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Aquaponics in Urban Agriculture: Social Acceptance and Urban Food Planning

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Abstract: Aquaponics is emerging as a novel technology with particular potential for urban agriculture (UA). The social acceptance of aquaponics and its place in urban food planning has not previously been studied. This study used focus groups, key informant interviews, and scenario analyses to investigate the reactions of Adelaide's urban food opinion leaders and local government area (LGA) officials to aquaponics. Most of the focus group participants were unfamiliar with aquaponics. The perceived negatives of the technology received greater attention than the perceived benefits. Aquaponics was thought to be most competitive in either niche or wholesale markets, with a need for scaled guidelines from backyard to large-scale commercial production. For aquaponics in urban settings the influence of urban planning and policy is an important, but to date unstudied, consideration. The urban growers' opinions of the overcomplicated nature of urban food planning corresponded with the mixed policy responses of the LGAs towards UA. This further supports the participants' desire for a supportive State Government stance on UA to encourage consistency in LGAs.

Keywords: aquaponics; business models; community perception; local food systems; social acceptance; urban agriculture; urban food planning

1. Introduction

Sustainability and food security are gaining greater concern both globally and in Australia, leading to a revival of interest and engagement in our food's provenance. In our suburbs and cities, community gardens, the sourcing of local food, and growing your own food, are becoming increasingly popular. Food production within city boundaries or peripheries, regardless of size, is known as urban agriculture (UA) [1]. UA is regarded as one way to achieve greater urban food security, as well as to help reconnect people with their food systems [2–4].

Beyond individual or community use, there is also a strong entrepreneurial take-up of UA businesses [5,6]. One such form of emerging UA to be considered for commercial expansion is aquaponics. Aquaponics combines two widely known technologies, recirculating aquaculture and hydroponics. It is defined as "a bio-integrated system that links recirculating aquaculture with hydroponic vegetable, flower or herb production" [7]. Aquaponics is often endorsed as a sustainable food system that is easily adapted to urban sites [8,9]. Although US and European aquaponics systems dominate research output, global studies show entry into the production sector in all world regions [10]. Within Australia there is a large backyard scale take-up of aquaponics [11]. This is also evidenced by multiple Australian online discussion forums.

Aquaponics has been less extensively studied than more common forms of UA, such as community gardens. Previous aquaponics research has tended to focus on the technical and management aspects such as: the optimal mix of species of fish and vegetables that work well together, the use of different

biofilters and growing media, or comparing one system to another [12]. Two baseline producer studies from the United States and Europe show distinctly different (albeit both male) producer profiles. Backyard systems and hobbyists dominated in the United States [13], whereas the European study included more small-scale commercial producers and educators/scientists [14].

A lack of research into the economic viability of aquaponics systems has been noted [15]. There is also a lack of knowledge on what people or communities, in major markets, think of aquaponics systems. Miličić et al. [16] moved beyond more common aquaculture and hydroponics consumer acceptance studies to European preferences, finding that over half of respondents had never heard of aquaponics. Innovation and sustainability enthused participants reported negative associations with the link between fish excrement and food, fish welfare, and mistrust of overreaching positive claims. In Likert scale statements, greater sustainability, advantages as compared to aquaculture, and a values preference for a soil-based growth medium showed the only market segments with purchase potential were "Innovators" (16%) and those willing to pay more for aquaponics output (23%) once information levels were increased.

South Australia is well known for its agricultural production, although it is familiar with the stresses of water restriction and drought. Adelaide has much of its food produced close by (within 60 km of the city centre) [17]. It has also been estimated that 80% of the nearby market garden produce is sold locally [18]. However, the growing needs of land for housing development competes with that of food production within the greater Adelaide region [19]. As this competition continues, the value of small-scale intensive forms of UA, such as aquaponics, could be expected to grow.

For aquaponics in urban settings the influence of urban planning and policy is an important, but to date unstudied, consideration. This corresponds with the concern in current literature on the absence of urban food planning and lack of leadership by urban planners and municipal councils alike to facilitate UA [20,21]. This lack of cohesive urban food planning is also apparent in Australia, where the link between land-use planning and food security is little understood [20,22,23].

An analysis of existing regulatory systems in Australia by Pires [24] found that municipal councils tend to unintentionally impact and restrict UA rather than support it. A recent review of the Adelaide Metropolitan City Plan [20] found Adelaide lagging behind when compared to other Australian capital cities with no mention or adoption of one of the UN Habitat trends for urban sustainability, 'Sense of Place'. This trend links to local economic development and place-based social capital, where UA could fit due to its strong ties to physical inhabitation [25].

This current paper addresses the paucity of social and regulatory data on aquaponics by presenting the results of two important, complementary investigations. Firstly, the results from a series of focus groups and key informant interviews map the receptivity of Adelaide's urban food opinion leaders towards aquaponics, within the context of UA. Secondly, we present the results of preliminary scenario analyses of the policy positions (implicit or explicit) of different local government areas (LGAs) towards UA in general, and aquaponics in particular. The combined results of these complementary studies will help inform future food planners and UA practitioners, particularly those interested in the development of an urban aquaponics industry and small-scale intensive UA more broadly, by mapping the current social and regulatory opportunities and barriers.

2. Materials and Methods

Three methods were used to collect data on awareness, appreciation, and potential business models of aquaponics systems. The methods were focus groups, key informant interviews, and scenario analyses, all of which are described individually below.

2.1. Focus Groups (FG#1–3)

To begin investigating the reactions of people already familiar and engaged in Adelaide's urban food system towards aquaponics, three focus groups with a directed line of questioning were held. Focus groups draw on people's attitudes, beliefs, experiences, and reactions [26,27] and are especially

useful when measuring topic consensus [28]. Participants were selected via both purposive sampling, the process of identifying people heavily involved in the chosen research field to ensure they are information-rich and relevant to the topic [29], and snowball sampling, where selected participants are asked to recommend other suitable people from within their network [30].

Participants were selected due to their involvement or experience in urban food related production, development, management, or marketing and sales. This resulted in a combination of growers, urban food business consultants, council representatives, market stall owners, wholesale sellers, and Community Supported Agriculture (CSA) members being present. The attendance numbers are listed below:

1. Focus Group #1 (FG#1); n = 8
2. Focus Group #2 (FG#2); n = 9
3. Focus Group #3 (FG#3); n = 7

Average group size roughly matches the desirable size range of six to eight people for focus groups recommended by Krueger and Casey [31]. Of the 42 people invited to participate, 23 of them were present for the focus groups, a response rate of 55% (n = 23; 65% males/35% females). The two top reasons for non-participation were being time short due to multiple prior commitments, and due to not perceiving themselves as 'expert' enough to participate. Each session lasted approximately 90 min, was audio recorded, and had two separate sets of notes taken.

Focus group participants were firstly shown photos of various sized aquaponics systems and given an explanation of how they worked. The photos were carefully selected by the research team to represent the full range of aquaponics systems: large to small and commercial to backyard. They were then asked for their initial reactions, level of familiarity, and what they perceived as the positives and negatives of the technology. A short list of the strengths and weaknesses of aquaponics (according to recent literature) was shown. Each group was asked to add any others they thought were missing. Suggestions were added to the original list and included for successive focus groups. The finalised list included all suggested points and was later presented during the key informant interviews.

Analysis was conducted using key-point transcripts created from each audio recording and notes. This form of analysis has moderate to high levels of perceived rigor and low risk of error [31]. Coding began early after the first focus group. Analysis was completed using the qualitative analysis software QSR NVivo 11 (QSR International Pty Ltd, Melbourne, Australia).

2.2. Key Informant Interviews (KI#1–18)

Initial broad topic coding of focus group responses revealed questions on which to base the topic guide for the key informant interviews, allowing us to pursue these ideas in greater depth. Topic guides ensure inclusion of important questions whilst still allowing each participant the opportunity to expand on topics that they, from personal experience, consider important [32].

A total of 18 key informant interviews were conducted out of 22 identified potential interviewees. Participants were identified either by being an opinion leader involved in Adelaide's urban food system (n = 15), or were not able to previously attend a focus group session, but indicated a desire to be part of the study (n = 7). Eighteen interviews is within the desired range of 15–20 recommended by Mason [33].

Each participant was able to choose between a face-to-face and a telephone interview, although face-to-face was presented as the preferred method. It was felt that having the telephone option would encourage more people to take part and so ensure a better response rate. The use of telephone interviews in qualitative research is increasing as more researchers learn about the logistical conveniences and methodological strengths such as time, speed, and cost [34,35]. Thirteen of the interviews were conducted face-to-face, four by telephone, and one via Skype. A study by Vogl [35] found no difference in reliability between phone and face-to-face interviews. The interview

response rate was 78% (n = 18), with an approximately even distribution of female (n = 8) and male (n = 10) participants.

Participants were emailed a participant information sheet, consent form, and a short booklet on aquaponics to familiarise themselves with the technology prior to their interview. The sessions were audio recorded and transcribed verbatim directly afterwards. The full unaltered interview transcript was then returned to each participant to check for accuracy. Analysis of the collected data followed the same analysis process as for the focus groups, again using QSR NVivo. Interview data was compared to focus group data to search for repeating concepts and underlying themes.

2.3. Scenario Analyses (SA#1–7)

Comparing urban agriculture policies at the local level helps to map the varying levels of administrative awareness and commitment to supporting, ignoring, or discouraging local food production. The 17 local government areas (LGAs) of Metropolitan Adelaide were divided into North, South, East, West, and Central regions, with one LGA from each region selected. These regions are shown edged in Figure 1. An extra two areas were included from the East region, as it contains a greater number of councils over a wide geographical spread. Adelaide; Mitcham; Salisbury; Charles Sturt; Norwood, Payneham, and St. Peters; Tea Tree Gully; and Prospect LGAs were selected to represent a mixture of geographical representation, population, average annual wage, and cultural heritage.

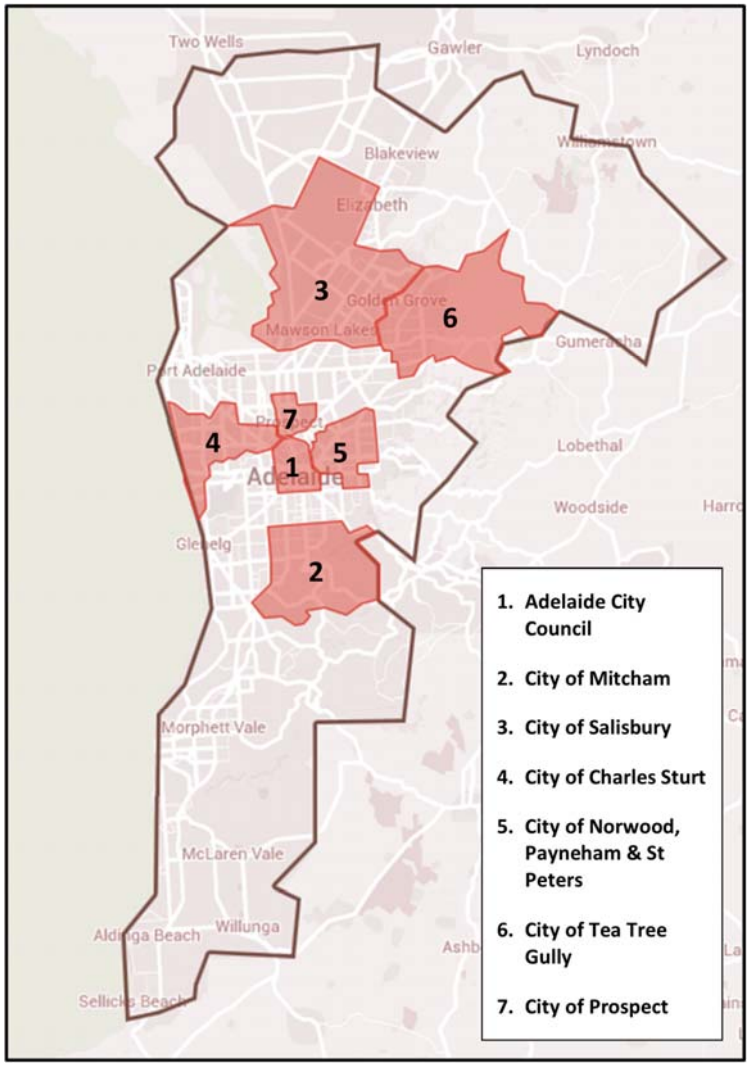

Figure 1. The seven selected Local Government Areas of Metropolitan Adelaide.

Seven hypothetical UA scenarios were developed, covering a range of simple food production activities that people may want to engage in within their council area: vegetable gardening, keeping chickens, keeping fish, planting fruit street trees, having community gardens, and starting a small home produce business. Though this study focused more on aquaponics, it was felt that since this is still a relatively new and unknown technology (even among those focus group and interview participants deeply involved in the UA scene), including a range of simpler and more common UA activities would provide better context for the council employees questioned.

Relevant Council employees such as Environmental Health Officers, Community Development Officers, or Planners at each Council were contacted. They were asked for broad and instinctive responses on whether they thought each of the seven scenarios was considered acceptable or not for their LGA and why. All of the seven Councils contacted responded. The Council responses gave a broad impression of how aware each LGA is of food production, and of the various UA activities within their area. Specific policies, guidelines, by-laws, and plans mentioned in the responses were reviewed on each Council's website. Other documents such as Tree Policies or Poultry Keeping Guidelines were also investigated for relevance to the UA scenarios.

3. Results

The results of this study were developed by weaving together the findings of the three distinct research methods. The various acronyms used to identify the quotes are as follows, FG#1–3 for the focus groups, KI#1–18 for the key informant interviews, and SA#1–7 for the scenario analyses. This section has been divided into two parts, Part 1 focuses on the perception of aquaponics, while Part 2 covers the urban planning aspects of the results.

3.1. Part 1: Perception of Aquaponics

Two-thirds of the focus group participants were completely unfamiliar with aquaponics, and of those who were familiar, only three participants considered themselves experienced. Initial reactions to aquaponics ranged from positive, through neutral or uncertain, and to simple dislike, as evident from the following quotes:

> "The aesthetics of the backyard systems are exciting" FG#1 and "I like the experimental side." FG#1

> "Seems to have the scope to scale up, so why hasn't it happened?" FG#1 and "I'd really miss the earth and all the things that are in the earth that feed my plants." FG#3

> "I think my honest gut reaction is suspicion" FG#3 and "[I'm] interested in looking at a future of energy constraints; aquaponics looks very energy and material based." FG#2

The focus group participants were asked to put forward their own opinions of the strengths and weaknesses of aquaponics. Their opinions varied from the 'technical' literature based strengths and weaknesses, being more concerned with the ease of operation and how aquaponics may be perceived (Table 1).

Although the discussion topics ranged considerably, the perceived weaknesses received the most attention. The persistent concern over the barriers to aquaponics was particularly evident during analysis of focus group data. Whenever a focus group participant commented on the expansion of aquaponics, their comment was categorised into one of the following topics: 'Benefits or Value of Aquaponics', 'Barriers to Aquaponics', or 'Business Related Expansion'. Content analysis of these three topics revealed that there were 395 mentions of 'Barriers to Aquaponics', 271 mentions of 'Business Related Expansion', and only 113 mentions of 'Benefits or Value of Aquaponics'.

Table 1. Comparison of Strengths and Weaknesses of Aquaponics.

Literature [1] Based Strengths	Focus Group Based Strengths	Literature [1] Based Weaknesses	Focus Group Based Weaknesses
■ **Space-efficient.** Suitable for urban land (e.g., unused/unproductive land/backyards) ■ **Shared costs** between the aquaculture system and the hydroponics system (start up, operating, infrastructure) ■ **Reduced water usage and waste discharge** (compared with aquaculture) ■ **Reduced nitrogen loss** as experienced by conventional field crops ■ **Increased profit potential** from simultaneous cash crops ■ Food grown **closer to consumers** ■ **Can diversify revenue**; educational tool, agri-tourism, and training.	■ **Can look great** aesthetically ■ Space-efficient and modular—**suitable for urban environments** ■ **Sustainable** due to nutrient cycling ■ **Not time consuming** once built ■ Can be **used on land that cannot grow food** (e.g., contaminated land) ■ Food grown closer to consumers (e.g., **very urban and local**)	■ Combining two hybrid systems **increases the potential for problems** ■ An aquaponics grower needs to be **competent** at raising fish and plants ■ Available **nutrients for plants are dependent** on the number of fish, the size of the fish, and the amount they are fed ■ **Fish are very sensitive** to chemicals, so can only use barriers and biological controls ■ Must **compromise the pH** between the plants and the fish ■ Must **compromise in temperature** between the plants and the fish ■ Fishmeal as the main protein in fish food is **unsustainable**	■ Have had/heard of **bad experiences** with aquaponics ■ Looks **too complicated**/requires technical expertise ■ Prefer/**more comfortable with soil** ■ **Expensive** start-up costs and infrastructure if commercial ■ **Lack of knowledge and research** done (technical, business, people, nutrients) ■ **Fish care and ethics** (e.g., temperature control) ■ Looks very "built"/**aesthetics can be ugly** ■ Much **more plant produce grown** than fish ■ Is **not sustainable** to feed fishmeal to grow fish

[1] Aquaponics positives and negatives sourced from [15,32,36].

3.1.1. Barriers

When aquaponics was first introduced to focus group and interview participants, the majority were unfamiliar or unsure, and all had questions about various aspects of how the technology works. Out of 14 barriers identified against or preventing adoption of aquaponics, the top four were: 'Negative preconceptions' (n = 17 out of 18 interviews), 'Ethics around fish' (n = 15), 'Suitability' (n = 14), and 'Aesthetics' (n = 11). These top four barriers were also present in all three focus group sessions.

Further analysis of the negative preconceptions found that every negative comment, with one exception, either reflected a lack of awareness, understanding, and experience (n = 12), or related to a lack of current examples of viable aquaponics businesses (n = 7). This suggests that it is a lack of familiarity and understanding of such systems that holds people back from easy acceptance of the technology. Without widely visible examples of successful aquaponics enterprises, there is currently little opportunity for people to familiarise themselves with the technology.

Participants were very interested in the fish production side of aquaponics systems. The 'Fish Ethics' topic (n = 16, FG = 3) included concerns of whether it was right to grow fish intensively, and stories of people having something go wrong with their aquaponics system and having many (or all) the fish die. Others asked about the particular species suitable for Adelaide and what you would feed them. In one focus group this led to a discussion of the environmental sustainability of using fishmeal to grow fish.

The consideration of 'Suitability' not only related to the suitability of the fish species or the temperature for Adelaide's climate, but was also concerned with the cultural suitability of aquaponics. Cultural suitability included gardening type preference, whether fish is part of a peoples' cultural diet, and potential stigma around the consumption or taste of freshwater fish when compared with saltwater species.

Aesthetics of the systems was a stronger concern than originally expected (n = 11, FG = 3). The artificial or constructed appearance of the aquaponics systems discouraged some people. Some participants asked if the systems could be naturalized, and commented that they would happily have a 'pretty' system such as the example photo of one encased in timber (Figure 2), but not one with lots of pipes showing. Having the system fit into the look of their backyard came across as a strong factor in participants' willingness to add aquaponics to their existing garden.

Figure 2. Photo of wooden backyard aquaponics system. Reproduced with permission from Justine Williams (City Food Gardens).

3.1.2. Benefits or Value

There were five perceived benefits and values of aquaponics, the top being 'Diversity' (n = 16, FG = 3). Less frequently mentioned, but still within the top three were, 'Water and nutrient cycling' (n = 13, FG = 2), and 'Size' (n = 11, FG = 2).

The apparent diversity of the technology appealed to most of the participants (n = 16, FG = 3). Discussion on this included some systems' modular design and small adaptable size, thus potentially suitable if renting (FG#1). Participants thought of many possibilities for aquaponics: to grow food on contaminated or under-utilized land (n = 7, FG = 3), to use the water cycling to help clean a dam (KI#9), for very isolated rural communities (KI#4), for school education (KI#11), and to assist in breeding endangered native fish species for conservation, for example, Murray Cod (*Maccullochella peelii*) an iconic and threatened species in Australia (KI#10).

The cycling of the nutrients and much of the water (although not a closed loop cycle) was appreciated by many participants (n = 13, FG = 2). This could possibly be for its likeness to a natural system, suiting some of the participants' sustainable values. The appeal of saving water in South Australia (the driest state in Australia) was also mentioned (FG#1, KI#1, and KI#18).

3.1.3. Business Considerations

When asked what scale of an aquaponics business the focus group participants thought would be the most successful, two scales were selected: small-scale niche (FG = 3) and larger wholesale selling (FG = 3). Each focus group discussed the appropriateness of having a series of scales. These scales were

presented in each key informant interview for further discussion. When asked to consider the merits and weaknesses of each model, the idea of an aquaponics business evoked 16 different considerations from participants. The top five concerns were: 'Need to do serious business research first' (n = 15), 'Marketing and brand perception' (n = 14), and then equally, 'Aquaponics story value' (n = 12) and 'Community and family education' (n = 12), and finally, 'Need demonstrations of aquaponics' (n = 12). These responses are broadly reflective of the social barriers identified earlier.

The need for serious business research covered everything from start-up costs, acceptable time to break-even, volume of production per system, the intensity of production, what kind of support you would need, and whether to consider value adding. Participants wanted all the details available before they would consider it.

Quite a few participants suggested demonstrations of aquaponics (n = 12) for people not only to become familiar with the technology, but also to help overcome some of the negative perceptions, and to assist in community and family education (n = 12), as evident in the following quote:

> "I think people need to touch and feel and smell. They need to see it working. To get close to it, to understand it." KI#1

The marketing and brand perception of such a business, especially whether or not it was possible to tell the difference between produce grown traditionally or with aquaponics, was also a strong consideration:

> "If I went to a farmers' market and there was a lettuce for sale, could I distinguish between one grown using aquaponics or conventionally? If trying to sell it—as a consumer, why would I choose one over the other?" KI#2

There were many potential marketable points raised: local production (FG#3, KI#3, KI#6, and KI#14), water efficiency (FG#1, KI#9, and KI#18), and freshness (KI#3 and KI#14). Value of the story was closely tied to brand perception. This would be how those trying to sell their produce could attempt to engage and connect with potential buyers (n = 12):

> "Selling the story. Differentiated, e.g., selling Kingfish to Sydney restaurants. I had to say why it was special and only available through here . . . . . You're selling food, not a fish." KI#3

There were many business structure ideas promoted with some variations on similar themes. These ideas are assembled into a variable scale of business deployment, presented in Table 2. They range from backyard sizes to large-scale wholesale. Small-scale niche market and wholesale commercial market sizes were considered the most potentially competitive commercially.

Table 2. Aquaponics business design options.

Structure	Suitable for
1. Backyard scale	One family Two families (sharing)
2. Community	Community garden Community collective
3. Limited niche market	Farmers market Restaurants
4. Social enterprise	Unemployment work program Migrant support program Home-based sales Youth training
5. Large wholesale commercial	Wholesale to supermarket Commercial partner
6. Food garden service	Part of garden design and build business

The success of UA at the niche market scale is dependent on selling at retail prices direct to consumers, otherwise the economies of scale are not viable. By selling direct, this strengthens the importance of a marketing strategy that makes the most of settings where connection can take place, such as a farmers' market. To make this link work in practice, however, the "story" is critical—people will not buy from a stall at a farmers' market if they do not like the producer's story. Selling produce in such a public place also ensures the opportunity for demonstrations and education of the people there in order to allow them to better understand and appreciate the produce. Hence, the social and community perceptions identified in this study have flow-on implications for the viable formation of a story, to producer-consumer connections, to retail pricing structure, and finally leading to a niche business model.

Consideration of starting an aquaponics business at the wholesale scale raised the idea of doing so with a commercial partner to make the most of their existing setup (n = 8, FG = 1). The aquaponics business would benefit from the existing structures and the business could use aquaponics as a point of difference in sales (KI#10).

There were also concerns for the production volume and consistency necessary for a wholesale business (n = 4, FG = 1). Although some did think that once you had the production volume consistent that it could be a more dependable market than the niche scale market (KI#6, KI#15, and FG#1).

Another business design put forward was that of an aquaponics social enterprise (n = 6, FG = 3). These participants thought that a network of people could work collaboratively on a larger scale project to develop their own brand and share in the profits. The other persistent idea linked aquaponics social enterprise to social justice and community capacity building with two options. Firstly, as an 'Unemployment Work Program' type setup where those receiving public financial support could contribute their time in exchange for skill development and produce vouchers for some of the produce grown, and secondly, as a 'Youth Training Program', which was described as particularly valuable for suburbs with high youth unemployment rates, such as Salisbury and Playford in Adelaide (KI#11).

3.1.4. Scaled Guidelines

The participants' desire for serious logistical business considerations, combined with the many potential structures for aquaponics systems, culminated in the idea that a set of scaled guidelines is needed (n = 7, FG = 2). Such guidelines would include financial, logistical, production volumes, time requirements etc. for each scale from backyard (for one or two families), community-sized (for a community garden or collective), niche market size, social enterprise, or large commercial operation. It should be noted that currently backyard aquaponics systems are the most common form of aquaponics in Australia [12]. However, having this background business information prepared would mean that any individual, community group, business, or council considering any kind of aquaponics system could browse this information and make a more confident decision than is currently possible.

Focusing on the different purposes of the aquaponics structures differs from previous considerations of aquaponics system viability. Goodman [15] researched inclusion of community benefits in addition to the financial feasibility of aquaponics businesses. Goodman [15] determined the net income of one small, one medium, and one large sized aquaponics business, and found that the likelihood of these businesses generating profit purely from the aquaponics production of fish and plants was slim. The odds did improve if the purpose of the system was for more than just financial profit, for example, if also for community benefit, such as Growing Power in Milwaukee. Goodman [15] made recommendations for cost-cutting: vertical integration (producing necessary inputs onsite; e.g., grow worms for fish food), getting things for free, and diversifying revenue streams. These are all suitable options for the smaller scaled aquaponics systems, such as niche market selling or social enterprise.

3.2. Part 2: Urban Planning

3.2.1. Focus Group and Interview Responses to Urban Food Planning

Of the focus group and interview participants actively involved in growing food in Adelaide, all of them alluded to a lack of Council support when asked about their experiences with urban planning. This belief was exemplified in the following quote:

> "I think it's much better just to fly under the radar as long as you can." FG#3

When asked if (and how) current urban food planning could be improved, many recommendations were made. The top six suggestions were: 'Importance of top-down government support or a positive stance' (n = 17), 'Value of smart urban planning' (n = 14) and 'Use of different planning tools to support UA' (such as incentive schemes) (n = 14), 'Need to provide space for UA' (n = 13), 'Adopt planning examples from other cities or countries' (n = 13), and 'Dependency of urban food planning on individual local Council' (n = 13).

3.2.2. Top Down Support

The idea, and apparent necessity of top down support was best described by one participant, an environmental policy lecturer:

> "If the government supports something or doesn't, there can be a policy vacuum. You have to have a high-level policy position. From these you can build programs and under them particular projects. But you need the driver up top." KI#2

There have been previous calls for strong top level support (federal and state) of urban food planning, both in the US [37] and in Australia [38]. When questioned whether they thought this support should come from state or federal level, more participants agreed with state support (n = 13), over federal (n = 3). Two current plans that could be expected to make some reference to UA in South Australia are the 30-Year Plan for Greater Adelaide, and the Premium Food and Wine from our Clean Environment Initiative.

In 2010, the South Australian Government published the 30-Year Plan for Greater Adelaide. A submission on the draft Plan by the Planning Institute of Australia (SA Division) commented on what they called unresolved conflict between the Plan's designs for a compact, transit-oriented city, with protection of primary food production land, and the land supply for housing development growth [19]. One interview participant, a Community Development Officer, had noticed how the Plan discusses green space but not urban food.

The Planning Institute's submission also pointed out that there is only a single policy (Chapter D, Health and Wellbeing, Policy 3) that mentions protection of some food production areas. Upon further reading, it was noticed that one other policy (Chapter D, Health and Wellbeing, Policy 2) does vow to promote the development of community gardens, albeit only for "social interaction and physical wellbeing" (Government of South Australia 2010, p. 101), and not for production capability or food security.

Another state level plan is the Premium Food and Wine from Our Clean Environment Initiative. When asked whether this program, which is assisted and implemented in part by PIRSA (Primary Industries and Regions South Australia), only supported the large-scale producers, one participant responded:

> "In terms of the farmers themselves, if you're small-scale, PIRSA helps in terms of over-arching policies and things but doesn't get involved in the day to day … So if you're small, you either become a member of a body that can represent you or you just do your own thing and not worry about anyone else." KI#15

Currently there appears to be no top-down support in place for small-scale producers if they are not interested in joining an association, or selling interstate or overseas. Further, the university-driven Extension function is not institutionalized in Australia, although the state's reputation for gourmet and quality food production means marketing initiatives such as Eat Local SA, Brand SA, and tourism food trails bolster awareness of point-of-purchase options. If aiming for a more cohesive approach to food security, UA, and urban food planning, some acknowledgement or policy support for the small-scale UA in South Australia needs to be made.

3.2.3. Improving Urban Food Planning

Every interview participant, bar one, explicitly expressed a desire for a supportive stance by Government and Council on UA. They valued well designed urban planning and mentioned numerous planning tools to assist in supporting UA, as well as mentioning a number of international examples and examples from other Australian cities. That the acceptability of UA activities depended heavily on each individual Council was a common perception (n = 13, FG = 2). The most positive Council attitude expressed towards UA was that of Adelaide City Council:

> "[We] already have a big push for 'Place Making' where the community leads the way and the Council works to support them in their endeavours and provide a little bit of structure and just make sure it's safe." SA#1

This idea of the Council providing some structure and safety while not impeding on any community engagement is a promising one, especially in light of a recent review of Australian cities released in February [20], which found Adelaide City to be lacking in 'Sense of Place'. Sense of place is built on local economic development and place-based social capital, where UA fits due to its strong ties to physical inhabitation [25].

Study participants were aware of the difficulty in attempting to manage and implement guidelines or policies, and did not overlook the complicated nature of growing food and selling it in public places. Because of this, some doubted that councils would be the ones to take the first step:

> "I think it's going to be more push than pull as in the community is going to have to push the council into asking for space rather than the council being proactive and saying 'we're going to give you this'." KI#15

3.2.4. Scenario Analysis

The perception of focus group and interview participants that urban food planning depends on each individual LGA was further explored through the scenario analyses.

There was very little consensus on each of the seven hypothetical scenarios put to the seven selected LGAs. There were also some policy vacuums where the council employee did not provide an answer on the acceptability of that UA activity, as there was no policy to cover such an instance.

The following quotes exemplify the pro-, uncertain, and anti-positions of the Councils. There was complete support for community driven UA, such as from Prospect Council:

> "This sort of thing keeps the food local which is good. Food security is associated with your environmental footprint, so we want to encourage people to keep it local." SA#7

Prospect Council has a proactive approach to vegetable growing on street verges with their Veggie Verges Project, to actively promote ownership of the streetscape and encourage neighbour interaction. They also have online poultry guidelines, no issue with fish ponds or bees, think home businesses are acceptable if small, would consider fruit street trees on a case-by-case basis, and already have a community garden that sells its produce at a local market.

In contrast to Prospect, an inner-city area with a relatively high socio-economic status, there was uncertainty and concern for complaints with Tea Tree Gully Council, an outer suburb with a lower socio-economic status:

> "We don't get too involved in growing food . . . Unfortunately bound by legislation with little room to move. If there is a justified complaint then that must result in instant action." SA#6

When questioned about the acceptability of residents growing food on the public verges in front of their houses, Tea Tree Gully Council was concerned for the possible health risk of the soil, and of food being grown in a public space. As part of a resident's application to request approval for doing so, the details of the particular plants planned must be included. It was commented that listing vegetables on an application would diminish the resident's chances of approval. Tea Tree Gully include the keeping of poultry in their local order making policy, in addition to having an online poultry fact sheet for residents to access. Fishponds of any size would be considered an issue and any attempt to sell fish would be shut down. Bees are listed as nuisance animals within Tea Tree Gully, and fruit trees are never considered for street trees.

There was some evidence of outright discouragement for certain aspects of UA, as with Mitcham Council, a suburb with a relatively high socio-economic status:

> "The Council no longer considers any community garden proposal to be established on Council property for the life of the Council." SA#2

Mitcham Council has several guidelines in place, but instead of simple guidelines to support particular UA activities, their guidelines tend to stipulate a large number of particulars and have long application procedures. Their online guidelines for poultry keeping are twice as long as (and more detailed than) any other Council. No mention of fish or ornamental ponds is made on their website. Mitcham Council has online bee guidelines seemingly intent on discouraging bee keeping, as hives are not allowed within 50 m of any home, road, or public place, thus making hive placement almost impossible in the suburban area.

Each LGA's policy position was tagged as encourage, discourage, or neutral. The policy framework of each Council contributed to this classification, with consideration of associated by-laws and actions towards UA. Three Councils (Adelaide, Prospect, and Norwood, Payneham, and St. Peters) actively encouraged UA development. One Council (Mitcham) actively discouraged UA activities. Three Councils (Salisbury, Charles Sturt, and Tea Tree Gully) had mixed responses to the scenarios and so were tagged more than once. Multiple tags could be an indication of the lack of holistic approach and management of UA, and reveal how each UA activity is judged individually rather than as part of a greater urban food planning framework.

The range of responses to the UA scenarios relating to aquaponics, mainly the fishponds, the community gardens, and the running of a small home business selling home-grown produce, are displayed in Table 3. For aquaponics, in addition to social barriers, there are likely to be mixed responses to wider uptake of aquaponics either at backyard small-scale, niche commercial, or as a social enterprise. However, there is not a universal barrier to aquaponics across LGAs, and there may be tentative support from some councils. In order to increase the awareness and cohesion of local UA policies across Adelaide, either the state could take a supportive stance, or people living in particular LGAs discouraging UA could communicate their desire for change.

Table 3. Scenario analysis results relating to aquaponics: having a fishpond, having an aquaponics system at a community garden, and running a small home businesses selling home-grown produce.

Fishponds	
Detailed stipulations about the depth, development approval, safety, and intensiveness of the fish keeping.	Charles Sturt Norwood, Payneham, and St. Peters
Vague. Would *probably* be okay, but . . . (not front garden and check Planning Department).	Adelaide Tea Tree Gully Prospect
No response to fishponds/no mention online.	Mitcham Salisbury

Table 3. *Cont.*

Community Garden	
Have community gardens on council land in their area.	Every Council except Mitcham.
Mentioned keeping "fish" in the community garden, but must consider scale and application requirements.	Charles Sturt Tea Tree Gully
Small Home Business	
Full guidelines for two separate sized scales: (1) A home activity; (2) A shop selling goods.	Norwood, Payneham, and St. Peters
Unsure. Could depend on scale (e.g., no more than 30 m^2 or 10% of block). Need to speak with Environmental Health or PIRSA and look up SA Food Act 2001.	Adelaide Charles Sturt Tea Tree Gully
No response to home business/no mention online.	Mitcham Salisbury Prospect

4. Discussion

The aim of this paper was to investigate the receptivity of Adelaide's urban food opinion leaders and local government areas towards aquaponics. The majority of focus group and interview participants were unfamiliar with aquaponics as a production methodology, and their initial responses varied greatly in rich, in-depth discussions. Participants tended to focus on and discuss the perceived negatives of aquaponics, with the strongest barriers to greater take-up of the technology being: a lack of awareness, experience, or successful examples of viable aquaponics businesses, ethics surrounding fish wellbeing, suitability, and aesthetics. The strongest perceived benefits were: diversity of system design, water and nutrient cycling, and the compact size of aquaponics systems. With regard to aquaponics as a business, focus group participants thought it could be competitive at either niche market or wholesale market scales. Study participants had many business concerns for aquaponics, the major ones being the need for serious business research (logistical), marketing and brand perception, community and family education, the story value of aquaponics, and the need for aquaponics demonstrations. Participants thought that niche-market aquaponics businesses would be more successful than wholesale ones, possibly as the benefits of a niche-market business better matched the participants' major business concerns. Perhaps the results obtained mirror biases the participants already possess. However, as all selected participants were involved in small-scale food production or have experience with Adelaide's urban food system, their insight and practical advice for the future of aquaponics is considered valuable. The wide range of aquaponics business scales suggested, together with participant demands for sound logistical business preparation, culminated in the idea of a need for scaled guidelines for each of the different sized systems and purposes.

The consensus of focus group participants was that 'flying under the radar' was the easiest way to handle the uncertainty, complexity, and continually evolving nature of urban planning and policy surrounding urban food production. This position becomes more understandable when considering the varied responses from LGAs in the scenario analyses. Each of the seven local government areas contacted had mixed responses to the UA scenarios put to them. Although the seven scenarios involved reasonably common UA activities, many of the council employees questioned were unfamiliar with one or more of them. Hence, there may be additional barriers to the uptake of less common activities such as aquaponics. The majority of the key informant interview participants wanted UA planning to improve, although they acknowledged how difficult this may be. All participants commented on the importance of top-down government support, and their desire for a supportive state stance.

5. Conclusions

This study is one of the first to explore social and emotional responses to aquaponics technology in the context of UA. The participants, as people already heavily involved in urban food production, education, distribution, or business planning at many levels, were mostly unfamiliar with aquaponics. Thus, it is likely that the majority of people less involved will be even less aware of this technology.

When asked how best to raise awareness and acceptance of aquaponics, participants stressed the need for greater understanding and experience of all kinds of aquaponics, including viable businesses. This study echoes several findings from Miličič et al.'s work [16], which called for an educational campaign of guided tours, workshops, and tastings to enable interaction with a new technology. As UA experts, the participants were able to elaborate on barriers and concerns that might be perceived by the public, and generate creative options for structural operations of aquaponics systems. Conversely, the fact that a sizable number of participants were non-experts in aquaponics suggests that future consumer research will be strengthened by field—rather than photo—exposure to the wide range of commercial and backyard aquaponics setups, as part of data collection.

The need for current urban planning and UA management by LGAs and State Level Government to adapt and support UA practices was strongly advocated. Local government officials need to reconsider the impact, intentional or not, that they can have on UA. It may be time to pay more attention to the UA activities being actively engaged in by people living in their suburbs, and to consider a cohesive approach to urban food planning in the future. This mapping of the current social and regulatory opportunities and barriers can be practically applied, and may help to inform future food planners and UA practitioners, particularly those interested in the development of an aquaponics industry.

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