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### Agroforestry for the future: motivations behind Tasmanian farmers planting trees

Josh Lipp  
*SIT Study Abroad*

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**Agroforestry for the future: motivations behind Tasmanian farmers planting trees**

Josh Lipp

Academic Director: Dr. Aysha Fleming

Land and Water, CSIRO

Tasmania, Australia

Academic Director: Tony Cummings

Home Institution: Williams College

Major: Geoscience

Submitted in partial fulfillment of the requirements for Australia: Rainforest, Reef, and Cultural

Ecology, SIT Study Abroad, Spring 2023



### ISP Ethics Review

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The ISP paper by Josh Lipp (student) does/does not\* conform to the Human Subjects Review approval from the Study Abroad Review Board (SARB), the ethical standards of the local community, and the ethical and academic standards outlined in the SIT student and faculty handbooks.

\*This paper does not conform to standards for the following reasons:

Completed by: James Anthony Cummings

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A handwritten signature in black ink, appearing to read "J. A. Cummings".

Signature:

Program:

Cairns: Rainforest, Reef, and Cultural Ecology

Date: May 12, 2023

Abstract:

Agroforestry is the act of combining farming and tree planting, and many Tasmanian farmers are starting to plant trees on their properties for multiple reasons. Through conducting 9 interviews with farmers and researchers and visiting field sites, 3 main themes were identified to answer the question: why are Tasmanian farmers planting trees, and what are the benefits and downsides to agroforestry? Interviews help us understand farmers' perceptions of agroforestry, and field data collection will prove the benefits of agroforestry in the future. Tasmania was chosen as the location of study as it is a state in Australia that largely focuses on agriculture, has a large logging industry, and is home to the ongoing Perennial Prosperity research project that is currently researching many topics relating to agroforestry.

The 3 themes identified are benefits agroforestry provides to farmers and ecosystems (1), challenges farmers face with agroforestry or problems not solved by agroforestry (2), and future opportunities positively relating to agroforestry (3). Farmers are planting trees to provide ecosystem services such as erosion control and shelter, increase farm productivity and biodiversity, help reach carbon neutrality, give security in the face of global climate change, improve aesthetics and mental health, and diversify income through supplying timber. Farmers face multiple challenges when using agroforestry, some of which include persisting problems with agricultural systems and costs for tree implementation. Future opportunities such as agroforestry research and shifts towards local agriculture could have positive impacts in various sectors. Agroforestry is likely to increase in the future, and understanding the various benefits trees give to humans and the planet will be important in future agricultural and agroforestry related endeavors.

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**Introduction:**

Agroforestry is the combination of agriculture and forestry: the act of increasing the number of trees on agricultural lands. There are many reasons to plant trees on farms, with the main benefits being increasing sustainability, productivity, and profit (Fleming et al., 2019). Agriculture currently covers 38% of the world's terrestrial land surface and uses 70% of its freshwater resources, and without significant change, modern agriculture will vastly overstep planetary boundaries (Gordon et al., 2021). Some of these planetary boundaries include biogeochemical flows, biosphere integrity, land-systems change, freshwater use, and climate change (Campbell et al., 2017), and the only way for us to return to below these boundaries is to change our agricultural practices (Gordon et al., 2021). One significant change that can help mitigate some of these sustainability issues with conventional agriculture is planting trees on agricultural lands.

The implementation of agroforestry can have positive effects on biodiversity by providing habitat (Torralba et al., 2016) and lessening the devastating effects of habitat fragmentation (Fahrig 2003, Debisnki and Holt 2001), increasing soil carbon (Stefano and Jacobson 2018), lessening and mitigating greenhouse gas (GHG) emissions (Lin et al., 2011), slowing or reversing soil degradation (Montgomery 2007), increasing climate resilience (IPES-Food 2016), and improving the mental health of farmers and people living on agricultural lands (Reichers et al., 2020). Planting trees on farms can also give farmers a secondary source of long term income, as trees produce valuable timber that can be harvested whenever farmers see fit. Farmers planting agroforestry plots with a diversity of species including timber and food producing species can diversify production, generate income, reduce farm risk, improve environmental conditions, and contribute to food security, while also helping meet commercial needs for timber which can help take pressure away from the logging of native forests (Roshetko

et al., 2013). While many of these environmental and practical values of agroforestry are important, the monetary value of trees for timber is often a driving factor for farmers to plant more trees on their properties.

**Persisting problems with food / agriculture system:**

While industrial agriculture currently produces the majority of the food for humans, many of its practices are unsustainable and have devastating effects on the environment. Due to the need to produce massive amounts of food for the increasing human population while also becoming more sustainable in the future, agriculture will play an integral role in meeting our sustainability and carbon neutrality goals of the near future (UN SDG, 2015). The majority of agriculture happening on an industrial scale currently relies on the mass use of synthetic fertilizers, chemical pesticides, tillage, monocultural production, and intensive animal husbandry also known as factory farming (Gordon et al., 2021). These practices are focused on scalability, simplicity, and production, without considering sustainability or the massive inputs needed to make these practices successful.

**Provide ecosystem services / increase production:**

Soil degradation and erosion are some of the main problems threatening modern agriculture, as large areas of soil are degraded every year leading to less land being viable for agriculture. Over 20% of land on earth is considered to be degraded with 12 million hectares of agricultural land becoming degraded each year due to the unsustainable practices of industrial agriculture (IPES-Food 2016). Conventionally plowed agricultural fields erode at average rates of 1-2 orders of magnitude greater than rates of soil production, erosion under native vegetation,

and long-term geological erosion, meaning that these plowed fields erode 1 mm of topsoil each year (Montgomery 2007). With soil production and geologic erosion rates of 0.2 mm/yr and conventional agriculture erosion rates of 1 mm/yr, the average 10 cm - 1 m soil depths would be eroded in a few hundred to a few thousand years, equating to the average survival lengths of historical agricultural civilizations (Montgomery 2007). If we want our current civilization to outlast that time constraint, we must adopt agricultural methods that promote the growth of new soils and the limitation of erosion. Soil erosion and degradation particularly affects small scale farmers by diminishing lands available for farming and yields often used for subsistence, as small scale farming is the largest occupation in the world involving over 2.5 billion people with over 70% living below the poverty line (Hurni et al., 2008). While erosion is negative to agricultural fields due to the simple loss of soil, it can also carry large amounts of nutrients and pesticides present in industrial agricultural soils and manure from high density livestock feedlots to nearby aquatic ecosystems, causing dead zones, algal blooms, and pollution in rivers and marine systems that can negatively affect coastal commercial fisheries and water sources that humans rely on (IPES-Food 2016).

Agroforestry has the potential to greatly decrease soil erosion and degradation while increasing soil health in multiple ways. A recent study researching agroforestry's effect on soil found that integrating trees into farms can enhance soil fertility, improve soil's physical, biological, and chemical properties, reduce runoff, reduce wind erosion, intercept rainfall, and bind soil particles together, all while producing food, fodder, and wood (Fahad et al., 2022). Some other methods to increase production and reduce soil erosion include residue return, zero tillage, minimum tillage, cover cropping, and crop rotation, all processes intended to minimize soil disturbance, increase organic matter on the soil surface, and boost biodiversity (Fahad et al.,



2022). Steep slopes can be more prone to soil erosion than flat agricultural lands, so a study in the tropical mountains of Rwanda containing 20-60% slopes observed how agroforestry could help erosion in this scenario. From comparing 9 runoff sites using 3 types of living hedges to standard plots without the presence of trees, they found runoff rates reduced from 10-30% runoff on bare plots to 2% runoff with living hedges after 2 years (Roose and Ndayizigiye 1997). By using strategies to slow runoff including letting land lie fallow with leguminous or natural growth, allowing trees to drop their leaves, and mulching to protect the soil from direct rainfall, the living hedges produced abundant firewood and leguminous forage (3 to 8 kg/m), and returned nutrients to the soil in quantities of 80 to 120 kg/ha/year of nitrogen, 3 kg/ha/year of phosphorus, 30 to 60 kg/ha/year of calcium and potassium, and 10 to 20 kg/ha/year of magnesium (Roose and Ndayizigiye 1997). A study in Northwest Missouri in the United States on highly erodible soils also tested to see if agroforestry rows could help mitigate erosion and be beneficial to farmers. They found that agroforestry is an effective low-input strategy for reducing topsoil erosion to appropriate levels, while also providing a diversity of products that can help ease some of the reliance farmers have solely from crop income (Kurtz et al., 1991). Out of the tree species tested, they found black walnut to be the most effective and financially feasible species to plant due to the early returns for nuts which can offset the cost of planting and establishment while also providing valuable timber harvests at a later time (Kurtz et al., 1991). Integrating agroforestry plots into farms can have many benefits, but erosion control is a central reason farmers consider planting more trees on their properties.

Another important ecosystem service agroforestry provides to farms is shelter in multiple forms. Often planted in systems called “shelterbelts,” high density strips of trees planted in agroforestry rows perpendicular to prevailing winds can drastically reduce wind speeds, and

therefore wind erosion on soils (van Ramshorst et al., 2022). A study researching the effects of shelterbelts found average wind speed reductions between 17% and 67%, and average wind erosion reductions between 24% and 97%, with shelterbelts planted perpendicular to prevailing winds being the most effective strategy while reducing wind erosion over 92% (van Ramshorst et al., 2022). Shelterbelts can provide many ecosystem services for livestock such as enhancing livestock health by reducing cold and heat stress, minimizing young animal mortality, boosting weight gain, bettering reproductive performance, and increasing feeding efficiency, allowing livestock to convert grass, agricultural waste, and grain into valuable milk, eggs, wool, and meat while also cycling nitrogen which can minimize the need for external inputs (Mume and Workalemahu 2021). Along with livestock, agroforestry shelterbelts can increase crop productivity through increasing growth with the use of nitrogen fixing trees (Mume and Workalemahu 2021), reducing the effects of extreme heat and damage from high winds, and increasing habitat for beneficial wildlife such as pollinators and predators that control pests (Emerson 2022).

### **Increase biodiversity:**

Biodiversity loss is a problem facing ecosystems worldwide, and human activities are the driving factor (Cardinale et al., 2012, Diaz et al., 2006, Hens and K. Boon, 2005). Some of the main causes of this observed biodiversity loss are the loss of habitats, the homogenisation of species in agriculture, the introduction of invasive species, and the overharvesting of biodiversity resources (Hens and K. Boon, 2005). The loss of habitat through deforestation and the subsequent replacement with simple monocrop agriculture systems reduces the complex ecological relationships previously occupying the land, making the new artificial ecosystem

unable to support healthy populations of native animals. Organisms influence the productivity of ecosystems by contributing to biogeochemical cycles and engineering the physical formation of habitats, and losses of certain species can have large impacts on the functioning and structure of entire ecosystems (Cardinale et al., 2012). Biodiversity has been an integral part of the human experience as we have learned to use various species for food, medicines, fibers, and other resources, as well as relying on biodiversity for our well being by providing us access to clean water, basic materials, and security from environmental change (Diaz et al., 2006). The stability of ecosystem functions through time relies on biodiversity, and losses in biodiversity reduce the production of biomass, the capturing of biologically essential resources, and the decomposition and recycling of essential nutrients (Cardinale et al., 2012). Activities used to produce human subsistence often lead to biodiversity loss (Diaz et al., 2006), and the impact of biodiversity on ecosystem processes is nonlinear, meaning that change accelerates as biodiversity loss increases (Cardinale et al., 2012).

Increasing the diversity of crops grown together on farms using practices such as agroforestry can have positive effects on local biodiversity in a multitude of ways (Bhagwat et al., 2008, Jose 2012, Torralba et al., 2016, Thrupp 2000). Some of the main benefits agroforestry has on biodiversity include: protecting species and habitats outside protected areas, maintaining heterogeneity at habitat and landscape scales, providing resources to reduce pressure on protected forest reserves (Bhagwat et al., 2008), providing habitat for disturbance tolerant species, preserving germplasm of sensitive species, reducing conversion rates of natural habitats to traditional monocrop agricultural systems by providing more productive and sustainable alternatives, connecting habitat remnants by creating corridors to help support more area-sensitive floral and faunal species, preventing degradation and loss of surrounding habitat

by providing ecosystem services such as erosion control and water recharge (Jose 2012). Agroforestry has been found to be beneficial on farms in Europe by providing ecosystem services and increasing biodiversity (Torralba et al., 2016), and some think agricultural biodiversity is critical in establishing food security around the world (Thrupp 2000). Much of the land we now consider pristine habitat often shows remnants of ancient indigenous peoples agricultural practices, showing how the biodiversity of today is a result of past human practices along with climatic and ecological processes (Bhagwat et al., 2008). Some examples include the ancient Maya in the Yucatan Peninsula cultivating trees in their communities and transporting algae from wetlands to bring fertility to upland garden plots, pre-Columbian native peoples in central Amazonia developing fertile Terra Preta soils by adding large amounts of charred residues, organic waste, excrement and bones to the soil, Kayapo Indians cultivating Brazil nut trees (*Bertholletia excelsa*) in the Amazon before European colonization, in Africa, the cultivation of the frankincense tree (*Boswellia papyrifera*) for over 2500 years and of bananas for 3000 years as well as keeping livestock, and the people in the highlands of Papua New Guinea growing banana plantations 6500 years ago (Bhagwat et al., 2008). These agricultural practices used by ancient people enhanced the native environments rather than degrading them to provide more food in the form of crops while supporting a wide array of useful flora and fauna.

Some agroforestry design features that are known to increase biodiversity are high floral and structural diversity, minimal management intensity similar to natural disturbance regimes (reducing tree density by thinning or prescribed fire), long rotation periods, and strategic locations in the landscape (between habitat fragments or near large natural habitats) (Jose 2012). Studies have shown that agroforestry systems can support a mean species richness of greater than 60% of forest values (Bhagwat et al., 2008), and supporting a wide array of life forms including

invertebrates will be important for food security in the future. Bees, flies, moths, bats, and birds pollinate crops and provide pest control services, yet there is currently a worldwide loss of pollinators due to habitat fragmentation, agricultural intensification, and the use of agrochemicals (IPES-Food 2016). The reliable production of food depends on pollination by wild pollinators, and estimates indicate that pollination represents over \$200 billion (USD) a year in benefits for domesticated and wild plants (Jose 2012, IPES-Food 2016). Monocultures support a much lower abundance and diversity of pollinators than fields with diverse forage and nesting sights (IPES-Food 2016), and agroforestry plots could supply farmlands with safe havens for pollinators to nest and reproduce.

### **Improve aesthetics / mental health:**

Besides providing ecosystem services such as erosion control (Fahad et al., 2022, Roose and Ndayizigiye 1997, Kurtz et al., 1991), and increasing biodiversity (Bhagwat et al., 2008, Jose 2012, Torralba et al., 2016, Thrupp 2000), agroforestry has the potential to have many direct benefits to humans. Humans have had close relationships with nature for most of human existence, yet the simplification of ecosystems into monocrop agricultural systems is disconnecting people from nature and reducing social relations and senses of agency, leading to the erosion of rational values (Riechers et al., 2020). Through using agroforestry to restore landscapes, many benefits to humans arise including providing food security, improving health and wellness, enduring sustainability, preserving agrobiodiversity, and helping reach sustainable development goals (Sharma et al., 2022). Wind protection in the form of agroforestry shelterbelts can lessen the consequences of wind chill on farmers, making outdoor labor more safe, pleasant, and efficient during winter months (Mume and Workalemahu 2021). Due to the many

environmental and social problems that come along with industrial agriculture, agroecological and smaller scale approaches have been suggested as possible solutions (Horrigan et al., 2002).

Experiences with nature are often correlated with mental health benefits (Bratman et al., 2019), and increasing the number of trees in landscapes could help people have more natural experiences with both flora and fauna. Nature's influence on the mental health of children and teens is especially important, with nature often helping with overall mental health, self-esteem, stress, resilience, depression and health-related quality of life (Tillman et al., 2018). While agroforestry is often implemented on farms, its use in urban and suburban areas could also be beneficial. One study found that neighborhoods with afternoon bird abundances and vegetation cover were correlated with lower prevalence of anxiety, stress, and depression (Cox et al., 2017). Indigenous people view themselves as part of nature, and without this coupling, life in both human and non-human forms can suffer and lose its sustainability (Salmón 2000). Allowing people to reconnect with nature through the use of agroforestry will help improve mental health in the future in both agricultural and urban settings.

### **Help reach carbon neutrality and climate change security:**

Agriculture is responsible for over 10% of global greenhouse gas (GHG) emissions and a quarter of the ongoing increase in recent GHG emissions, with the majority of emissions assigned to the unsustainable practices of industrial agriculture (Lin et al., 2011). Alternative agricultural methods have the potential to emit less GHGs while also sequestering more carbon through changing crop management choices to decrease materials used and practices involved in the release of GHGs, decreasing the fluxes involved in pasture management and livestock production, and emphasizing local food systems to reduce the transportation of agricultural

products, inputs, and outputs (Lin et al., 2011). Globally, organic systems are often more profitable than conventional systems, and 80% of global food demands are produced by small scale farms (Valenzuela 2016). The specialization of industrial agriculture and the emphasis on exportation have reinforced one another, making small producers in developing countries struggle to compete with high food safety and quality standards, restrictive regulations, and the many requirements of international trade (IPES-Food 2016). 85% of countries show low food self sufficiency due to the increased homogeneity of the regional and global food supply, and climate change will have effects on agriculture that will further impact food security (Valenzuela 2016).

The many ecosystem services provided by agroforestry helps make farms much more resilient and food secure, and this will continue to be important as adverse effects of global environmental change become more prevalent (Emerson 2022). A study researching farms in Southwest Asia observed how different farms used different tree species in agroforestry systems for different specific purposes including food, timber, medicine, and industrial values (Al-Mohamed et al., 2023). Farms integrating trees with crops (agrosilvicultural) used trees such as chestnut, jujube, date palm, and fruiting pine; farms integrating trees with livestock grazing systems (silvopastoral) mainly used trees such as carob and Euphrates poplar; farms integrating trees, crops, and grazing (agrosilvopastoral) used trees such as mahlab, sumac, laurel, and mangroves (Al-Mohamed et al., 2023). These trees not only make farms more climatically resilient and food secure, they provide other sources of income to farmers if their main crops fail due to rapidly changing climates.

**Provide income diversification and security:**

Monetary value is of the utmost importance to farmers, as they do all they can to increase production to get the largest amount of income for their land. Agroforestry can be a reliable source of supplementary income on farms through supplying valuable timber, making more farmers turn to planting trees as a smart solution in a time of changing climates when crop production will only become less reliable. A study carried out in Nepal found that 289 households implementing agroforestry increased their income by 37%-48% and provided food to the poorest households for six extra months in the year, taking 63% of households out of poverty while also avoiding food shortages (Pandit et al., 2019). People use agroforestry around the world for many different reasons, yet the direct income coming from trees planted on farms are timber and fruits (if fruiting species are planted). In Europe, a timber shortage due to the declining import of tropical timber and lack of local timber supply has forced the European Union to form agroforestry plans to attempt to figure out viable tree species to produce timber (Báder et al., 2023). They found that high value tree species include apple, olive, cherry, pear, orange, oak, various nut producing trees, and chestnut, due to their ability to produce fruit for selling or animal feeding purposes while also supplying timber, and other non fruit species including poplar, silver maple, willow, and black locust have rapid juvenile growth and can produce high quality timber (Báder et al., 2023). A study in Northern Honduras found that cacao plantations with a focus on timber production are highly profitable, with farms accumulating over \$95,000 USD of combined revenues equating to \$3775 ha/year (Ramírez-Argueta et al., 2022). With timber needs only increasing in the future along with native forests diminishing, agroforestry will be an important alternative source of timber while also making farms more profitable.



**Perennial Prosperity Project:**

Farmers in Australia are starting to use agroforestry on their farms to help increase sustainability, security, productivity, and income (Fleming et al., 2019). A study as part of the Perennial Prosperity research project conducted in Tasmania and Australia in 2019 by Fleming et al. attempted to learn farmers' perceptions of agroforestry through interviewing 44 mixed enterprise farmers and farm advisors (Fleming et al., 2019). Through analyzing the interviews with discourse analysis, they identified three main groups of farmers' perceptions of agroforestry which included (1) trees as an economic proposition, (2) trees as uneconomic and (3) trees as essential regardless of economics (Fleming et al., 2019). There are varying reasons why farmers may be hesitant to plant trees, some of these factors including lack of time and money, past failures of reforestation schemes, and lack of awareness of the benefits of trees (Fleming et al., 2019). Natural capital accounting (NCA) is a newly emerging way of attempting to assign a monetary value to the benefits of agroforestry, hopefully helping convince more farmers to increase the number of trees on their properties (Fleming et al., 2019). A more recent study by the Perennial Prosperity team used a similar discourse analysis technique to analyze interviews with 57 stakeholders to understand the opportunities for behavior, awareness change, and perceptions relating to the use of NCA (Fleming et al., 2022). This is one of the first studies applying discourse analysis to perceptions of NCA, and they found the four main areas of conflict were relating to values, complexity, digital technology, and the desired future vision of NCA in society, as well as differing views on whether NCA should have a consistent approach for all or a more tailored approach for specific circumstances (Fleming et al., 2022).

With this current study being conducted four years after the initial perceptions of agroforestry paper, the main goals are to distinguish how perceptions have changed with more information available and increasing awareness of farmers, and identify possible important future areas of study. While the time constraint of one month did not allow the conduction of as many interviews as the previous study, key themes were still identified and farmers and researchers highlighted areas that are lacking in research that could benefit the agroforestry and agricultural community with future study. The Perennial Prosperity ethics team as well as the School for International Studies ethics team approved the questions used for interviews, allowing for the use of data collected from interviews in the study.

### **Materials and Methods:**

Thematic analysis was used to analyze data from interviews with Tasmanian farmers who have implemented agroforestry plots on their farms and researchers studying topics relating to agroforestry. The farmers had different types of agroforestry plantings on their farms including shelter belts, new or established plantations for timber harvest, fenced off native vegetation, riparian planting along streams and rivers, and various native plantings. Interviews were conducted in person, over video conference on zoom, or over the phone. Interviews were recorded and transcribed (with permission from participants), followed by themes being assigned to commonly mentioned topics.

Farmers and researchers were asked similar questions relating to general agroforestry, food production and modern food systems, habitat and biodiversity, sustainability and climate change, and the future of agriculture and research. Questions were left open ended to allow long and varied responses with questions such as: How has planting trees on your land changed your

farm? What do you think are the main benefits and downsides to agroforestry? What would you do differently next time? What crops do you currently produce, and where do you sell to (locally/overseas)? Do you think it would be feasible for most of the food people eat around the world to be produced locally, and why or why not? Do you find value in native habitat, and if so, why? With expanding human populations, how do you think it will be possible to preserve or expand native habitats while also producing more food? What do you think the future holds for agroforestry, and agriculture in general? Each interview lasted for around 45 minutes to 1 hour, and transcriptions were done with a combination of AI software and manual inputs.

The transcriptions of interviews were placed into a single document, and themes were assigned by highlighting with different colors. Themes were then refined with similar themes being grouped together or broad themes split into more specific themes, and the number of times specific themes were mentioned was noted. Some quotes used in the study have been slightly edited for readability. Researchers also visited multiple field sites to observe plantings in the agricultural context and collect data on the mortality and flowering of young trees to add to the ongoing Perennial Prosperity study. At older sites, researchers also collected tree height and width as well as soil samples to calculate future projections of the carbon storage capabilities of different agroforestry sites.

Tasmanian farmer contacts with agroforestry plots implemented on their land were supplied by the Perennial Prosperity team, as they are currently working on many agroforestry related projects that involve farmers, as their farms are the data collection study sites. These different projects include groups looking into how agroforestry benefits biodiversity, shelter, pollination, and socio-cultural aspects. This type of research involving a large interdisciplinary

team studying many different parts of a single subject is a relatively new phenomenon, allowing scientists to come together from different fields to combine their expertise into a larger project.

**Results:**

After conducting and analyzing 9 interviews, the three main themes identified were benefits agroforestry provides to farmers and ecosystems (1), challenges farmers face with agroforestry or problems not solved by agroforestry (2), and future opportunities positively relating to agroforestry (3). The themes falling under the benefits agroforestry provides to farmers and ecosystems include how agroforestry can provide ecosystem services / increase production, increase biodiversity, help reach carbon neutrality and climate change security, provide income diversification and security, and improve aesthetics / mental health. The themes part of the challenges farmers face with agroforestry or problems not solved by agroforestry include the persisting problems with the food / agriculture system, establishment / fencing problems, and the requirement to log native forests. Themes falling under future opportunities positively relating to agroforestry include the research that would promote / improve agroforestry, solutions to agricultural problems presented by local agriculture, incentives for agroforestry implementation, and educational opportunities of agroforestry.

Theme	Number of Occurrences
<b>Benefits agroforestry provides to farmers and ecosystems</b>	130
Provide ecosystem services / increase production	46
Increase biodiversity	33
Help reach carbon neutrality and climate change security	21
Improve aesthetics / mental health	16
Provide income diversification and security	14
<b>Challenges farmers face with agroforestry, or problems not solved by agroforestry</b>	59
Persisting problems with food / agriculture system	37
Establishment / fencing problems	15
Requirement to log native forests	7
<b>Future opportunities positively relating to agroforestry</b>	67
Research that would promote / improve agroforestry	36
Solutions to agricultural problems presented by local agriculture	17
Incentives for agroforestry implementation	14

Table 1: Number of times participants mentioned each of the major three themes and each subtheme, helping depict which topics were most important to farmers and researchers involved in agroforestry. Each of the 3 major theme counts is a sum of the subthemes in that category.

## **Discussion:**

### **Benefits agroforestry provides to farmers and ecosystems**

#### **Provide ecosystem services / increase production:**

As the most abundant subtheme in the study with 46 mentions (Table 1), the ecosystem services provided by agroforestry are of the utmost importance. The main ecosystem services

mentioned were shelter, erosion control, and how ecosystem services help increase crop or livestock production. After being asked if they are happy with their decision to plant trees, participant 3 responded with an enthusiastic yes, saying that the best time to plant trees was 20 years ago and he wishes he had planted trees on his farm long ago. He then presented his goals with planting trees: “There's two goals. Ideally, to have every north south fence line in trees for the shelter from the prevailing westerly winds.” The other goal was getting enough trees interspersed within his pasture to become carbon neutral or negative. Participant 3 then elaborated on the shelter the trees are providing, saying “But you do notice, like you go up big hills on a windy day, you walk behind the shelter belt and you can see clearly like you feel it, that it's making a difference, and seeing some of those around two, three, and four year old pine rows and they're getting up 2 to 3 meters now, so they're growing really well, and so, yeah, look, they're making a difference.” With some of participant 3’s shelterbelts being only two years old and already reducing wind speeds shows the effectiveness that even young trees can have on slowing winds that can otherwise cause erosion of soils, affect crop growth, and cause livestock problems. Participant 3 helps confirm the study mentioned previously that found agroforestry shelterbelts to reduce average wind speeds between 17% and 67% (van Ramshorst et al., 2022), clearly falling within the boundary of noticing a clear difference in wind speed behind the trees. Participant 3’s trees will only become more effective at reducing wind as they grow older, and future Perennial Prosperity projects or other agroforestry research can help confirm these results.

The addition of shelter through agroforestry plantings can have positive effects on livestock, making trees a smart choice to plant in and around pastures. Participant 6 noted, “We've done a lot of native shelterbelts. We worked out that there's a good 10% difference in lambing percentages with paddocks that have good shelter. So we split up a lot of paddocks and

put tree lines down there. Generally the western side, southwestern sides.” Participant 6 runs a large lambing operation, as well as raising cattle and growing vegetables such as potatoes and broccoli on a large scale. When running a farm with multiple different enterprises on a large scale, collecting data of efficiency and productivity is important in identifying positive changes that can help the farm. This 10% increase in lambing percentage is quite significant as it has convinced participant 6 to implement more trees into more pastures, even though there may be additional costs for implementation initially. Later in the interview when discussing fencing costs, participant 6 said, “So I guess it's a bit of a hidden cost of what the tree fencing cost because we just include it in our development costs. If you put down 10% increase, that's an average, you get these bad paddocks, you're up to 20%, 25% increase in lambing percentage. So it's quite easy to know what lambs are worth and how much you make on them. So it's quite easy to work out with 25% increase, what money you can spend on it that you're happy to spend because even if you break even, well, not quite breakeven, to have the trees there that you've nearly paid for.” Currently, there is not much data on how trees influence livestock survival rates. More data is needed to confirm these increases in lambing percentages, yet these numbers are promising in confirming that livestock benefits from the shelter of trees in various ways such as enhancing livestock health by reducing cold and heat stress, minimizing young animal mortality, boosting weight gain, bettering reproductive performance, and increasing feeding efficiency (Mume and Workalemahu 2021).

Reducing erosion, especially around streams and rivers, is one of the main benefits that agroforestry plantings can help with, especially when combined with fencing to keep livestock away from riverbanks. After planting native species and limiting livestock access to the river on his property, participant 3 noticed something interesting: “But certainly we're confident now that

those streams are fenced off from livestock and the main issue is livestock having unfettered access to the streams. So they now are either watered off water troughs in the paddock or we've restricted them to very narrow 20 meter areas of a stream that's got a gravel bed where they can't do too much damage to the banks. And interestingly, when you watch how herd animals behave, they have a pecking order. So you'll find that when they've got unfettered access to the streams, they'll go and stand in it. There's no pressure from their peers from behind to move out. Whereas now the pecking order is that the cattle will come in and drink from that stream from that restricted area, and as soon as they finish, they'll move out because their peers are coming in behind them.” Reverting the area around the stream to a more natural habitat with only small access points for cattle, similar to how there are often small openings to streams surrounded by thick vegetation, completely changed their behavior, making them act as if they were wild in their natural environment. This change with the implementation of riparian agroforestry and fencing not only improved water quality and turbidity, but it still allowed cattle to access the stream instead of completely fencing them off.

**Increase biodiversity:**

All participants cared about biodiversity, with 33 mentions of the subject throughout the interviews (Table 1). Biodiversity is important for ecosystem health, as high biodiversity keeps systems balanced with different species supplying different ecosystem services (Cardinale et al., 2012). Industrial agriculture often consists of monocrop growing systems which greatly reduces the native biodiversity that was once present, forcing farmers to use chemical pesticides and fertilizers that would have been supplied by different species such as predatory insects killing pests and mammals supplying fertilizer through their waste products. Using agroforestry



practices on farms is a reliable way to bring biodiversity back to agricultural landscapes (Bhagwat et al., 2008, Jose 2012, Torralba et al., 2016, Thrupp 2000), and many farmers are starting to see the benefits of biodiversity on their farms. Farmers are often scrutinized for not supporting the native biodiversity on their farms, yet they can still care deeply for the natural environment while growing crops the way they have been taught. Participant 2 notes, “But I just think we’re meant to live in harmony with the land around us, and I think the farmers get a bad rap for just very much being a monoculture on their properties. And I think the majority of farmers I know are respectful of the land around and working within the landscape because it’s all part of keeping your land healthy.” Participant 2 knows that keeping the land healthy is not only beneficial for the biodiversity around the farm, but it can actually help her farm where she raises sheep and oysters.

Participant 3 also finds significant value in biodiversity when he says, “There’s a benefit of a good biodiversity within your farm just to help out with pests, disease management, things like that. Particularly, you know, if you’ve got the predators there living happily, and you have a problem, they’ll take care of it. [...] There’s an intrinsic value of just feeling good about the fact that you’re not raping and pillaging the landscape.” Participant 3 has directly observed biodiversity helping his farm, and he even mentioned earlier in the interview that he has bats living in the walls of his shed that eat the insect pests on his crops at night. As farmers start seeing biodiversity as an asset that can control pests and diseases while possibly diminishing the need for pesticides, more farmers will turn to agroforestry as a solution.

While there are some benefits to farms with higher biodiversity, there can also be some downsides. Participant 4 highlights some of the negative effects of biodiversity on his farm: “The value is, I suppose, that we are confident we’ve still got a population of all those native animals

that were here before white man turned up. But on the other side of the coin, if we're going to continue to produce food and fiber, then we do need to control them to a level that is acceptable for us to still run a viable agricultural enterprise. In Tasmania, our tourists go cack about the road kill, but that's because there are just so many millions of little demons that they can't help but get [...] run over on the road. The issue for us, I expect you know, is the damage they do to fences and crops. So it's a double edged sword for us. We like seeing them around, but we just need to keep them at a population level that was probably somewhere near what they were before we introduced highly nutritious pastures where their populations explode pretty well once they pop out of the bush and feed on improved pastures.” The issues of grazing pressure from wildlife can influence farms’ productivity, forcing people to control populations that start to get out of control due to increased food availability for grazing animals. Controlling wild populations is often a necessity, yet multiple farmers noted that nothing is wasted with wild meat often going to the freezers of farmers to eat or for pet consumption. Increasing biodiversity on agricultural lands has its upsides and downsides, but the benefits to the surrounding ecosystems and to farms vastly outweigh the negative effects.

### **Help reach carbon neutrality and climate change security:**

For farmers, reaching carbon neutrality and keeping their farms secure in changing climates will only become more important in the future, as they mentioned the subject 21 times (Table 1). Governments around the world are starting to require farms to be carbon neutral or carbon negative, and farmers can also sell their products to consumers at a higher price if they can market it as coming from a carbon negative farm. Participant 2 states, “Because now, of course, a lot of farmers need to be able to have carbon neutral properties in order to get the best

price for their land and their beef, and even their milk going forward, and so to do that, trees are part of the solution, not the only part, because obviously soil is a massive area to work on, but it's a big part.” This can be a large incentive for farmers to start planting more trees on their farms, as planting would allow them to become carbon neutral or negative with the proper calculations and management of trees.

Climate change will most likely affect most sectors of the economy in various ways, yet farmers are possibly the most at risk to climate change due to their livelihoods directly relying on stable climates that their crops can thrive in (Karki et al., 2019). Agroforestry can help protect farms from changing climates and ever harsher environments. Participant 1 comments, “And I think agroforestry, particularly when we talk about trees with the potential to harvest the timber, the diversification of income, but also those multiple benefits from livestock protection, wind protection, when you've got this changing climate, you know, creating that microclimate on soils and being able to have longer grass production, you know, reducing land mortality rates in the ever changing weather that we're getting. I think it is so important.” These ecosystem services can help protect crops and livestock in variable conditions, and harvesting timber can give farmers supplementary income if their main crops start to fail due to changing climates.

**Provide income diversification and security:**

With 14 mentions from participants (Table 1), agroforestry providing income diversity and security to farmers was one of the main reasons why farmers are starting to plant trees. Unlike annual crops or livestock that must be harvested at a set time, timber trees can be left in the ground indefinitely to be harvested whenever needed, with their value only increasing over time. When crops fail or markets crash, farmers can harvest their timber to sell. There will

always be a market for timber, as it is a sustainable and reliable building material that can be used to make a variety of products. Participant 4 comments on how the monetary bank of timber helped him in tough economic times, “Back in the mid 70s, when our livestock prices crashed and I was highly geared, we had a large mortgage on the property. The only thing that stopped the banks foreclosing on me was the fact that they knew that I had a timber resource sitting here, that if I'd have defaulted on any of the repayments due to the banks, then they would have demanded that I sell that timber resource, which would have most likely got us out of trouble. But I worked pretty hard not to have that happen because I didn't want someone else dictating to me when I could and couldn't sell the timber.” Without this timber resource on his farm, banks most likely would have taken possession of his property if he missed payments as they did to many other farmers at the time without timber resources.

When asked about what they think the future holds for agroforestry and agriculture, participant 2 responded with, “I hope our property's in our family for generations to come. In farms, you have to work out how to parse out your land and so an important part of that is working out, like we got two children, so someone gets the land and someone else gets a heap of money. A good way to do that is plant trees, so when you harvest trees that money goes to the other child. You know, farms can't be chopped in half, farms have to stay whole. So a really really important part of farming is succession planting.” Planting trees is a long term investment, and often timber may not be harvested in the lifetime of the farmer who put the tree in the ground. Participant 3 says, “And now we've just finished planting some Californian redwoods along a creek bed, which they'll be there for 100 years. If the property is still in our family, eventually my great grandchildren may get to selectively harvest one or two out of there, but it'll be a riparian reserve, which means that it's basically there to protect the water quality.” This

farmer is thinking two generations ahead, and we have to start thinking about future generations if we want to have a sustainable future. If we only harvested timber from native forests without replanting, our children and grandchildren would have very little timber to harvest and may have to shift towards using more unsustainable building materials such as cement and steel.

Participant 6 discussed another benefit to planting trees for timber harvesting, “Plantation timber is really making the most of the hardy country. Pines do very well on some of these rockier banks and some of the country that's too hard to manage properly with livestock intensively. So we've sowed pines in them which will likely add a financial benefit to that country that's not worth as much.” This has allowed participant 6 to utilize harsher environments that he can't use for livestock or crops, and transform these areas into profitable land that will also provide ecosystem services to the surrounding environment.

### **Improve aesthetics / mental health:**

Participants mentioned improvements to aesthetics and/or mental health due to agroforestry 16 times throughout the interviews (Table 1), and it was often the first thing they brought up when discussing their trees. The addition of actively growing biodiverse forests to otherwise flat farmlands helps give structure to the landscape, and this makes the land more enjoyable to be in. Participant 6 notes, “Certainly as we've split up paddocks, we've fenced off bushland and the aesthetics look a lot better with the bush. The areas of older bush are regenerating now instead of all the trees just dying out. [...] It's nice to be able to fence off, have trees along boundaries, to not see areas you don't want or things you don't want. But they are used well for security and privacy.” Adding these trees not only helps with basic aesthetics, but can help bring in biodiverse nature for the enjoyment of people living or working on the lands.

Experiences with nature improve the mental health of people in multiple ways (Bratman et al., 2019), and participant 5 agrees that nature is enjoyable to be around by saying, “(Biodiversity) does a lot of things for us as far as stabilizing ecosystems, controlling pests, and I guess the enjoyment value of [...] nature and the enjoyment from the experience of being able to observe it kind of readily and widely distributed.” Humans used to be part of and around nature all the time, and making this reconnection can be beneficial to our health.

### **Challenges farmers face with agroforestry, or problems not solved by agroforestry**

#### **Persisting problems with food / agriculture system:**

Various problems with our current food and agricultural systems were mentioned 37 times (Table 1), making it the second most abundant theme after the ecosystem services that agroforestry provides. As outlined in the introduction, there are many problems with our modern industrial agriculture practices including the mass use of synthetic fertilizers, chemical pesticides, tillage, monocultural production, and factory farming to name a few (Gordon et al., 2021). Participant 7 highlights an interesting point about our food and agriculture system that must be solved in the future, “Well I think the main issue with expanding population is probably more food wastage. I think we're already producing a lot of food that we don't actually use and some of that is driven by consumer demand as in quality. So I don't think we need to produce a lot more. We just have to be a bit cleverer in the way that we use what we grow. [...] It's just a massive issue. Yeah. But not only at farm level, and also I mean at the consumer level, the amount of food the people throw out.” A study on food waste in the EU found that cereals, fruit, and vegetables were the food groups accounting for the highest amount of food waste, with the consumer level being responsible for the largest amount of food waste in most food groups

(Caldeira et al., 2019). Globally on average, 65kg of food per year is wasted by a single person, with high-income countries wasting six times more food by weight than low-income countries (Chen et al., 2020). On average, a person's daily food waste equates to environmental footprints of 124 g CO<sub>2</sub>, 58 liters of freshwater, and 0.36 m<sup>2</sup> of cropland use (Chen et al., 2020). There have been various strategies suggested to utilize food waste, one example being insect based bioconversions of food waste into valuable products including human food, animal feed, fertilizer, and other secondary industrial compounds (Ojha et al., 2020).

Participant 6 brings up another problem that our agricultural system faces: "The cities will have to start going up instead of out. A lot of towns are in some of the best agricultural areas there are. Obviously that's where they first started building their colonies near some of the best agricultural land, so as the urban sprawl kids go out, they're just taking over good cropping land." After bringing up the same point, participant 3 says, "And all of a sudden that food production is getting pushed further and further and into less viable areas that require more transportation. So, yeah, we're pretty good at making mistakes that come back to bite us in the ass pretty hard in the next 10 to 15, 20 years." People often settled in the most productive areas with the best soil, because these places would produce the most food. As an increasing number of people moved to these areas, they got converted first from productive native habitat, to farmland, and finally to urban cities where food is no longer produced. This has taken many of the best agricultural lands out of production and forced food to be produced away from where people live, causing the need for food to be shipped around the world into urban centers where people live as highlighted by participant 3. Earlier in the interview, participant 6 talks about how strange some of our food system practices seem, "A lot of our food is produced here in Tassie and then shipped straight to the mainland and then sorted and packed and then sent back to

Tasmania. Which seems ridiculous, but it obviously comes down to labor and efficiency and costs.” Food miles, or the distance food travels before reaching the consumer, contribute large amounts of GHG emissions due to shipping, and focussing on more regionalized agricultural systems could reduce these food mile emissions (Pradhan et al.,). This would require large changes to both the producer and consumer side of food production including closing yield gaps, reducing food waste, shifting toward diversified agriculture, and consuming produce that is in season (Pradhan et al., 2020).

Participant 5 discusses why we don't see more of this regional local agriculture happening, “So there's some crops, say, citrus, we don't see growing in Tasmania. Are there parts of Tasmania where the climate is probably suitable for growing citrus? Yes, but the supply chain is bringing it down from other parts of Australia down to here. And so you don't typically see citrus crops. Whereas I'm sure there could be. [...] I guess one of the problems is the big supermarkets requiring national suppliers. And so if somebody wanted to set up a mixed food kind of agriculture farm in Tasmania for citrus, say growing oranges, somewhere the climate is suitable, if they don't have access to somewhere like the big supermarkets, then they don't have a market to sell their produce to. And so that's why I guess the market is biased towards the large producing regions rather than being diversified.” If supermarkets were to have incentives to buy produce from local suppliers, then there may be an increase in local diversified farms, but without that incentive, we are stuck in a system that focuses on only large scale production along with global shipping.

Our current system is also quite fragile, as it relies on shipping large quantities of food from one part of the world to another. Circumstances such as war or a global pandemic such as Covid-19 can easily disrupt these systems, leading to food shortages around the world. Multiple



participants discussed this issue of food security. Participant 4 commented, “Well, I guess if there's a serious conflict in the world and our shipping lanes get disrupted, then we're in trouble. Yeah, that does concern me. But in Australia, if we couldn't export most of our agricultural commodities, we'd be in trouble anyway because we'd just flood the market here. We're only less than 30 million people and we produce enough food for many millions more than that.” While running out of food would be a problem in many parts of the world, participant 4 highlights the problem of having too much food, as in the case of Australia. This would lead to farmers not getting compensated for the valuable products they have produced, as well as a large spike in food waste as there are not enough people in Australia to eat the amount of food that is produced locally in the country. There are many other problems with our current food and agriculture systems, but these are just a few main topics brought up while conducting interviews. While agroforestry may help alleviate some of these issues, it is not the only answer, as highlighted by participant 1: “But I definitely don't think [agroforestry is] the solution to some of the industrial issues on farming. I think a lot of those issues on farming actually need to be resolved on a farm level. Trees aren't going to be the answer to a lot of it. A lot of it needs to be reducing emissions, looking at alternative energy sources, removing stock, a lot of it [consists] of operational issues.” If our world wants to have a food secure and sustainable future, many changes, both at the producer and consumer levels, will need to be changed.

**Establishment / fencing problems:**

With 15 mentions in interviews, fencing and tree establishment seem to be the biggest hurdle to jump when implementing an agroforestry plot (Table 1). Firstly, fencing can cost a lot, and is often the biggest expense when planting trees. Participant 2 says, “We spent \$70,000 on

fences. It's a massive, massive amount of money, and that's before we put anything in the ground. [...] Fencing is everything. [...] The fencing is way more than the trees, way more than the planting to do that. [...] And when our farm burnt, we lost 50 kilometers of fencing. That all had to be put back, and where we put in our trees, it was along one fence line anyway. So we didn't fence up the whole stuff for \$70,000, we fenced off one side." Spending \$70,000 on fencing may seem like a lot, but without fencing, there is a high chance that trees will not survive due to browsing wildlife or livestock. Participant 4 says, "If you've got high native animals, it's really hard to get your vegetation on your tree plantings established because the little monkeys love to eat it. We put 5,000 blackwoods in many years ago, and hardly any of them survived because of the damage from possum and wallaby." Grazing wildlife can be harmful to crops and pasture as discussed earlier, but they can also make tree establishment near impossible without fencing.

Sometimes, problems with tree establishment can be out of the farmer's hands, even if fences are built and trees are protected. Participant 6 talks about his problems with establishing his trees: "We had a bad year last year. We planted about 15 hectares of native trees and we lost about 13 hectares to flood, it all just went under and we lost all the tree guards and they got spread out across the farm. That was just a bad year of bad timing, which has put a damper on it. [...] I'm not sure if it was a wet year, but we resowed and probably 90% of the plants we resowed died out again. And we've tested them and whatnot, but no one's taken ownership of why it happened. It's got to be a real reason why it happened, we replanted them at the right time. Well, wildlife play a big issue in survival. But we had that under control." Environmental factors such as flooding or droughts can kill off young trees, and trees can even die from unknown causes on a large scale, making farmers spend money and time just to end in failure. More reliable ways of

tree establishment would help farmers trying to start agroforestry on their farms, and subsidies for fencing could also help farmers get over the expensive hump that large scale fencing causes.

### **Requirement to log native forests:**

While many people around the world believe that the logging of native forests should be stopped at all costs, people involved in the forestry and timber industry know that there can actually be benefits in selectively logging forests while helping meet the world's large requirement for timber. Throughout the interviews, participants mentioned the need for the logging of native forests 7 times, helping illustrate the value in this practice (Table 1). When asked if agroforestry could help take pressure away from logging of native forests, participant 1 said, "So I don't think our timber supply could solely come from farmers, but I think it has the potential to help with meeting our demand because quite simply the industrial plantation scale, that's not going to continue to expand in Australia on a large scale because the land prices are too high. As much as people don't like native forest logging, it's amazing the amount of products that are made from native forest, in particular in Tassie. [People think] it's okay to wipe that market out, but we're going to have to obviously find some [where] that solution is going to come from with these select products, and I think farmers could be an integral part of that." Participant 1 works for Private Forests Tasmania, a company that supplies people with tree seedlings and helps with implementation of new agroforestry plots, and she still sees the value of logging native forests. Agroforestry is not yet on the scale that our timber needs can solely be supplied from farms, but this participant notes that in the future, some of these forest products could come from agricultural lands.

Aside from supplying much needed timber, selective logging operations have the potential to benefit the health of the forest. Participant 4 notes, “Well, the last time, many years ago, we measured the native forests in Tasmania. We were growing 10,000 tons of wood fiber every 24 hours. Now that's the merchantable part of the trees, if you just leave that untouched, then at some point you're going to have a catastrophic fire. Those of us that manage our native forests for timber production, we would argue that we lessen the risk of fire because we're removing a certain amount of biomass and making sure that our logging roads are open and our trash is dealt with.” Removing the buildup of biomass may reduce the risk of fire, but there is still debate on how logging influences disturbance regimes as it may even increase the frequency and severity of fires (Linenmayer et al., 2020). Salvage logging, or the act of removing timber after wildfires, also does not necessarily reduce the risk of disturbance in the future, and may even increase fire likelihood and magnitude (Leverkus et al., 2021). Participant 4 also had thoughts about the environmental friendliness of logging: “The most sensible thing we can do is manage our native forests. [...] We run native forest. Some is reserved, some is managed for production, and we've got our plantation. And if you want me to make a comment about which is most environmentally friendly, I would say that managing our native forest is more environmentally friendly than plantations. But [...] those that would have us get out of native forest logging won't agree with us. I mean, we've had field days here where we've had conservationists with us, and they certainly don't like the arguments that we put up.” When choosing to allocate land to native forest or single species timber plantations dedicated to logging, allowing biodiverse native forest to grow naturally can help support a much larger number of species while also growing timber for logging. Timber plantations, often planted in monocultures, support a much lower diversity of species and do not provide as many ecosystem

services as native forests, making participant 4 think it is more environmentally friendly to manage native forests than allocate more land to timber plantations.

Participant 3 sees a problem with how Tasmania is currently managing their native forests: “To be honest with you, the biggest problem with Tasmanian forestry is we've reserved too much area and so we can't spread the rotation around a bigger area. We could go from 80 year to 120, 130 year rotation of native forest logging really easily if we hadn't locked so much of it up and taken it out of production.” Protecting areas of forest is important for allowing ecosystems to thrive without human interference, yet if too much forest is protected, the smaller, unprotected pockets of forest have large amounts of pressure put on them due to large timber requirements that they may not be able to sustain. Participant 3 explains how if less forest is locked away from logging, the entire ecosystem as a whole may be healthier as unprotected forests will not be logged as often.

### **Future opportunities positively relating to agroforestry**

#### **Research that would promote / improve agroforestry:**

Participants brought up future areas for agroforestry study 36 times, making it the 3rd most frequent category (Table 1). Agroforestry research is still in its infancy, with the majority of papers mentioning agroforestry being published in the last few years. To prove the benefits of agroforestry with sufficient data to help more farmers implement agroforestry practices on their farms, more research must be carried out in the future. Participant 8, the head of the Perennial Prosperity research team, says, “I think we're just scratching the surface. I think we need to, at this stage, get a better handle on the understanding of the biophysical system at the farm scale. That's why we need to go a lot deeper into each of the different natural capital benefits. We need

to work out where, when, [...] and what trees on farms can improve the triple bottom line of the environment, the economy and society. And we need to bring people along for the journey and come up with the solution. We need to bring farmers and the rest of society along with it.” As the leader of the Perennial Prosperity team, participant 8 is already helping run specific projects looking at the benefits of biodiversity, shelter, pollination, as well as the sociocultural benefits of agroforestry, and now he thinks it will be important to research agroforestry at the broader scale of benefiting the environment, the economy, and society. More studies along with Perennial Prosperity will be needed to prove the benefits of agroforestry, and once these benefits are proven, broader scale studies can be conducted.

Tree establishment is often a large problem during agroforestry operations, and future research could help find more reliable ways to help trees thrive after planting. One way to help establishment would be to research which species are best adapted to certain microclimates. When asked what aspects of agroforestry are most important to research, participant 5 said, “Probably climate adapted species and forecasting. I’m certainly seeing lots of farms where they put trees in that have died because they’ve been too dry, that died off because they’ve been too wet, and so that’s probably a pretty substantial investment for land owners to put in trees. And so any assistance there in the form of research would be a benefit.” Participant 5, an agroforestry researcher, showed me the CSIRO plant nursery located at the University of Tasmania, where scientists are experimenting with native Tasmanian trees to find new varieties that are better adapted to certain climates. If more climate, disease, and pest resilient varieties are identified, these new varieties can be cloned through propagating cuttings, and these genetic clones can be implemented onto farms where they may have a better chance of surviving than other varieties of the same species.



CSIRO - Sandy Bay Site Experimental Tree Nursery

While finding climate adapted species is important before implementation, planning how and where to plant species in conjunction with one another is also an important step to helping with establishment. Participant 2 notes, “I wish that when we planted our black woods, we had planted a blue gum on either side to force them up. I’ve heard since we planted them that that is a more effective way of growing black woods, which we didn't know at the time.” Blackwood (*Acacia melanoxylon*) is a nitrogen fixing tree, so mixing this species with other trees such as blue gum can support the ecosystem by supplying valuable nitrogen to the soil, helping the blue gums grow more rapidly. Researching planting consortiums such as this can help make tree establishment more successful, as diversified systems are often more resilient than single species plantings. At Zaytuna Farm, a permaculture farm I visited located in NSW, they focus on agroforestry systems with highly diversified food producing species. In the image below, a diverse system of coffee (understory), guava (mid canopy), citrus (mid canopy), annona (mid-high canopy), nitrogen fixing species (mid-high canopy), and pine (emergent) can all be



observed growing together. Participant 9, a worker at Zaytuna farm, says, “You can occupy all the niches. In the land, you can fill all the gaps. [...] Not only timber, because you can create a forest with different layers. In the understory, you can plant cardamom or ginger or tumeric. And the timber is growing up.” While most agroforestry plantings currently only focus on a single target timber species, there are many opportunities to fill niches, making plantings more diverse and resilient while supplying other forms of income. In 2022 (1 year before the image was taken), massive floods occurred in this area near Lismore, NSW, and these systems survived with little damage due to diverse root systems of trees and bamboo, and the use of 26 dams connected by swales to divert water to desired areas. This also helps Zaytuna farm stay water secure in times of drought. If this was planted in a monoculture of any of these species, the system most likely would not have survived the recent floods. Planting food producing trees also allows for another source of income, as fruits, nuts, and other products such as coffee can be sold before the



timber is ready for harvest.

This farm looks very different from some of the other farms I visited that focus on certain enterprises and have agroforestry plots planted to provide timber and ecosystem services to help the rest of their business. The images below depict two monoculture tree plantings on two different farms, and the differences to the diverse planting above are obvious.

Zaytuna Farm, NSW, “Food Forest” Agroforestry system.





Tasmanian farms with young agroforestry plantings.

While these plantings are younger than the one depicted at Zaytuna farm, they are distinctly different in multiple key ways including regular spacing and single species. The single species and regular spacing are made to make logging easier at a later time, yet it does not utilize the land as extensively as a native forest which fills many more ecological roles than a single species can fill. The Zaytuna Farm planting looks much more like the native forest shown surrounding the timber plantation on the right, as it models its methods off of native forest growth to provide the maximum amount of ecosystem services to the land. I visited these sites with a Perennial Prosperity research member to take data of survival and pollination rates, helping track the progress of these sites through time. This can allow researchers to compare the data of different sites to figure out what leads to the most successful plantings, and it may be confirmed in the future that plots planted with multiple species have stronger survival rates than monocultural plots.

Aside from species selection, further research in practices used for tree establishment could help farmers find more efficient and sustainable ways to ensure tree survival. Participant 1

highlights a problem with tree establishment, “often the site prep and some of the things that occurred I don't really agree with, like often, it's the weed control that has to be done because grass competes with the trees. I get that, but the moment that they do [chemical herbicide] weed control, like all of our sites, if you were to go and visit them, because it's had bare soil, all that's there is weeds. So I'd love to see some alternatives done. Like I know in the UK and that they'll put clover seed out, for example, on mounds, and obviously clover's a legume. So yes, it will compete with the trees initially, but it's going to fix nitrogen and it's going to help trees long term. We just don't do anything like that. So I do see a gap there for finding sustainable ways to establish trees that are trying to create more biodiversity, environmental outcomes where we're not actually degrading the environment to actually get there, which I'd say to a certain degree is what we do now.” If future research can find ways to establish trees without the widespread use of chemical herbicides to keep weed pressure down, costs and labor of spraying could be avoided and harsh chemicals would not no longer need to be released into the surrounding environment. Participant 2 brings up another problem she had with establishing trees on her farm: “There were issues in planting to do with fertilizer put in with the plants that burnt the roots, just technical issues like that.” Nitrogen fixing ground covers as suggested by participant 1 could help mitigate the need for chemical fertilizers as well, and researching the proper amounts of fertilizer young trees need can also help with tree establishment in the future.

Participant 1 also brings up the problem of small scale harvesting, “We often have issues around small-scale harvesting. And a lot of work's been done on how you can do small scale harvesting, but it's quite frankly just not happening.” Participant 5 also brings up this issue, and research into small-scale timber harvesting can help convince more farmers to plant trees on their properties, even if it is not on the massive scale that timber harvesting currently happens at to

make harvesting profitable. After timber is harvested, there are many uses for wood of different qualities including saw wood (high quality timber) or wood fiber or chips (low quality timber), yet there are many other uses for wood that need to be researched further. Participant 3 says, “So I think there's a lot of opportunities in regenerative and renewable products that we produce on farm, particularly timber products. I went and saw a presentation on circular economy and stuff based on wood fiber and the hell of a lot of products that we can get out of that, but it just seems sort of like we've been talking about it for a long time and it just doesn't seem to want to get over that next level.” Participant 3 sees the future value in wood products, but future research will reveal new ways to use wood that will only increase the value and need for timber.

Another important area of future study is in the natural capital and carbon accounting sectors, as there are currently many problems with these calculations. Participant 4 highlights some problems he has encountered with the carbon accounting done on his farm “So I think any further work that we can do on shaking some of the gremlins out of the software programs that we've got now for measuring a farm's emissions profile and practical things that we can do to mitigate that would be useful. [...] The difficult thing is to get all this stuff to a point where it's based on the science, and it's not being unfairly influenced by the politics. [...] When the last audit came back, none of my plantations were included in the audit, because when I spoke to the auditor, I said, you haven't included our softwood and hardwood plantations. And she said, no, there wasn't a box for me to enter anything for that. So that gave us a distorted outcome as well.” Reliable software programs to help calculate a farm's carbon balance will surely emerge in the future, but further research will be the only way to ensure the accuracy of these programs. Inaccuracies in natural capital accounting (NCA) is another current problem that faces farmers, and the Perennial Prosperity team is currently researching further into how to make NCA more

reliable. They also conducted a study in 2022 in attempt to promote discussion and reflection about how NCA can help farmers find value in their land with natural resources such as soil, vegetation, animals, water, and biodiversity (Fleming et al., 2022).

### **Solutions to agricultural problems presented by local agriculture:**

Many of the participants had thoughts about local agriculture and how it could help some of the problems that plague our modern agricultural systems, with the subject getting brought up 17 times (Table 1). When asked if it would be feasible for most of the food people eat to be produced locally, overwhelming, the participants responded yes in the case of Tasmania. Participant 7 says, “I think in somewhere like Tasmania, I'd say yes, because I think we can grow enough different things here that you could live on. It would be seasonal, but that doesn't necessarily hurt. You know, you don't have to eat asparagus 12 months of the year.” Many of the participants brought up this idea of shifting towards eating seasonal food, and how a large shift in consumer habits would be necessary to produce enough food locally for the population. Participant 5 discussed the idea of how it makes more sense to import certain products such as bananas which are often shipped from North Queensland down to Tasmania, and how rice is much easier to produce in certain climates such as in Southeast Asia with the soils in Australia often not being suitable for rice growing. Participant 8 had a similar idea of agreeing that food should be produced where it grows best which doesn't always mean local, but he brought up food security concerns for relying only on importing food, “I think food security is a big one, and I do agree with the concept of globalization and producing things where they're best produced. But also, food security is pretty important. If global supply chains are reduced somehow, then we need to be able to maintain production of both food and fuel locally. I think Australia would be

okay. But there are lots of countries in the world that are food insecure and rely on imports, so you would see a lot of global tensions emerging if those global supply chains are cut, or you know, reduced.” This food security concept is key, as producing food locally allows places to be much more food secure without only relying on imports.

Participant 1 brought up some economic benefits that come along with producing food on a local level, “And if you're producing food locally, you're going to have a local shop, it's a local delivery person. You know, I think even the employment and the amount of cash flow that would occur throughout the whole Australian economy would be better.” Just as supporting local businesses helps the local economy, local farms could help boost the economy in a similar way and keep money from leaving a community. Participant 6, a large scale farmer, agrees, “There are plenty of benefits in local [food systems]. You've got less competition. [...] If you can sell local and sell your story, you can make more money and, obviously, the smaller the farm, you can concentrate more on your product.” Participant 6 sees the economic benefits of being able to connect to consumers, as this is much harder to do when exporting to different countries.

Participant 3 also thinks producing food locally is a good idea, but he has gotten resistance from his peers, “Tasmania could feed two and a half million people, so why isn't our population two and a half million? But none of the other people in Tassie think that's a good idea, they reckon that's a bit too many people. But, you know, that's one way to look at it, the way you are to move the food to the people or the people, to the food.” This idea of moving the people to the food is quite smart if we can live in ways that still allow us to produce food. As mentioned earlier, we have moved the people to the food before, as most urban areas are built on high quality soils that used to produce food, but our living habits have made it near impossible to produce large

amounts of food where cities are located. To produce food locally on a global level, not just in Tasmania, we would have to change our life habits in multiple ways.

### **Incentives for agroforestry implementation:**

Participants mentioned various strategies that would help push farmers to implement agroforestry on their land, with participants mentioning the topic 14 times (Table 1). The most popular agroforestry incentives that participants thought would help push other farmers in the right direction were monetary grants from the government and data showing the positive effects of agroforestry on farms. Multiple participants explained how even if grants may not pay for the whole planting, it helps push farmers over the hump of deciding whether or not to plant trees. The data incentive is obvious, and it will only take time for more data to be collected and more studies to be published to prove the benefits agroforestry can have on farms in terms of providing ecosystem services and diversifying incomes through timber harvesting. Another popular incentive mentioned was the goals or future requirements to reach carbon neutrality.

When asked what will convince other farmers to implement agroforestry, participant 1 said, “I think farmers are going to be convinced from farmers. I think the more that we can help educate, [...] essentially I think that will be the best outcome once farmers get the knowledge themselves. And then they start talking to neighbors and then going to the pubs and talking to other farmers about the trees they're implementing. [...] It's not coming from foresters, it's not coming from scientists, it's not coming from consultants, it's coming from other farmers who are saying, ‘here's the benefits I'm having on my farm. Have you looked into it?’” This is an interesting thought, as it relies on the word of mouth spread of ideas that can grow exponentially to help convince more farmers to plant trees. Participant 8 reveals his strategies for trying to give

farmers the incentive for agroforestry, “As well as trying to convince farmers, we've be trying to convince the whole value chain from banks and land valuers through to the end consumer of agricultural products that trees, if they're done right, make a difference to the farming enterprise, and they bring public benefits as well as private benefits.” This idea of trying to convince not only farmers but the entire value chain is smart, because it can start to put pressure on farms from many angles at once to plant trees. This strategy seems like it will be successful in helping entire communities realize the value in trees on farms.

**Conclusion:**

Agroforestry is a method of integrating trees into farms that can help provide ecosystem services such as erosion control, shelter, increase crop and pasture productivity, and increase biodiversity, provide a diversification of income, help reach carbon neutrality, give farms security in changing climates, and improve farm aesthetics. Farmers are slowly waking up to the importance of planting trees on farms, and perceptions seem positive for the future of agroforestry. After conducting and analyzing 8 interviews in Tasmania and 1 interview in NSW, Australia, the three main themes identified were benefits agroforestry provides to farmers and ecosystems (1), challenges farmers face with agroforestry or problems not solved by agroforestry (2), and future opportunities positively relating to agroforestry (3). Future research into the effects of agroforestry will be needed to confirm farmers' perceptions and help convince other farms to implement agroforestry. Farmers identified food security benefits to focusing on local food production, yet consumers would have to change behaviors to make large scale local food

production possible. Overall, farmers are happy with their decision to plant trees and believe there is a positive future for agroforestry on farms.

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Email Address: josh.lipp@mail.sit.edu

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