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Adaptation of resilient regenerative agricultural practices by small-scale growers towards sustainable food production in north-central Arizona

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ABSTRACT

The demand for agricultural lands for other uses because of population growth and extreme climate in Arizona led to 57% decrease in average farm size and 127% increase in farm numbers from 1997 to 2017, which threaten sustainable local food production. Small-scale family farms of less than 10 acres make up 50% of the farmer population in the state and have a vital role in resilient and sustainable practices that maximize land use with less negative impact on the environment. This study investigated land use and farm practices among small-scale growers in north-central Arizona in their resilience in sustainable food production. The finding revealed 52% of the small farms are family operations with dominant regenerative and sustainable practices (27% cover cropping, 26% compost, 23% crop rotation, 22% animal and green manure, 21% no-till, and 18% reduced tillage) with less interest in conventional practices (5% intensive tillage and 13% synthetic fertilizers). Ninety-five percent of the growers used biological, cultural, or mechanical practices for weed, pest, and disease control, while only 5% used conventional synthetic chemicals. For water use, 78% of the growers used water-saving irrigation practices (drip, subsurface, and sprinklers), while 11% used open flood irrigation. Driving forces for the sustainable practices among the small-scale growers are their consumers (community supported agriculture, restaurants, Farmers' Markets, and farm stands) and extreme climate conditions. Small-scale growers have great potential in advancing resilient, environmentally friendly practices for sustainable local food production and environmental stewardship.

1. Introduction

The world's population is growing with increasing climate related issues and land degradation stemming from intensive and unsustainable agriculture and other human activities (Millennium Ecosystem Assessment, 2005). To feed the growing population now and in the future, sustainable agricultural practices must be central in all agricultural operations. "Sustainable agriculture" was addressed by the United States Congress in the 1990 "Farm Bill", which defined sustainable agriculture as an integrated system of agricultural production practices (plant and animal) that have a site-specific application that will in the long-term satisfy human food and fiber needs; improve the quality of the natural resource and environment on which agriculture depends; efficiently use non-renewable and on-farm resources with integration of natural biological cycles and controls where appropriate; sustain farm operation's economic viability; and enhance the quality of farmers and society's lives (Gold, 1999). According to Reganold et al. "For a farm to be sustainable, it must produce adequate amounts of high-quality food, protect its resources and be both environmentally safe and profitable. Instead of depending on purchased materials such as fertilizers, a sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the farm itself (Reganold et al., 1990)."

While progress is made around the globe and locally by incorporating sustainable agricultural practices, there are still persistent challenges that need attention. For example, in the United States, loss of prime farmland, water scarcity, reduced genetic diversity, increasing costs of production, loss of mid-sized commercial farms, threats to the health and safety of farm workers, and declining prosperity of agriculturally dependent communities are some of the drawbacks reported with more concerns about the survival of small- to mid-sized commercial family farms (National Research Council, 2010; Reganold et al., 2011). Losing the small farms in food production is a great threat to sustainable food production locally and may result in a greater carbon footprint

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from agricultural food transportation and distribution.

By USDA definition, a small farm includes all farm operations with less than $250,000 in gross income, which is subdivided into commercial (sales of $10,000 to $250,000) and noncommercial farms (sales less than $10,000 per year) (USDA, 1998). Arizona is one of the states in the United States (US) with a high population of small-scale farmers. Fifty percent of Arizona farms have less than ten acres of land in their operation, with 88% of the farms earning is less than $25,000 in annual sales (USDA, National Agricultural Statistics Service, 2018). According to the United States Department of Agriculture (USDA) agriculture census data from 1997 to 2017, average farm sizes in Arizona decreased by 57% while the number of farms increased by 127% (Fig. 1, (USDA, National Agricultural Statistics Service, 2018)). Extreme climate conditions, population growth, and competition for agricultural land for alternative uses could be reasons for the trends in farm numbers and size in Arizona (National Center for Farmworker Health, 2014), which poses a threat to local food production and security. According to a recent report from American Farmland Trust on agricultural lands under threat, Arizona farmlands have a medium threat with inadequate policy responses (Freedgood et al., 2020).

The future of crop production in Arizona will depend on regenerative and sustainable on-farm practices, resource use efficiencies, and practices which maximize ecosystem benefits and reduce the impact of extreme climate events such as drought and heat. Some of these regenerative and sustainable agricultural practices include no-till, reduced tillage, cover crops, recycling farm waste into resources (compost and manure) (FAO, 2013; Yapwattanaphun, 2015), and efficient irrigation systems. Mpanga et al. reported increased use of these sustainable agricultural practices in Arizona from 2012 to 2017 based on USDA agriculture census data. However, most sustainable practices in Arizona for that period occurred on large-scale farms, while small-scale farms lagged at the state level (Mpanga et al., 2020a). Currently, and specifically among small-scale farmers at the county level, specific agricultural production systems, sustainable practices, the factors that drive them, and their role in sustainable food production are unknown. Yavapai and Coconino Counties are among the counties with large populations of small-scale farms and were selected for this study as part of the newly created Commercial Horticulture and Small Acreage (CHSA) research and extension program at the University of Arizona Cooperative Extension. Yavapai (central Arizona) and Coconino (northern Arizona) range in elevation from 1900 ft in the Sonoran Desert near Phoenix to over 12,500 ft on Mount Humphreys near Flagstaff. Small growers in these two counties are located in the greater Flagstaff and Navajo Reservation areas of Coconino County, and the Verde Valley, Chino Valley, Paulden, Dewey, Cordes Junction, and Prescott in Yavapai County. These counties are rich in cultural diversity, including the Native American tribal communities who resided and grew food crops for thousands of years in the area. The two counties' population increased in recent years with diverse economic activities, including real estate development and tourism, and a growing demand for locally grown food (Mpanga et al., 2020b). However, a significant part of the food consumed in these areas is imported from far distances outside the region, which poses a food security threat that was exposed by the pandemic.

The study aimed to:

1. Understand the current land-use practices among small-scale growers in Yavapai and Coconino counties.
2. Identify the influence of farm income type (main or supplementary income) and farmer's gender on the use of sustainable and regenerative agricultural practices.
3. Identify the role of small-scale farms in sustainable local food production and environmental stewardship.

2. Materials and methods

2.1. Study area and target group

The survey was conducted from January to April 2020 in Yavapai and Coconino Counties in Arizona, United States of America (USA), using an online format (Qualtrics) and printed copies. The University of Arizona Institutional Review Board (IRB) reviewed and approved the survey questions for human subject requirements before they were sent out for responses. Yavapai and Coconino counties were chosen for this study because they are among the counties with large populations of small-scale farms. Also, the study is a needs assessment as part of the newly created Commercial Horticulture and Small Acreage (CHSA) research and extension program in the two counties by the University of Arizona Cooperative Extension.

2.2. Target group

Farmers included in this survey were adult (18 years and above) crop producers and growers with commercial operations, meaning they fully or partially earn their family income from growing crops in Yavapai and Coconino Counties. A multistage random approach was used to select farmers for the study. Yavapai and Coconino counties were selected for the study, but the subgroups (gender and type of farm income) were self-identified by the farmer.

2.3. Survey questions and response rate

A descriptive study was used with a closed-ended survey question, which limited responses to a broader pre-set category of responses that generated quantitative data for each survey question set. A total of 80 contacts were made both online and in-person to solicit survey

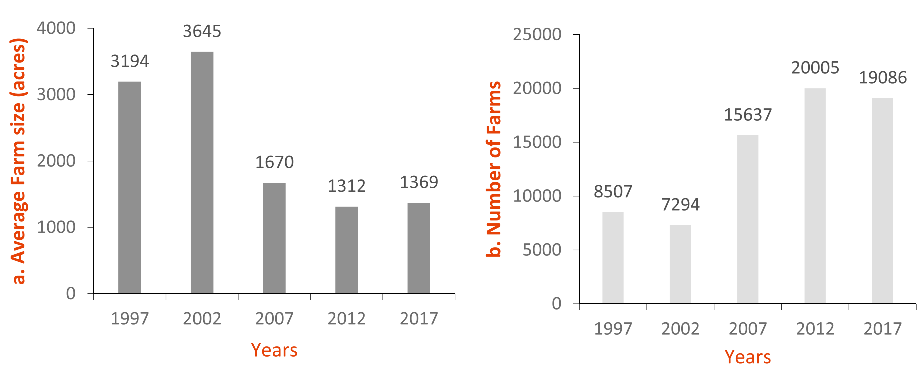

Fig. 1. Number of farms and average farm size in Arizona from 1997 to 2017. The data here includes all agriculture operations making a thousand dollars or more in annual income (Graphics prepared by the authors using data from 1997 to 2017 USDA agriculture census data (USDA, National Agricultural Statistics Service, 2018)).

responses; thirty responses were received, which represents a 37.5% response rate.

2.4. Survey participant's demographics

The demographic survey questions were categorized by county, gender, ethnicity, veteran' status, family farm, and farm income type. Because ethnicity is a delicate issue, respondents were given the option to respond or not, which led to a low response rate. Sixty-eight percent of survey respondents resided in Yavapai and 32% in Coconino County. Response by gender was 62% male and 38% female. While 38% of respondents used farming as the main family income, 62% used farming for supplementary income. Ethnicity was self-reported by only nineteen out of the thirty growers who participated in the survey, with seventeen White, one Asian, and one Native American. Ten percent of the respondents had veteran status. Most of the growers were first-generation farmers with 52% less than five years in operation, 10% with 5 to 10 years in operation, and 38% with more than ten years in operation. Another interesting demographic was that 52% of those who took part in the survey are family-owned and run farm operations, while 48% are non-family owned and operating farms.

2.5. Production systems and types of crops

The questions asked in this category included production systems (whether they farm in open fields, hoop house/greenhouse or both), organic production and sustainability, and types of crops produced (Mpanga et al., 2020b). The production systems of respondents consisted of open fields (23%), greenhouse or hoop houses (13%), and both open field and hoop houses (57%). None of the growers are USDA organic certified, about 20% are self-defined organic growers, 10% conventional growers, and about 70% defined themselves as sustainable producers. The type of crops grown by the respondents are vegetables and fruits (52%), field crops (3%), landscape and ornamental horticulture crops (3%), and 32% produced all the crop categories (Mpanga et al., 2020b).

2.6. Marketing channels and income

The marketing questions focused on whether the growers had markets for their produce and the market channels at the time of the survey. The survey also asked income levels of the respondents. Most of the growers sold their produce at farmer's markets, through community supported agriculture (CSA), restaurants, and on-farm sales. Seventy-nine percent of the survey respondents reported having an available market for their products, while 21% did not have a ready market at production time. Sixty-two percent used their produce sales as supplemental income, while the remaining 38% depended on the farm sales as their primary household income. For total annual household income from sales, 82% of the respondents earned less than $25,000, similar to the USDA agriculture census report for 2017 (USDA, National Agricultural Statistics Service, 2018). Eleven percent earned $26,000 to 50,000 while 7% made $200,000 and more.

2.7. Statistics

A Chi-square test (x^2) was use at $p = 0.05$ to determine the relationships of farm income type (main income or supplementary to the family) and gender of the farmers on the use of sustainable agricultural practices on the farm using the formula below. Chi-square test (X^2) = Sum of ((Observed – Expected)^2)/Expected. Where observed is the measured value while the expected is computed as (row totals x column total)/all totals. The *P* values were then computed from the range of observed and expected to test the independence.

3. Result

3.1. Current land use and soil amendment practices

Common land-use practices include the use of cover crops (27%) and crop rotation (23%), followed by no-till (21%) and reduced tillage (18%). Intensive tillage was the least used practice among respondents (Fig. 2). The most common soil amendment practices used by survey participants were compost (26%), animal manure (22%), and green manure (22%) with less use of synthetic chemical fertilizers (13%), and pH and salinity management (10%) (Fig. 2). No relationships were observed between land use and soil amendment practices with family income type (supplementary or main income) and gender at $p = 5\%$ in X^2 (Table 1a and b; S1).

3.2. Regenerative and sustainable agricultural practices

The most used sustainable and regenerative practice by respondents were soil health and quality (17%), water use efficiencies (17%), reduced pesticides and herbicides use (15%), and recycling waste into resources (16%) (Fig. 3).

Other sustainable and regenerative practices used among the respondents included increasing biodiversity (12%), conservation agriculture (8%), energy use efficiency (10%), and efficient mineral nutrient use (6%) (Fig. 3). In a needs assessment for these growers, Mpanga et al. (2020b) reported that extension and research programs on sustainable agricultural practices are critical to the small-scale growers with less need for programs related to synthetic chemicals (Mpanga et al., 2020b). However, no associations were found between family income type from the farm and gender on the selected on-farm sustainable agricultural practices at $p = 5\%$ in X^2 (Table 1a and b; S1).

3.3. Pest, disease, and weed management practices

Mechanical and cultural management were the highest (39%), followed by biological control (31%) and chemicals that are allowed in organic production systems (25%). Chemicals that are not permitted in organic production systems were less used among the respondents (5%) (Fig. 4). Regarding weed management, 60–80% of the respondents said using cultural, mechanical, biological, and organic certified accepted approaches were very important to them, while 30% said using synthetic chemicals is important to them. The trend was similar for both disease and pest control, with very little interest in the use of synthetic chemicals (Mpanga et al., 2020b). Furthermore, income type and gender did not have influences on the use of pest, disease, and weed management practices among the farmers at $p = 5\%$ in X^2 (Table 1a and b).

3.4. Water sources and irrigation systems

Half (50%) of the respondents used well water for irrigation, 27% used rainwater, and 17% used water from rivers, streams, creeks, and ditches (Fig. 5a). For irrigation systems, 54% of respondents used drip irrigation, 21% sprinklers, 11% open flood, and 2% each used subsurface drip and pivot sprinklers. Eight percent of the growers used other irrigation systems such as hand watering or hydroponics (Fig. 5b).

Interestingly, family income type from the farm and gender did not influence the choice of water source and type of irrigation system on the farm at $p = 5\%$ in X^2 (Table 1a and b; S1).

4. Discussion

Farmland acreage continues to decrease drastically with a significantly increasing number of farms in Arizona (Fig. 1), which means small-scale farms hold a potential role in the sustainable local food supply now and in the future, especially in Yavapai and Coconino Counties. It has even become more critical as the region faces an

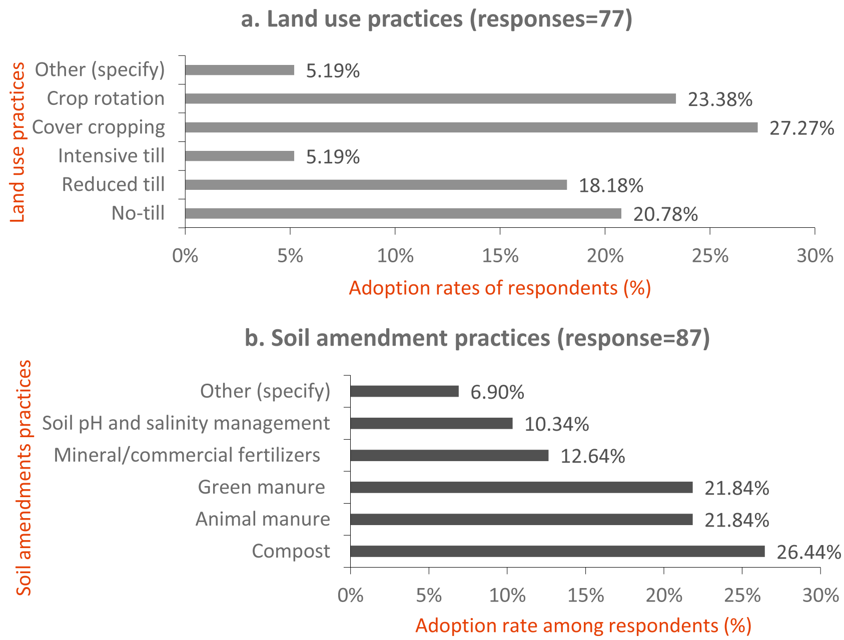

Fig. 2. Land use and soil amendment practices (other soil amendment practices include humic acids, worm castings, and soil microbial inoculations). Participants were able to make multiple responses that applied to them.

Table 1
Associations of farm practices with income and gender of small-scale farmers in North-central Arizona using Chi-square test at $p = 5\%$.

a. Association between selecting a sustainable practice and income		
	Degrees of freedom	X^2 at p = 5%)
Land use practices	5	1.00
Types of soil amendments used on Farms	5	1.00
Sustainable agricultural practices on the farm	6	1.00
Weed control methods	3	0.38
Sources of water	3	1.00
Type of Irrigation systems used on the farm	5	0.99
b. Association between selecting a sustainable practice and gender		
	Degrees of freedom	X^2 at p = 5%)
Land use practices	5	1.00
Types of soil amendments used on Farms	5	1.00
Sustainable agricultural practices on the farm	6	1.00
Weed control methods	3	0.38
Sources of water	3	1.00
Type of Irrigation systems used on the farm	5	0.99

increasingly drier and hotter climate. While gender and income type from farm had no effects on the choice and use of sustainable agricultural practices, the practices remain crucial for sustainable local food production and environmental stewardship as reported previously. (eganold et al., 1990).

According to Ngo et al. (2020) an economic dimension is the most crucial factor contributing to overall sustainable agricultural practices selected by farmers, followed by the socio-territorial dimension and agroecology. Consumers, climate extremes, and human capital could be a motivating factor to small-scale growers with limited resources to use sustainable and regenerative agricultural practices (D'Souza et al., 1993).

For example, in our study, we found that the small-scale growers sold most of their farm produce to the local community through farmers' markets, community-supported agriculture (CSA), restaurants, farm stands, and pick-ups (Mpanga et al., 2020b). The patrons of these market outlets are mostly community members conscious of what they eat and want to know the source and how their foods are grown. This has created a relationship between the farmers and the consumers, especially those in the CSA programs and farmer's markets, which transcend into connecting with nature and caring for the environment (USDA, 1998; D'Souza et al., 1993). Consumers influence an essential decision-making factor for the growers to think about how they grow, which has become the bedrock for using sustainable and regenerative practices (Figs. 2–5b) to meet their customer's needs. These consumers sometimes visit the growers on their farms for pick-ups and agritourism visits, which are widespread among the small vineyards and wineries in Yavapai County. These relationships between the growers and the consumers have become a vital component of all decisions made on the farm, a practice that is not common among larger farms that supply their produce to the supermarket chains. The grower's willingness to implement customer's desired farm practices with less synthetic chemicals is driven by an economic dimension (Ngo et al., 2020). Also, D'Souza et al. (1993) reported that financial capital affected farmer's decisions on sustainable agricultural practices. However, in this study, the type of income from the farm (that is whether partial or main income to the family) had no relationship to the use of on-farm sustainable agricultural practices among small-scale farmers.

As the climate continues to change in terms of decreasing precipitation and rising temperatures with more extremes in areas such as Arizona, conventional farming methods may not be sustainable and could lead to more issues, which could compel farmers to use alternative methods that are more resilient. According to D'Souza et al. the likelihood of adopting sustainable agricultural practices among farmers is affected most by environmental conditions (D'Souza et al., 1993). For example, extreme heat, drought, and erosion could cause rapid depletion of soil fertility and force farmers to use cropping systems and cultural practices that minimize severe environmental impact by continuously building soil health and microclimates through methods such as reduced tillage and the use of organic soil amendments.

According to Rosset, "If the loss of biodiversity or the sustainability of agriculture concerns us, small farms offer a crucial part of the solution (Peter, 1999)." Yes, most of the small-scale farms are philosophical in their farming approach and want to be part of the solution to biodiversity loss, so they currently adopt sustainable agricultural practices

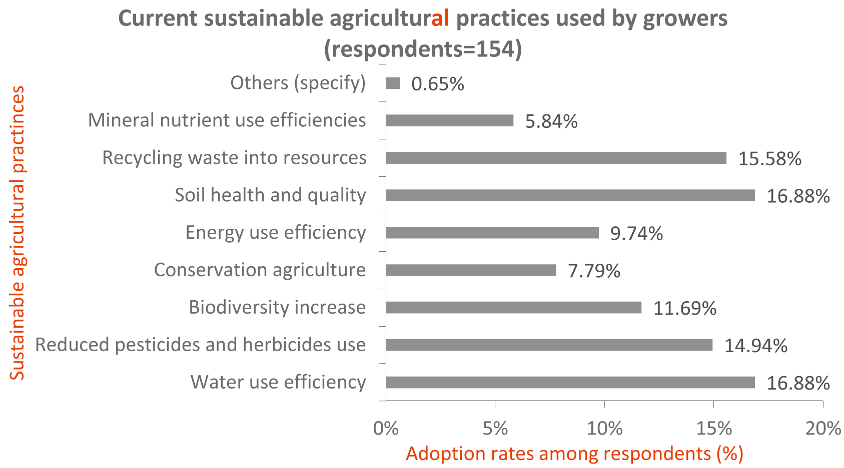

Fig. 3. Sustainable agricultural practices among growers in Coconino and Yavapai Counties. The survey participants were able to make multiple responses that applied to them. Others are any sustainable practices that are not listed in the options above. Biodiversity increases include practices aimed at increasing biological diversity on farm such as crop rotation, multiple cropping, and silvopasture.

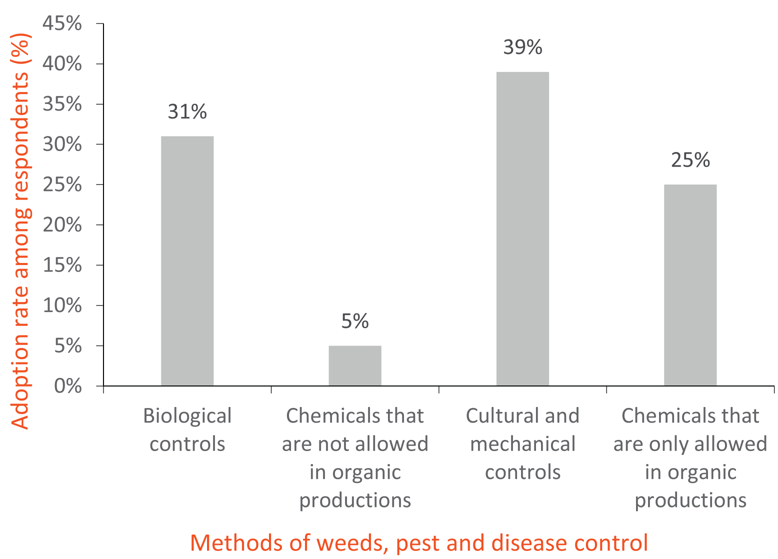

Fig. 4. Weed, pest, and disease management practices among growers in northern Arizona. The survey participants were able to select multiple responses that applied to them.

(Figs. 2–5b). In a need's assessment for commercial horticulture and small acreage growers in the region, farmers reported an interest in sustainable agricultural practices on their farm and wanted to be a part of the solution by participating in research projects and even serving on research project advisory boards (Mpanga et al., 2020b).

Published literature and policy makers may have an inherent bias that undervalues the contributions of small-scale producers to sustainable rural communities and food security (Laborde et al., 2020; Nature, 2020). McDonagh et al. clearly emphasized that small-scale farms are catalysts in revitalizing the rural economy locally and are key players in addressing food security (McDonagh et al., 2017a). Also, small-scale farmers are a key source of income and employment. For example, in Africa and Asia 65% of the jobs are created by small-scale farming as a sources of livelihood and can reduce poverty, which was recognized in the report "Sustainable Agriculture for the Future We Want" by the European Commission (European Commission, 2012).

Contrary to developing countries where the majority of the population is employed in farming, in the U.S., less than 2% of the labor force work in agriculture (American Farm Bureau Federation, 2020; USDA Economic Research Service, 2020), which is an indication that most consumers have very little connection to agriculture and food production, especially those living in big cities. Most urban dwellers are not aware of the benefits of nature, apart from recreational activities, leading to a lack of appreciation for farming where cultivation of the earth produces the food that sustains them, which is a concerning trend that requires action. The small-scale farmers bridge these gaps through urban agriculture, farmers markets, CSA, and direct farm stand sales as observed in north-central Arizona (Mpanga et al., 2020b).

Monoculture systems reduce diversity of our ecosystems, however, small farms have a high level of diversity in land ownership, cropping systems, landscapes, ecosystem services, biodiversity, culture, and traditions. This diversity contributes to the resilience of food systems against climate extremes with sustainable local food security in rural communities. It also depicts the rural communities' landscapes in ways that are appreciated by urban dwellers. The diversity of production systems such as using high tunnels and greenhouses enables small-scale

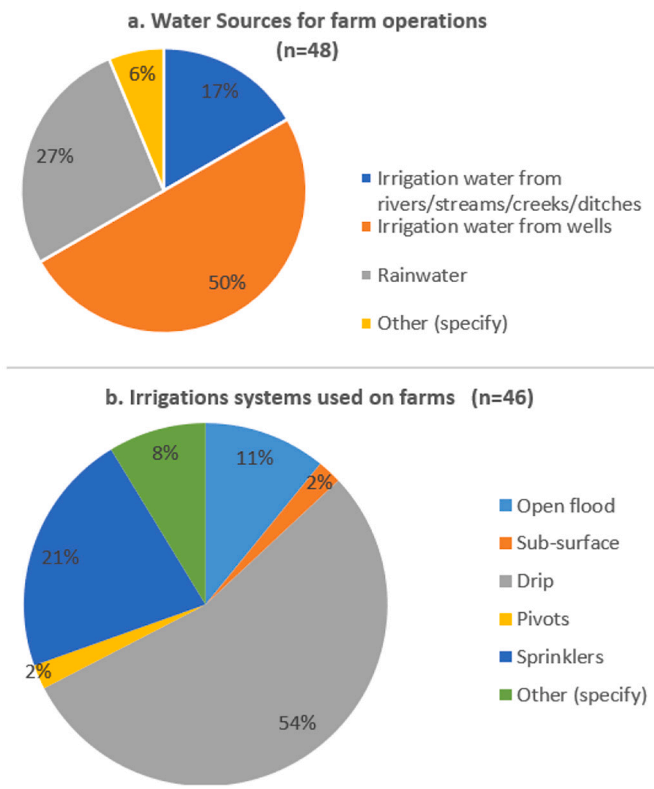

Fig. 5. Water sources and irrigation systems use among northern Arizona growers. Other water sources include city and reclaimed water while other irrigation systems include hand watering and hydroponics. The survey participants were able to select multiple responses that applied to them.

growers to produce fresh local food more efficiently and extend the growing season in both spring and fall. (Schuch, 2018). Small farms practice mixed and multiple cropping with continuous crop rotations throughout the year and other soil health practices such as adding compost and manure (Mpanga et al., 2021). The use of various crops also creates habitat for beneficial insects such as pollinators (Fig. 6).

Additionally, the small farm is a place to raise responsible and hardworking children, which is an excellent heritage for rural American families (Fig. 7, (D'Souza et al., 1993)) and farming families in other parts of the world. The smiles in the faces of Schaffer's children playfully

Fig. 7. A small farm winter wheat field with happy children running through it in spring. Picture snapshot from Schaffer's family farms videos on Instagram. (Schaffer Farms is a small-scale family farm located in Paulden, Yavapai County, Arizona, USA with certified natural grown status).

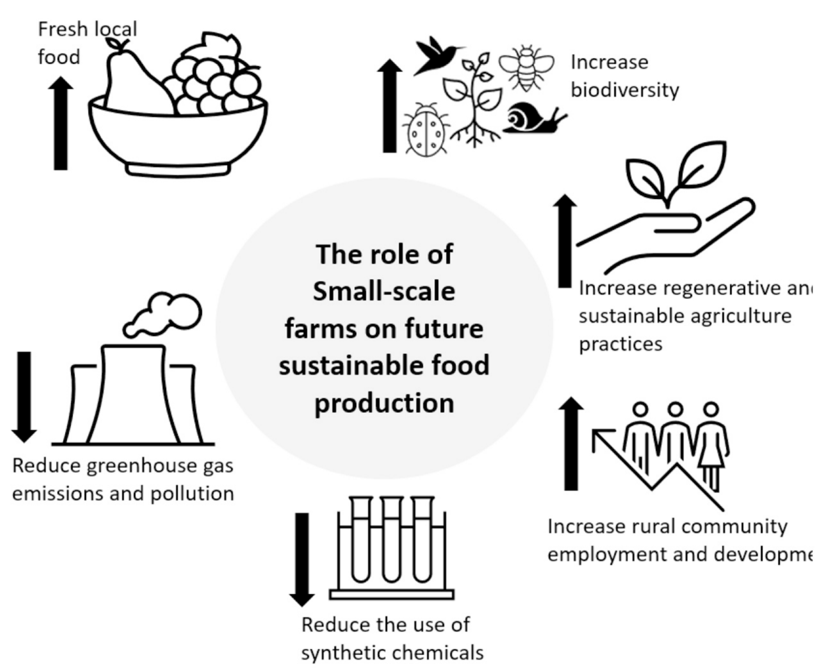

Fig. 6. Importance of small-scale farms on sustainable local food production (Adapted from USDA (USDA, 1998)). Arrows pointing up = increase whiles arrows pointing down = decrease.

running in the winter wheat fields during spring tells it all (Fig. 7).

It is very important to incentivize small and family farms, protect farming lands to keep these operations because the children grow up knowing how to farm, and nothing should stop them. These small farms will fit best in what Freedgood et al. called "rural smart growth," a well-respected approach to development that protects farmland, open space, and the environment at the same time encouraging mobile neighborhoods. The rural smart growth concept guides community development, protects working lands, and preserves rural character with a potential low carbon footprint (Freedgood et al., 2020).

Though agriculture contributes 10% of the greenhouse gas emissions in the US with soil management activities (application of synthetic and organic fertilizers, deposition of livestock manure, and growing N-fixing plants) being the largest contributors in 2018 (United States Environmental Protection Agency, 2020), small farms have the potential to reduce that impact (Fig. 6). The cumulative effect of all small farms utilizing sustainable and regenerative management practices improves the environment (reduced water, air, and soil pollution with increasing resource conservation) and produces food locally without having to transport it hundreds of miles. Using local resources such as recycling waste without importing chemical fertilizers in a circular agricultural approach are outstanding contributions to reducing greenhouse gas emissions. There is no doubt that sound investments into these viable small farm operations will be more profitable and sustainable in terms of environmental stewardship and resource conservation for a resilient, sustainable fresh local food production now and in the future (McDonagh et al., 2017b).

Apart from financial constraints, extreme climate conditions, land grabbing, and market access, which are common and pose obvious challenges, there is a form of neglect from researchers and private companies on technologies and information that are small-scale agriculture operation focused. Most technologies are designed for large-scale farms with very limited to no equipment that fits the small farm operation. In situations where research and technologies are developed for small farms, farmers were not involved in these critical steps, and technologies and research have limited adoption and usefulness (Laborde et al., 2020; Nature, 2020). The world's farm population is about 570 million, with more than 475 million smaller farms (less than 2 ha). However, more than 95% of research work, especially in developing countries, was not relevant to smallholder farms and their families' needs (Laborde et al., 2020; Nature, 2020). A similar trend is observed in Arizona with more research in the counties such as Yuma and Maricopa with significant large-scale agriculture operations than other counties such as Coconino and Yavapai with predominantly small farms. This indicates that specific institutions, states, and countries needs to overcome political and economic challenges to be able to launch a smallholder-based agricultural revolution as an agricultural engine of growth (Reganold et al., 2011; Birner and Resnick, 2010), especially in rural communities and developing countries. According to Mizik, due to the high risks and low returns in agricultural productions, small-scale farmers consider immediate financial returns before making decisions on climate-smart agricultural practices. Hence, small-scale farmers need; compensation for providing environmental benefits, support with simpler methods with low labor intensity, access to the different financial instruments and inputs, science-based information through extension, and land use security to continually use climate-smart and regenerative agricultural practices (Mizik, 2021). The Farm Bill seeks to play such a vital role in the United States agriculture (Monke and Johnson, 2010), but more needs to be done at the state and county levels with focus on small-scale farmers.

Conversely, working with small farms from a researcher's perspective also comes with extreme challenges of limited resources (time, land, equipment, and labor) to spare from the farmer for research collaborations. The small-scale farmer also has a role to play by getting involved. For example, it is even challenging for researchers to get reasonable response rates from farmers to participate in needs assessment surveys and feedback to direct research, technology, and extension programs to meet their needs.

5. Conclusion

The use of sustainable and regenerative agricultural practices is a clear trend among small-scale farmers in north-central Arizona as adaptation strategy to climate extremes and local food security, which is independent of income type from the farm and gender of the farmers. Supporting and promoting these small-scale farming operations with research and technology will support sustainable local food production, reduce the negative impacts of conventional agricultural production systems, and enhance rural communities' development. As the Nature 2020 editorial correctly put it, "Ending hunger: science must stop neglecting smallholder farmers." We will add that science and technology should consider the value and ecological services provided by small-scale farms as part of profitability.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.crsust.2021.100067.

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<u>Update</u>

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Erratum regarding missing Declaration of Competing Interest statements in previously published articles

Declaration of Competing Interest statements were not included in published version of the following articles that appeared in previous volumes of Current Opinion in Endocrine and Metabolic Research.

The appropriate Declaration of Competing Interest statements below.

1. Assessment of flood recession farming for livelihood provision, food security and environmental sustainability in the Ganga River Basin [Current Research in Environmental Sustainability, Volume 3, 2021, 100,038] https://doi.org/10.1016/j.crsust.2021.100038

   Declaration of Competing Interest: The authors were contacted after publication to request a Declaration of Interest statement.
2. A comparison of the technical efficiency of Aquaculture Stewardship Council certified shrimp farms to non-certified farms [Current Research in Environmental Sustainability, Volume 3, 2021, 100,069] https://doi.org/10.1016/j.crsust.2021.100069

   Declaration of Competing Interest: The authors were contacted after publication to request a Declaration of Interest statement.
3. Investigating SES variables causing changes in sense of place in the context of coastal wetland conservation - A case of Pulicat lagoon [Current Research in Environmental Sustainability, Volume 3, 2021, 100,061] https://doi.org/10.1016/j.crsust.2021.100061

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4. Adaptation of resilient regenerative agricultural practices by small-scale growers towards sustainable food production in north-central Arizona [Current Research in Environmental Sustainability, Volume 3, 2021, 100,067] https://doi.org/10.1016/j.crsust.2021.100067

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5. Inaugural issue Editorial [Current Research in Environmental Sustainability, Volume 1, January 2020, Pages A1-A2] https://doi.org/10.1016/j.crsust.2020.06.002

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6. Sustainability analysis of integrated farms in coastal India [Current Research in Environmental Sustainability, Volume 3, 2021, 100,089] https://doi.org/10.1016/j.crsust.2021.100089

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7. A review of water-forest-energy-food security nexus data and assessment of studies in East Africa [Current Research in Environmental Sustainability, Volume 3, 2021, 100,045] https://doi.org/10.1016/j.crsust.2021.100045

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