

Commercial aquaponics production and profitability: Findings from an international survey

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Abstract

Aquaponics is the integration of aquaculture and hydroponics. There is expanding interest in aquaponics as a form of aquaculture that can be used to produce food closer to urban centers. Commercial aquaponics uses methods and equipment from both the hydroponics and aquaculture industries. There have been few studies of commercial-scale aquaponics production, and the purpose of this research was to document the production methods, crop and fish yields, and profitability of commercial aquaponics in the United States (US) and internationally. An online survey was used for data collection, and 257 respondents met the inclusion criteria for the study. Eighty-one percent of respondents lived in the US, and the remaining respondents were from 22 other countries. The median year that respondents had begun practicing aquaponics was 2010. A total of 538 full-time workers, 242 part-time workers, and 1720 unpaid workers or volunteers were employed at surveyed organizations. The most commonly raised aquatic animals by percent were tilapia (69%), ornamental fish (43%), catfish (25%), other aquatic animals (18%), perch (16%), bluegill (15%), trout (10%), and bass (7%). Production statistics, gross sales revenue, investments, and sales outlets for operations are reported and compared to other fields of aquaculture and agriculture. A multivariable logistic regression model was used to study which factors were associated with profitability (as a binary outcome) in the past 12 months. Several factors were significantly associated with profitability: aquaponics as the respondents' primary source of income ($p < 0.01$; Odds Ratio: 5.79; 95% Confidence Interval: 3.8–9.0), location in US Department of Agriculture plant hardiness zones 7–13 ($p < 0.01$; OR: 4.17; 95% CI: 3.2–5.5), gross sales revenue $\geq \$5000$ ($p < 0.01$; OR: 3.58; 95% CI: 2.2–5.8), greater aquaponics knowledge ($p < 0.01$; OR: 2.37; 95% CI: 2.0–2.9), and sales of non-food products (e.g., supplies, materials, consulting services, workshops, and agrotourism) ($p = 0.028$; OR: 2.13; 95% CI: 1.1–4.2). Our survey findings provide a better understanding of the business of aquaponics, which may enhance future commercial operations.

Keywords:

Aquaponics, Hydroponics, Tilapia, Recirculating aquaculture system, Commercial producers, International survey

Introduction

Aquaponics is the integration of aquaculture and hydroponics, a soilless system for crop production. The recirculating aquaculture research community introduced the idea of aquaponics in the mid-1970s (Lewis et al., 1978; Naegel, 1977; Sneed et al., 1975). In their studies, edible plants were used to remove waste products from recirculating aquaculture systems. Today, commercial aquaponics production exists primarily in controlled environments, such as greenhouses or outdoor locations with favorable climates, using methods and equipment that draw from both the hydroponics and aquaculture industries.

A handful of studies have documented the productivity of research-scale aquaponics operations (Rakocy, 2012; Rakocy et al., 2006; Watten and Busch, 1984), and in 2013 the United States Department of Agriculture (USDA) began collecting aquaponics production data as part of the Census of Aquaculture, which was last published in 2006 (USDA, 2006). Results from research facilities and other factors, such as expanding interest in sustainable agriculture and

producing food closer to urban centers, have stimulated interest and involvement from a small but growing aquaponics industry. However, little research has been conducted on commercial-scale aquaponics production. The purpose of this study was to document the production methods, crop and fish yields, and profitability of commercial aquaponics in the United States (US) and internationally.

2. Materials and methods**2.1. Survey**

We created and implemented an online survey as previously described (Love et al., 2014). The study was reviewed by Johns Hopkins University School of Public Health Institutional Review Board (IRB No: 00005088).

We collected 1084 complete responses between June 25, 2013 and October 1, 2013. Summary findings from the total survey population (which mostly included hobbyist gardeners, but also included educators, non-profit organization staff and commercial operators) were published elsewhere (Love et al., 2014). Survey respondents who sold aquaponics-related food or non-food products and services in the previous 12 months were administered additional survey questions; the data collected during this sub-survey are reported here.

2.2. Data analysis

Data from the survey software (Qualtrics, Provo, UT, USA) were exported and analyzed in Excel (Microsoft, Redmond, WA, USA), STATA (StataCorp, College Station, TX, USA) and Prism (v5, GraphPad, La Jolla, CA, USA). T-tests were used to compare the means of two groups by factors such as farm size and aquaculture system volume. A Kruskal–Wallis test was used to compare groups of three or more when the data was not normally distributed, and a Dunn multiple comparison post-test was used for intergroup comparisons.

Conclusions

There is growing interest in locally produced food that is sold directly to consumers, and aquaponics is a growing form of aquaculture that easily fits into a local and regional food system model in part because it can be practiced in or near large population centers. Many operations in the survey resembled small farms in their size and gross sales revenue, and they utilized more direct sales outlets to sell their products than a typical small farm. We found that gross sales revenue and profitability were higher for operations that diversify their revenue stream by selling non-food products, services, or educational trainings. In addition, less than one-third of respondents were profitable in the previous year, and while many of these are new businesses that expect to be profitable in the short term, future studies are needed to track their outcomes. Our findings indicate that more research and development are needed to determine if aquaponics will evolve into a profitable food production method.

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