmental problems such as the heat island effect and pollution. Thus, peri-urban areas face decisions regarding not only the extent to which they wish to preserve agricultural production, but also regarding the type of agricultural production that is suitable for their area.

The right-to-farm law concept has an important value, though it is difficult to accurately gauge the effectiveness of the laws because it is difficult to estimate how many nuisance suits are not filed due to the existence of the laws (Hamilton, 1998). Despite this difficulty in quantifying outcomes, most observers would agree the laws are a valuable protection for agriculture (Hamilton, 1998). However, these laws must be balanced and capable of considering the nature of changes that will be protected and the types of activities that are desirable for retention in peri-urban areas. Further, as noted by Hamilton, ‘to function most effectively the law must be part of a more comprehensive program, such as a system of planning, regulation, and economic incentives’. Right-to-farm laws alone cannot protect peri-urban agriculture, and perhaps the best protection against nuisance laws that farmers can enjoy is a planning system that does not allow the conversion of adjacent lands to incompatible uses.



4.0 Valuing Benefits of Peri-Urban Agriculture

The previous section discussed various land-use planning responses to peri-urban agriculture. A key challenge for peri-urban agriculture is the failure of planning and other relevant professions to properly value the benefits provided by peri-urban agriculture. This section describes a framework for valuing the benefits of peri-urban agriculture that could be useful in understanding the full suite of benefits that peri-urban agriculture can impart on a city.

4.1 A framework for identifying the benefits of peri-urban agriculture

Currently, planners must make decisions regarding land use change based on inadequate information. Without information regarding the total value (social, environmental and economic) of peri-urban agriculture, they cannot fully understand the implications of converting that land to alternative uses (such as residential sub-division and development). Information regarding the total value of agricultural land, including ecosystem and food security benefits) is not generally quantified (or quantifiable), thus determinations of 'highest and best use' are conducted with limited information regarding the value of agricultural lands.

A key finding of a stakeholder workshop conducted for related research was that 'there is a need to better demonstrate and communicate the true value of agricultural land (including non-economic benefits of health, biodiversity, in addition to other supply chain economic benefits)'. Further, it was identified that there is a 'need to consider the role of agriculture in supporting urban sustainability and resilience, including food security, food miles, nutrient reuse and other benefits'.

In response to this lack of information regarding total benefits provided to urban systems by peri-urban agriculture, we have developed a framework for capturing the diverse set of benefits associated with agriculture in peri-urban areas. Figure 9 provides a framework for understanding the diverse suite of benefits that these activities bring. It shows the benefits that sit under five key categories: emissions and waste, socio-economic, food security, environmental and urban liveability. Of course, this is likely only one of many ways of organising these benefits that would work for this set of benefits.

Another way of understanding these benefits is to identify their potential to mitigate key risks faced by the Sydney Basin. This corresponds to the need identified by stakeholders to 'consider the role of agriculture in supporting...urban resilience', as mentioned above. Table 2 shows how these benefits map against key risks faced by the Sydney Basin.

Finally, a third dimension to understanding benefits is the scale at which these benefits occur. That is, while urban rooftop gardens might not generate levels of food production commensurate with peri-urban agriculture, they might provide benefits in terms of water management, urban cooling, amenity, food literacy and so on. Table 3 identifies a variety of urban food systems that occur at different settlement scales, and the range of benefits they address.

The section that follows describes how these benefits operate within the system. Most of the examples refer to the Sydney Basin, as this was the focus of this project. However, many, if not all, of the findings will be applicable to most other jurisdictions.



Figure 9

Potential benefits of local food systems. The loss of food production can therefore erode such benefits and increase costs.

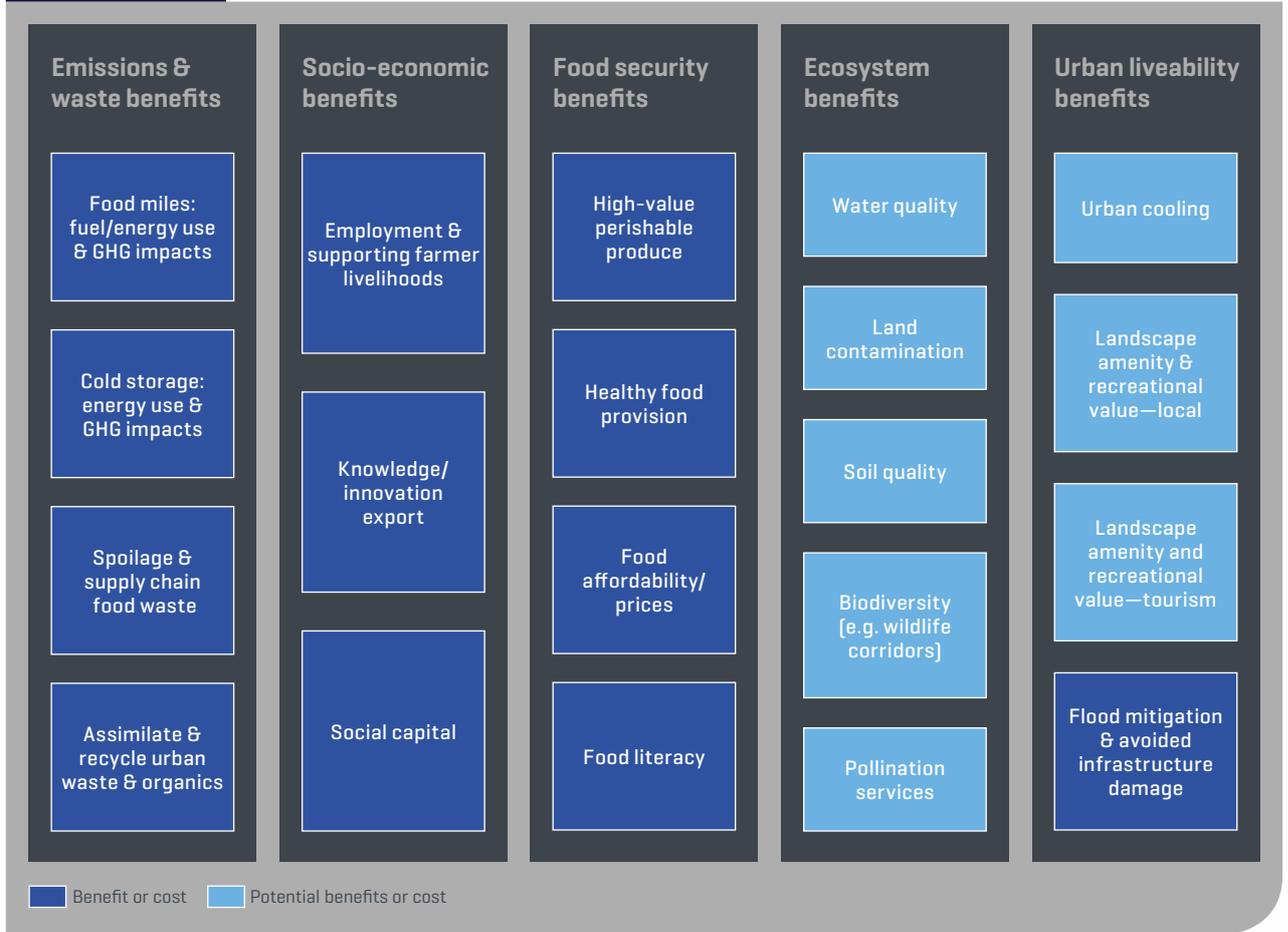


Table 2
The potential of local food systems to mitigate important risks faced by the Sydney Basin

Mitigating benefits of local food systems	Risks faced by the Sydney basin						
	Changing climate				Economic and price pressures		
	Increased temperatures	Drought in Sydney	Increased flooding	Drought in other food bowls	Fuel and energy prices	Global food price increase	Sydney economic downturn
Emissions and waste benefits							
Cold storage energy use and GHG impacts	✓				✓		
Food miles (transportation) fuel/energy use and GHG impacts	✓				✓		
Food waste in supply chain	✓						
Spoilage from harvest to purchase	✓						
Socio-economic benefits							
Employment and farmer livelihoods				✓	✓	✓	✓
Knowledge and innovation export				✓	✓	✓	✓
Social capital				✓	✓	✓	✓
Food security benefits							
High-value perishable produce	✓	✓	✓	✓	✓	✓	✓
Healthy food provision	✓	✓	✓	✓	✓	✓	✓
Food affordability	✓	✓	✓	✓	✓	✓	✓
Ecosystem benefits							
Waste produced—landfill impacts, resource recycling potential							
Water quality				✓			
Land contamination							
Soil quality				✓			
Biodiversity	✓	✓	✓	✓			
Pollination services	✓	✓	✓	✓			
Urban liveability benefits							
Urban cooling	✓						
Landscape amenity and recreational value—local	✓	✓	✓				
Landscape amenity and recreational value—tourism	✓	✓	✓		✓		✓
Flood mitigation and avoided infrastructure damage			✓				

Table 3

Feasible food system types at different settlement scales, and the potential benefits they provide

Land-use type	Feasible food system types	Water quality management	Increase food affordability and access	Increase 'food literacy'	Increase urban liveability	Significant food production	Significantly reduce supply-chain waste and emissions	Significant employment	Biodiversity and ecosystem benefits	Mitigate climate change risks
High-density residential	Rooftop gardens/Balcony gardens	✓	✓	✓	✓					
Medium-density residential	Backyard gardens	✓	✓	✓	✓					
Precincts	Allotments/Community gardens/Social enterprise urban farms	✓	✓	✓	✓					
Industrial	Vertical gardens	✓				✓	✓	✓		
Peri-urban	Hobby farms	✓			✓		✓		✓	✓
	Commercial farms/Market gardens	✓	✓		✓	✓	✓	✓	✓	✓
	Aquaculture systems	✓				✓	✓	✓	✓	
Rural land	Broadacre agriculture	✓				✓	✓	✓	✓	✓



4.2 Emissions and waste benefits

Russo et al (2014, p98) note that a city's ecological footprint is 'notably influenced by the food system (production practices, transport distances, energy input, managing organic waste, etc.)' and 'urban agriculture could be central to improving these issues'. Mougeot argues that urban agriculture ... must be viewed not as a problem, but as a tool contributing to sustainable urban development (Mougeot, 2000).

Agricultural land in and around cities provides many important environmental and ecosystem services such as ameliorating the urban heat island effect, acting as pest-control and providing corridors for wildlife. If managed well, agriculture is a good buffer between protected areas, such as national parks, and urban development.

Advances in transport such as refrigeration, large storage, and an increasingly global economy mean that we can bring food to our cities from much further afield than was the case a few decades ago. However, these long travel distances mean more transport fuel – and hence greenhouse gases. The greater distance travelled by food from paddock to plate has contributed to the concept of food miles, describing the total distance that food travels from where it was grown and harvested to where it is consumed. Food miles have increased dramatically over the past 20 years – particularly in developed countries (Fagan, 2008), where affluent urban populations began to demand year-round availability of seasonal fruit and vegetables.

However, as Fagan (2008) reports, the system of large-scale, industrialised agriculture that produces the majority of our food today is very energy intensive, regardless of how far away from our kitchens our food is produced. The environmental impact of food miles is contested, argued by some to be an oversimplification of impacts, with an undue focus on transport fuel rather than other input requirements (such as water and fertiliser) which might make producing in a far flung area more efficient than in a nearby area, thus offsetting any gains achieved through reduced transport distances. However, with its high and reliable rainfall (relative to the rest of New South Wales), the Sydney Basin is ideal for producing many green leafy vegetables, herbs and other perishable goods, meaning that, in this context at least, there is likely to be a reduced environmental impact achieved by producing close to market.

Further, reductions in fuel are not the only way in which local food might have a lower environmental impact than food transported long distances. Reductions in food waste, less water consumed in preservation and cold storage, fewer emissions from cold storage as well as fewer chemical enhancements to ensure that food does not spoil in transit, are just some of the advantages that local food has over food transported long distances.

The potential to absorb and reutilise many of the waste resources generated by cities – such as Phosphorus, may provide a key means of achieving production input

efficiencies that greatly exceed that of more distant areas. Globally, the cost of sourcing Phosphorus fertilisers essential for food production has risen in recent years, and the supply of Phosphorus fertiliser is vulnerable to geopolitical tensions and instability. Through food waste and sewage, many cities produce Phosphorus in excess of what could be utilised by agriculture in adjacent areas. Peri-urban agriculture thus presents a unique opportunity to utilise the Phosphorus produced by cities, diverting waste from landfill or our oceans and providing a secure and affordable alternative for peri-urban farmers.

4.3 Socioeconomic benefits

Relative to other forms of agricultural production, peri-urban agriculture appears to make an economic contribution which outsizes its geographic area. Despite Australia's peri-urban regions comprising less than 3% of the total amount of the continent's land that is used for agriculture, peri-urban agriculture is responsible for almost 25% of the total value of agricultural production (Houston, 2003), meaning that its importance to the Australian agricultural industry is much greater than its physical size might suggest. Agriculture in the Sydney Basin makes an important contribution to the economic development of western Sydney, and represents a significant proportion of NSW's production of perishable food. Estimates suggest agricultural production in Sydney was worth around \$1 billion in 2011. The vegetables produced in the Sydney region account for 22% (\$167 million) of total NSW vegetable production (Malcolm & Fahd, 2008). At certain times of the year, the Sydney region is the source of 90% of NSW's vegetable products.

Agriculture, with its high labour requirements (especially for intensive agriculture) provides significant employment for people living in adjacent areas—areas that tend to experience high average levels of unemployment. In the Sydney context, the sector directly employed 7,069 workers on 2,210 farms in 2011 (ABS, 2011). In addition to direct farming jobs, agriculture is linked to employment in significant secondary industries associated with food processing, packaging and transportation.

Agricultural industries are also an important source of employment for people from culturally and linguistically diverse backgrounds—for migrants who can bring their knowledge of agriculture from overseas and who may not have a wealth of alternative employment options available to them in Australia. Stakeholders interviewed for this project identified that Chinese farmers from the Pearl River Delta, experienced with farming sandy soils similar to that in Sydney, and Maltese farmers who have farmed Sydney's south west for decades, are important for inter-generational knowledge transfer. Anecdotally, stakeholders also identified that the peri-urban agriculture sector has been an important source of employment for Cambodian, Eastern European (Macedonian, Yugoslavian etc) and Vietnamese migrants, many of whom arrive with limited English-speaking skills but who bring with them farming experience and skills.

Finally, peri-urban agriculture has economic development potential in its unique appeal for tourists: farmgate trails, cellar doors, pick-your-own-fruit weekends and farmers' markets are potentially-lucrative alternative sources of income for farmers, and can increase the total income brought into the region. Stakeholders identified that agro-tourism has recently become a key source of income for farmers in the Sydney region, particularly in the regions that serve as good 'weekender' trips, such as the Hawkesbury, Blue Mountains, Wingecarribee and Shoalhaven regions, each of which are within two hours drive of the city and provide natural scenery and heritage towns in addition to agro-tourism.

4.4 Food security benefits

Food security is a topic that Australians might more readily associate with developing nations in famine or suffering food crises. However, food security is a very real issue in Australia – regarding current rates of obesity, diabetes and access to affordable and healthy food, and, into the future as our climate changes and our population grows.

Food security is defined by the United Nations' Food and Agriculture Organisation as being access by all people to sufficient, safe and nutritious food. That is: food is available, accessible and our bodies are healthy enough to utilise the nutrients in food. 'Access' refers to:

- Physical access: being easily able to reach a market or source of food
- Economic access: that safe and nutritious food is affordable
- Social access: people's access to food is not restricted by their social status or class.

Food security is increasingly threatened by price rises in inputs to agriculture, such as fossil fuels and fertilisers, which lead to food price increases. Between 2002 and mid-2008, global food prices increased by 64% (FAO 2008), reducing many people's capacity to purchase sufficient healthy food to feed themselves and their families.

Australia is a net exporter of food, producing enough food annually to feed an additional 40 million people to Australia's population (DAFF, 2012). According to the ABS, Australian farms produced 93% of the total volume of food consumed in Australia in 2009. Indeed, Australia has plans to increase export production, tapping into strong Asian demand growth, however the security of supply is by no means guaranteed. It is unclear where the human resources (such as farmers) and natural resources (such as water and fertile soil) will come from to produce, and whose role and responsibility the management of adverse consequences are.

Further, the price of food in Australia is relatively high, meaning that although Australia produces enough food to feed our population, not all Australians are able to access it. Almost 20% of the Australian population are welfare dependent and could not afford to purchase fresh, healthy food (Kettings et al. 2009). Even within the City of Sydney, some households with children and many government-assisted households will be experiencing or approaching food stress. For example, many government-assisted households are spending a third of their incomes on food⁷.

Food produced locally is, however, less vulnerable to price rises. Food transported over great distances is vulnerable to spoilage, more likely to be enhanced using preservatives and colours, is exposed to price fluctuations due to reliance on fossil fuels, and is more likely to be expensive than food produced locally (Paul and Haslam McKenzie, 2011). Thus, there exists an opportunity for farmers in peri-urban areas to provide affordable food in an increasingly unaffordable market, and to minimise the relative environmental impact of the food they produce.

If there was a disruption to Sydney's main transport route (from bushfires, fuel supply disruption or other) – Sydney's fresh food reserves are estimated to last only a few days based on the throughput of the Sydney Flemington Market. Changing trends in food demands, having a competitive advantage over other products because of their freshness, locally grown and no food miles involved.

Under a changing climate, many of the world's agricultural lands are vulnerable to changes in temperature, rainfall and extreme events. Globally, many cities have developed in highly productive areas, along rivers, on floodplains and close to highly-productive areas that meet the city's demand for food. The importance of these areas to food production will only continue to grow as our climate change. This is certainly the case in NSW. Over 50% of NSW vegetables are grown in the Murray-Darling and Murrumbidgee regions to the west and south-west of the state, where water availability is becoming a significant problem, particularly as our climate changes and droughts become longer, more severe, and more frequent. Sydney has good quality agricultural land and may also have more reliable rainfall than inland areas as climate change occurs. The capacity for Sydney to continue to provide locally-grown vegetables should be not just maintained, but increased, if Sydney is to be food secure.

⁶ http://www.sydneyfoodfutures.net/wp-content/uploads/2015/11/ISF_-_2014_Food-Basket-Conference-presentation.pdf

Climate change might also affect our ability to store and transport food from distant sources. As the costs of transport fuels rise, both due to global carbon markets and increasing oil scarcity, transporting our food long distances from rural regions to cities will become more expensive. The costs of refrigerated storage will also rise, and this, too, will affect the price of fresh food. These increasing costs will reduce the affordability of fresh fruit and vegetables, potentially impacting people who are poor or elderly.

4.5 Ecosystem benefits

Peri-urban agriculture provides benefits described as 'ecosystem services'—services produced by ecosystem and biological systems that are essential for human life and wellbeing. These are widely documented in the literature (see, for example, the Millennium Ecosystem Assessment⁷) and include improved water and waste management, reduced urban heat effects and improved air quality, reduced carbon emissions, conservation of biodiversity, and improved nutrient recycling. Of course, agriculture can also have negative impacts upon water quality, waste production (especially dairying) and air quality. These variations are largely dependent upon the type and scale of agriculture—for example, industrial feedlot piggeries are likely to pose challenges for their local environment—while permaculture and horticulture may be less impactful and generate positive benefits.

However, by its very nature, well-managed productive farmland discourages feral animals and weeds that might otherwise destroy native flora and fauna through competition and predation. In contrast, unproductive rural land 'in waiting' for urban development generally promotes exotic weeds and is a haven for feral animals and pests, posing a serious threat to biodiversity. (Of course, agriculture has its own implications for biodiversity, such as threats to genetic diversity posed by monocultural production and those posed to wildlife due to habitat destruction). Lifestyle lots and land waiting for urban development also have potential biosecurity implications, as discussed earlier in this report. The implications of poorly maintained or neglected non-agricultural lots may be severe, encouraging invasive species, diseases and pests. Protecting agricultural lands can provide biodiversity and other benefits, including allowing for effective groundwater recharge and maintaining soil quality.

4.6 Urban liveability

As the climate changes and cities become less liveable due to extreme weather and temperature increases, we will become more reliant on the ecosystem services that peri-urban agriculture is capable of providing, including mitigating the heat island effect, providing amenity through open green space, and flood mitigation benefits.

The 'urban heat island effect' is the name given to the phenomenon that sees our cities retaining and creating more heat than adjacent areas, due to their concentration of cars, buildings and surfaces that store heat, such as a concrete and bitumen. As our climate becomes increasingly extreme, the frequency of 'very hot days' that we experience will rise, and the importance of these cooler areas to ensuring that our cities are liveable will grow.

The peri-urban areas that are adjacent to cities, which have a much lower density of buildings and roads and much more greenery such as grass, crops and tree coverage, are cooler than suburban and urban areas. Recently developed 'heats maps' show the stark difference between large acreage lots and moderate density residential lots on a mid-summer's day: the large acreage lots remain substantially (10 – 15°C) cooler than the residential areas on such days (unpublished work, ISF 2015). As the number of extreme heat days increases under a changing climate, the cooling effect of peri-urban areas will become ever more crucial.

Further, peri-urban areas provide scenic amenity adjacent to highly developed cities (Kelleher et al, 1998). The contribution of open spaces and green spaces to making cities more liveable is now virtually unquestioned. Though on the edges of our cities, rather than in the dense cores, peri-urban areas can provide accessible open and green spaces providing scenic amenity, as well as opportunities for recreation in these areas, including walking and cycling routes, and cellar door and farm gate tours. Such amenity provides city-dwellers with access to open space and green areas, facilitates opportunities to interact with biodiversity, as well as having potential benefits for food system literacy.

Finally, agricultural land uses are more suitable land uses for flood-prone areas than suburban development. Much of Sydney's existing peri-urban agriculture occurs on flood plains at the base of the Blue Mountains and the Great Dividing Range, making it more appropriate for agriculture than many other uses. Open spaces, such as those provided by many types of agricultural land use, provide opportunities for stormwater management and flood mitigation (Hamin & Gurrán, 2009). Not only can agricultural land provide flood-mitigating benefits, but agricultural land uses will yield lower infrastructure damage costs in following an extreme event.

⁷ <http://www.millenniumassessment.org/en/index.html>

5.0 Conclusion

The loss of peri-urban agriculture may well be considered a wicked problem—it involves many competing priorities, and few ‘quick fixes’.

Although the planning system has attempted to deliver responses to mitigate the loss of peri-urban agriculture, responses have typically fallen short and failed to prevent the decline of food production in our cities. Key barriers to effective responses within the planning system in Sydney (and many other jurisdictions) include:

1. A lack of information regarding the total value of agricultural land, meaning determinations of ‘highest and best use’ are conducted with limited information regarding the value of agricultural lands
2. Strategic plans fail to explicitly protect agricultural land, and, indeed in many cases explicitly involve the development of agricultural areas for residential growth
3. Decisions about land-use change are often handled as stand-alone events, and the city-wide and long-term implications of such decisions are seen as outside of planners’ responsibility
4. A failure to recognise that residential and agricultural land uses are incompatible as neighbouring land uses
5. A failure to respect the property rights of farmers to operate their businesses on appropriately zoned land, and a lack of appropriate dispute resolution processes in place to resolve land-use conflicts relating to incompatible neighbouring uses
6. Planners do not necessarily consider the ways in which fragmentation of rural zones and conversion of land to residential uses might infringe on farmers’ property rights, such as through threats to biosecurity, liability to nuisance cases and other incompatibilities between agricultural and residential land
7. Few financial incentives exist for farmers to continue production in peri-urban areas due to declining profitability and the increasing saleable value of land for sub-division
8. A lack of initiatives targeting middle-ring suburbs for densification, and a set of incentives and regulations that encourage continued urban sprawl.

In addition, local authorities will need to conduct data collection and modelling programs to understand landscape changes over time, areas most in need of protection, and future scenarios for likely land use change.

Achieving the above outcomes will involve at least some of the following components, likely several in combination:

- A transferable development rights scheme to provide additional income for farmers and improve economic viability, as well as recognise the true cost of development and density in urban areas,
- More rigorous zoning and buffer zones to prevent the rezoning of agricultural land,
- Right-to-farm legislation that balances the rights of neighbours with farmers’ right to operate their businesses profitably, recognising that changes in activities will occur over time, but preventing significant infringement of neighbour’s amenity,
- Modelling of likely changes to land use and food production in peri-urban areas to assist farmers in understanding the impacts of conversion of lots to alternative uses,
- Recognition in strategic plans of agriculture as a priority land use and the inclusion of an explicit intention to preserve agricultural land in peri-urban areas,
- Reconsideration of the doctrine of ‘highest and best use’ to ensure that the broad suite of benefits that are provided by peri-urban agriculture are weighed in planning decisions relating to the future of peri-urban land and development,
- Strategic planning measures such as an urban growth boundary or green belt, and
- A framework, as suggested in the following section, to more fully value the benefits of peri-urban agriculture to allow more informed assessment by planners in considering rezoning applications.

Given the multi-faceted nature of the problem of peri-urban agriculture loss, a multi-faceted solution is likely required. Simply providing a property right protection such as a right-to-farm, while effective in ensuring a farmer’s right to operate their business, will not necessarily prevent the conversion of neighbouring land to urban uses, nor will it necessarily guarantee the viability of the farming operation. Similarly, while strategic planning measures such as urban growth boundaries can be effective, they will likely be unsuccessful if not supported by strong zoning and explicit protections for agricultural land uses.

Jurisdictions around the world provide a variety of tools for protecting peri-urban agriculture, though few appear to have comprehensively addressed the complex problem of peri-urban agricultural loss. We suggest that a multi-pronged approach is needed, addressing strategic planning, financial, property rights and fragmentation issues simultaneously, to provide protection from the various pressures that peri-urban agriculture is currently facing.

6.0 References

- Amati, M., & Yokohari, M. (2006). Temporal changes and local variations in the functions of London's green belt. *Landscape and Urban Planning*, 75(1-2), 125–142. <http://doi.org/10.1016/j.landurbplan.2004.12.007>
- Avery, D. (1995) *Saving the planet with pesticides and plastic: the environmental triumph of high-yield farming*. Hudson Institute.
- Burnley, I. H., & Murphy, P. A. (1995). Exurban development in Australia and the United States: Through a glass darkly. *Journal of Planning Education and Research*, 14, 245–254.
- Centner, T. J. (2007). Governments and Unconstitutional Takings: When Do Right-To-Farm Laws Go Too Far?, 87(May).
- Choy, D. L., & Sutherland, C. (2008). A changing peri-urban demographic landscape. *Australian Planner*, 45(3), 24–25. <http://doi.org/10.1080/07293682.2008.9982672>
- Clancy, T. F., & Lesslie, R. G. (2013). A scoping assessment for a national research centre addressing land use and food security issues. ABARES, (October).
- CSIRO, & Bureau of Meteorology. (2015). *Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report*, CSIRO and Bureau of Meteorology, Australia.
- DAFF (2012) *Australian Food Statistics 2011-12*. <http://www.agriculture.gov.au/SiteCollectionDocuments/ag-food/publications/food-stats/daff-foodstats-2011-12.pdf>
- Fagan, B. (2008). Feeding Sydney understanding food miles, (April).
- FAO. (2008). The state of food insecurity in the world 2008. High food prices and food security – threats and opportunities, Food and Agriculture Organization of the United Nations, Rome, Italy. Retrieved November 14, 2011 from <ftp://ftp.fao.org/docrep/fao/011/i0291e/i0291e00.pdf>
- Golledge, R. G. (1960). Sydney's metropolitan fringe: A study in urban–rural relations. *Australian Geographer*,
- Griffith, G. (2015). Right to farm laws, (June), 1–21.
- Hamilton, N. D. (1998). Right-to-Farm Laws Reconsidered: Ten Reasons Why Legislative Efforts to Resolve Agricultural Nuisances May be Ineffective. *Drake Journal of Agricultural Law*, 3(479), 103.
- Hamin, E. M., & Gurran, N. (2009). Urban form and climate change: Balancing adaptation and mitigation in the U.S. and Australia. *Habitat International*, 33(3), 238–245. <http://doi.org/10.1016/j.habitatint.2008.10.005>
- Houston, P. (2003). The national audit of Peri-urban agriculture. *Australian Planner*, 40(3), 43–45. <http://doi.org/10.1080/07293682.2003.9995278>
- Jackson, L. (1998) Agricultural industrialisation and the loss of biodiversity, in Guruswamy, L., (1998) *Protection of global biodiversity*. Nature.
- Kettings, C., Sinclair, A., & Voevodin, M. (2009). A healthy diet consistent with Australian health recommendations is too expensive for welfare-dependent families. *Australian & New Zealand Journal of Public Health*, 33 (6), 566–572.
- Kelleher, F. (2001). Urban encroachment and loss of prime agricultural land. Hawkesbury: Centre for Farming Systems Research, University of Western Sydney.
- Kelleher, F.M., Chant, J.J., Johnson, N.L., 1998. Proceedings of the 9th Australian Agronomy Conference, Wagga Wagga.
- Kelleher, F. M., Chant, J. J., Johnson, N. L., 1998, Impact of Rural Subdivision on Agriculture, A Report for the Rural and Industrial Development Corporation, Farming Systems Research Centre, University of Western Sydney, Hawkesbury.
- Kline, J. D., Thiers, P., Ozawa, C. P., Alan Yeakley, J., & Gordon, S. N. (2014). How well has land-use planning worked under different governance regimes? A case study in the Portland, OR-Vancouver, WA metropolitan area, USA. *Landscape and Urban Planning*, 131, 51–63. <http://doi.org/10.1016/j.landurbplan.2014.07.013>
- La Rosa, D., Barbarossa, L., Privitera, R., & Martinico, F. (2014). Agriculture and the city: A method for sustainable planning of new forms of agriculture in urban contexts. *Land Use Policy*, 41, 290–303. <http://doi.org/10.1016/j.landusepol.2014.06.014>
- Malcolm, P., & Fahd, R. (2008). Ground Truthing of the Sydney Vegetable Industry in 2008, 07073.
- Merson, J., Attwater, R., Ampt, P., Wildman, H., & Chapple, R. (2010). The challenges to urban agriculture in the Sydney basin and lower Blue Mountains region of Australia. *International Journal of Agricultural Sustainability*, 8(1), 72–85. <http://doi.org/10.3763/ijas.2009.0464>
- Mougeot, L. (2000). Urban agriculture: definitions, presence, potentials and risks. *Growing cities, growing foods: urban agriculture on the policy agenda*, 1–42.
- Paul, V., & Haslam McKenzie, F. (2011). Agricultural areas under metropolitan threats: Lessons for Perth from Barcelona. In G. Luck, D. Race, & R. Black (Eds.), *Demographic change in rural landscapes: What does it mean for society and the environment?* (Landscape series). London: Springer
- Pruetz, R., & Standridge, N. (2009). What makes transfer of development rights work? *Journal of the American Planning Association*, 75(1).
- Reinert, A. A. (1998). *The Right to Farm: Hog-tied and nuisance-bound* (Vol. 1694).
- Rose, C. M. (1989). Property rights, regulatory regimes and the new takings jurisprudence—an evolutionary approach. *Tennessee Law Review*, 57, 577–594.
- Rothwell, A., Ridoutt, B., Page, G., & Bellotti, W. (2015). Feeding and housing the urban population: Environmental impacts at the peri-urban interface under different land-use scenarios. *Land Use Policy*, 48, 377–388. <http://doi.org/10.1016/j.landusepol.2015.06.017>
- Russo, P., Tomaselli, G., & Pappalardo, G. (2014). Marginal periurban agricultural areas: A support method for landscape planning. *Land Use Policy*, 41, 97–109. <http://doi.org/10.1016/j.landusepol.2014.04.017>
- Tripp, J. T. B., & Dudek, D. J. (1989). Institutional Guidelines for Designing Successful Transferable Rights Programs. *Yale Journal on Regulation*, 6, 369.
- Yeh, S., Kug, J., Dewitte, B., Kwon, M., Kirtman, B. P., & Jin, F. (2009). El Niño in a changing climate. *Nature*, 461(7263), 511–4. <http://doi.org/10.1038/nature08316>

7.0 About the Authors

The Institute for Sustainable Futures (ISF) was established by the University of Technology Sydney in 1996 to work with industry, government and the community to develop sustainable futures through research and consultancy. Our mission is to create change toward sustainable futures that protect and enhance the environment, human wellbeing and social equity. We seek to adopt an interdisciplinary approach to our work and engage our partner organisations in a collaborative process that emphasises strategic decision-making.

For further information visit: www.isf.uts.edu.au

Wynne, L., Cordell, D., Chong, J. and Jacobs, B. (2016). Planning tools for strategic management of peri-urban food production. Prepared by the Institute for Sustainable Futures, University of Technology Sydney, for the Royal Institution of Chartered Surveyors, UK.

Disclaimer

The authors have used all due care and skill to ensure the material is accurate as at the date of this report. UTS and the authors do not accept any responsibility for any loss that may arise by anyone relying upon its contents.







Confidence through professional standards

RICS promotes and enforces the highest professional qualifications and standards in the development and management of land, real estate, construction and infrastructure. Our name promises the consistent delivery of standards – bringing confidence to the markets we serve.

We accredit 118,000 professionals and any individual or firm registered with RICS is subject to our quality assurance. Their expertise covers property, asset valuation and real estate management; the costing and leadership of construction projects; the development of infrastructure; and the management of natural resources, such as mining, farms and woodland. From environmental assessments and building controls to negotiating land rights in an emerging economy; if our members are involved the same professional standards and ethics apply.

We believe that standards underpin effective markets. With up to seventy per cent of the world's wealth bound up in land and real estate, our sector is vital to economic development, helping to support stable, sustainable investment and growth around the globe.

With offices covering the major political and financial centres of the world, our market presence means we are ideally placed to influence policy and embed professional standards. We work at a cross-governmental level, delivering international standards that will support a safe and vibrant marketplace in land, real estate, construction and infrastructure, for the benefit of all.

We are proud of our reputation and we guard it fiercely, so clients who work with an RICS professional can have confidence in the quality and ethics of the services they receive.

United Kingdom RICS HQ

Parliament Square, London
SW1P 3AD United Kingdom

t +44 (0)24 7686 8555
f +44 (0)20 7334 3811
contactrics@rics.org

Media enquiries
pressoffice@rics.org

Ireland

38 Merrion Square, Dublin 2,
Ireland

t +353 1 644 5500
f +353 1 661 1797
ricsireland@rics.org

Europe

[excluding UK and Ireland]
Rue Ducale 67,
1000 Brussels,
Belgium

t +32 2 733 10 19
f +32 2 742 97 48
ricseurope@rics.org

Middle East

Office G14, Block 3,
Knowledge Village,
Dubai, United Arab Emirates

t +971 4 446 2808
ricsmiddleeast@rics.org

Africa

PO Box 3400,
Witkoppen 2068,
South Africa

t +27 11 467 2857
f +27 86 514 0655
ricsafrica@rics.org

Americas

One Grand Central Place,
60 East 42nd Street, Suite #542,
New York 10165 – 2811, USA

t +1 212 847 7400
f +1 212 847 7401
ricsamericas@rics.org

South America

Rua Maranhão, 584 – cj 104,
São Paulo – SP, Brasil

t +55 11 2925 0068
ricsbrasil@rics.org

Oceania

Suite 1, Level 9,
1 Castlereagh Street,
Sydney NSW 2000, Australia

t +61 2 9216 2333
f +61 2 9232 5591
oceania@rics.org

East Asia

3707 Hopewell Centre,
183 Queen's Road East
Wanchai, Hong Kong

t +852 2537 7117
f +852 2537 2756
ricsasia@rics.org

China (Shanghai)

Room 2006, Garden Square,
968 Beijing Road West,
Shanghai, China

t +86 21 5243 3090
f +86 21 5243 3091
ricschina@rics.org

China (Beijing)

Room 2507-2508B, Jing Guang Centre,
No.1 Hu Jia Lou Road, Chaoyang District
Beijing 100020, China

t +86 10 6597 8586
f +86 10 6581 0021
ricschina@rics.org

Japan

Level 14 Hibiya Central Building,
1-2-9 Nishi Shimbashi Minato-Ku,
Tokyo 105-0003, Japan

t +81 3 5532 8813
f +81 3 5532 8814
ricsjapan@rics.org

ASEAN

06-22 International Plaza,
10 Anson Road,
Singapore 079903

t +65 6635 4242
f +65 6635 4244
ricssingapore@rics.org

South Asia

48 & 49 Centrum Plaza,
Sector Road, Sector 53,
Gurgaon – 122002, India

t +91 124 459 5400
f +91 124 459 5402
ricsindia@rics.org