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Pathways

Agriculture

Demand tailwinds, risk-adjusted returns, and its in lation hedge characteristics | Originally published in March 2022

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Natural or environmental disasters, such as earthquakes, fires, floods, hurricanes, tsunamis, and other severe weather-related phenomena generally, and widespread disease, including pandemics and epidemics, have been and can be highly disruptive to economies and markets, adversely impacting individual companies, sectors, industries, markets, currencies, interest and inflation rates, credit ratings, investor sentiment, and other factors affecting the value of the Portfolio's investments. Given the increasing interdependence among global economies and markets, conditions in one country, market, or region are increasingly likely to adversely affect markets, issuers, and/or foreign exchange rates in other countries. These disruptions could prevent the Portfolio from executing advantageous investment decisions in a timely manner and could negatively impact the Portfolio's ability to achieve its investment objective. Any such event(s) could have a significant adverse impact on the value and risk profile of the Portfolio.

Gross domestic product is a measure of all goods and services produced by a nation in a year. It is a measure of economic activity.

The Bloomberg Global Aggregate Index provides a broad-based measure of the global investment grade fixed-rate debt markets.

Consumer Price Indices (CPIs) are a measure of inflation, representing changes in prices of all goods and services purchased for consumption by households.

The FAO Food Price Index (FFPI) is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices weighted by the average export shares of each of the groups over 2014-2016.

The MSCI World Index represents large- and mid-cap stocks across 23 developed market countries worldwide. The index covers approximately 85% of the free float-adjusted market capitalisation in each country.

The NCREIF Farmland Index is a quarterly time series composite return measure of investment performance of a large pool of individual farmland properties acquired in the private market for investment purposes only.

The S&P 500 Index measures the performance of 500 mostly large-cap stocks weighted by market value and is often used to represent performance of the US stock market.

The S&P US Treasury Bond Current 10-Year Index is a one-security index comprising the most recently issued 10-year US Treasury note or bond.

Index performance returns do not reflect any management fees, transaction costs, or expenses. Indices are unmanaged and one cannot invest directly in an index.

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Introduction: Meeting food demand while contributing to climate solutions

Agriculture as an investment has been growing in popularity in recent years. With the world's population set to increase by more than two billion people by 2050, and the climate challenge intensifying all the time, at a global level agriculture may have two important roles to play in the decades ahead. For food demand, not only will the world's population likely increase by more than 25 per cent over the next three decades but growth in real incomes, we conclude, will likely drive diets to become richer in high-quality proteins, a food source that requires more arable land for its production. According to the United Nations Food and Agriculture Organization (FAO), agriculture will need to produce almost 50 per cent[1] more output to meet demand by 2050.

At the same time, agriculture is set to play a vital role in helping the world reach net zero carbon emissions. To achieve decarbonisation targets, carbon sequestration – a process of atmospheric carbon dioxide removal – is likely to be required to offset unavoidable emissions. With the soil and vegetation being some of the Earth's largest carbon sinks, land-based carbon removal strategies will be a key piece in the climate solution puzzle. With about half[2] the world's habitable land used for agriculture, farm management practices that abate emissions and sequester carbon may offer considerable decarbonisation opportunities as well as generate another income stream in the form of carbon credits. This emerging dynamic has the potential to enhance farm incomes, add another layer to demand for farmland and, ultimately, support agricultural land values.

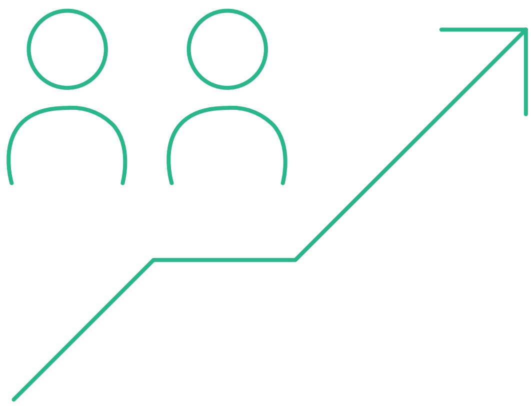
1. Compared to 2012, according to the FAO, "The future of food and agriculture: Trends and Challenges" (2017).
2. Our World in Data, FAO. https://ourworldindata.org/land-use

Historically, agriculture has delivered relatively strong and stable returns through the cycle and has exhibited a low correlation with other asset classes. Since 1991, Australian agriculture[3] has delivered an annualised return of 8.4 per cent, better than both global equities and bonds. At the same time, the stability of agriculture's returns has been similar to bonds. Our analysis shows that adding agriculture to a portfolio of global equities, bonds, and property could increase portfolio returns and lower the volatility of those returns. Moreover, amid growing inflationary pressures around the world, agriculture (courtesy of the composition of its revenue line) may be well positioned to act as an inflation hedge.

This note is split into four sections. In the first section, we examine the key trends, such as rising populations and increasing real incomes, that are driving the demand for, and supply of, agricultural land. The second section provides an overview of the decarbonisation opportunity and how nature-based solutions offer a sustainable way to manage farmlands, while also creating a new income stream for farm owners. In the third section, we undertake a comprehensive analysis of agriculture returns compared with those of other asset classes, including the calculation of risk-adjusted performance, correlations, the impact on a portfolio, and other topics. The fourth section examines how farmland performance has historically been related to inflation. We examine the link between food prices and inflation, how farmland values perform in high- and low-inflation environments, and we look back to the 1970s to see whether agriculture's performance did indeed improve during this historical period of high inflation.

3. Australian agriculture returns refer to large farmland where gross turnover exceeds $US1 million.

Demand and supply: Growing populations and rising real incomes are long-term tailwinds



Agriculture is an asset class supported by robust long-term fundamentals. Rising incomes drive demand for protein-rich foods and, consequently, the land they are grown on, while the supply of arable land per capita is declining. At the same time, decarbonisation policies are pushing for the wider deployment of biofuels, increasing demand for grains, oilseeds, and land. Sustainable, innovative solutions can help improve land productivity, strengthening land income generation potential. Altogether, these inexorable trends are expected to drive the value of farmland over the coming decades.

Demand for agricultural commodities can be broadly split into three categories: food, feed, and fuel. Global demand for food remains the main component for most agriculture, while feed and fuel use have experienced rapid growth rates in recent decades and remain essential for several commodities. In the paragraphs that follow, we examine each of these drivers in detail.

Demand driver no.1 – Food

The world's population is expected to reach 9.7 billion[4] in 2050, implying an increase in food demand from an additional two billion[5] people (Figure 1). At the same time, real incomes[6] are forecast to more than double[7] by 2050 (Figure 2). With rising incomes, human diets tend to shift towards both higher protein consumption and more expensive protein sources such as beef. Urbanisation, something that tends to increase with growth in incomes, accommodates this change in diet by providing access to a greater variety of food. Meeting this higher demand for livestock requires more grain and more productive land.

Figure 1:
Global population is expected to reach 9.7 billion people in 2050...

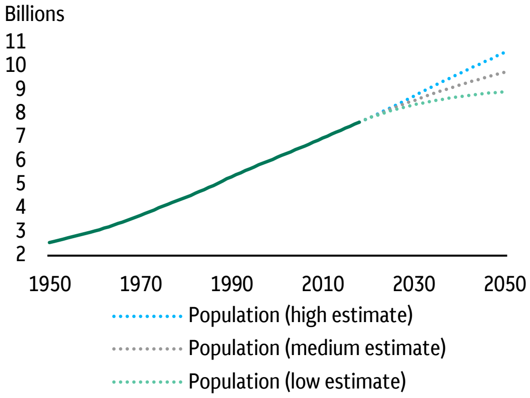
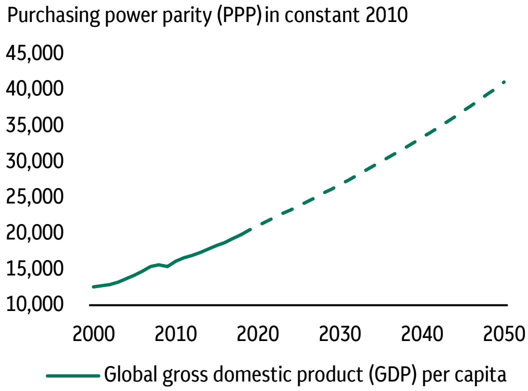


Figure 2:
...while real incomes are forecast to double by 2050

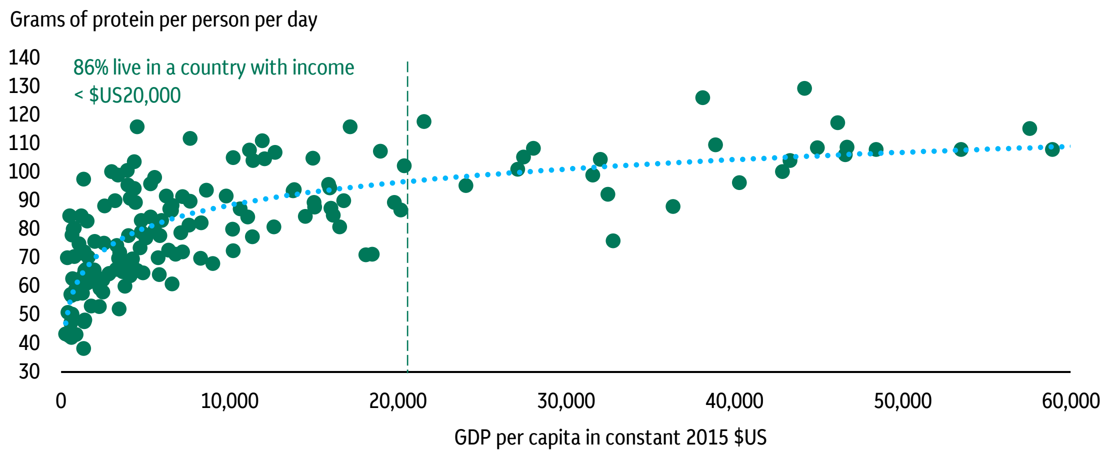


Sources: UN World Population Prospects (2019), Organisation for Economic Cooperation and Development (OECD) (2018).

4. Based on UN Population Projections (medium estimate).
5. Compared to 2019 estimates.
6. Real GDP per capital, PPP, constant 2010 $US prices.
7. OECD statistical database (2018).

Figure 3 depicts the relationship between protein consumption and income. On average, an increase of $US1,000 in an individual's income relates to an almost one-gram-per-day increase in protein consumption. However, this relationship is not linear but rather logarithmic: the rapid growth in protein demand occurs when per capita income is below $US20,000.[8] Currently 86 per cent of the world's population lives in countries with an average income level below $US20,000. Over the next three decades, the UN forecasts average real income growth in developing economies (3.2 per cent) to exceed average income growth in developed economies (1.3 per cent).[9] Put simply, as many of the world's most populous countries continue to catch up to developed-world living standards, the demand for protein receives a double-barrelled boost as these rapidly growing economies go through the period of development in which protein consumption is most sensitive to income growth.

Figure 3:
Protein consumption tends to increase with rising incomes



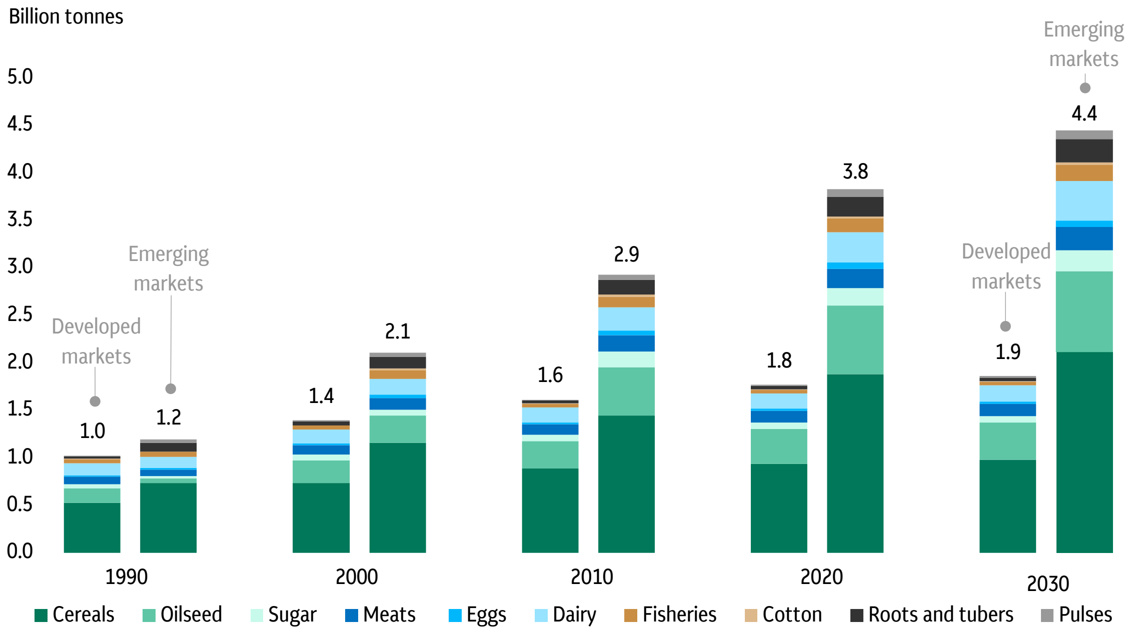
Sources: FAO, World Bank (2019). The data points for incomes higher than $US60,000 are consistent with the trendline.

8. Based on World Bank data, GDP per capita, constant 2015 $US.
9. Based on UN data, GDP per capita, constant 2012 $US.

Demand driver no.2 – Feed

As incomes improve and protein consumption increases, the demand for feed expands, which adds to demand for land. Global consumption of animal proteins (meat, dairy, eggs, and fish) is projected to increase by 17 per cent[10] by 2030 (Figure 4). The dynamics of feed demand, however, may differ across regions. Several low- and middle-income countries are forecast to experience strong growth in feed demand over the coming decade as their livestock sectors expand. By 2030, developing countries are expected to consume 22.5 per cent more animal protein than in 2021. This compares with about 6 per cent growth in animal protein consumption in developed countries. In the near to medium term, consumption of red meat per capita may gradually decline on the back of health and environmental concerns. However, this decline is likely to be offset by population growth, which is forecast to lead to an overall increase in red meat consumption.

Figure 4:
Emerging markets are driving growth in the consumption of major agricultural products



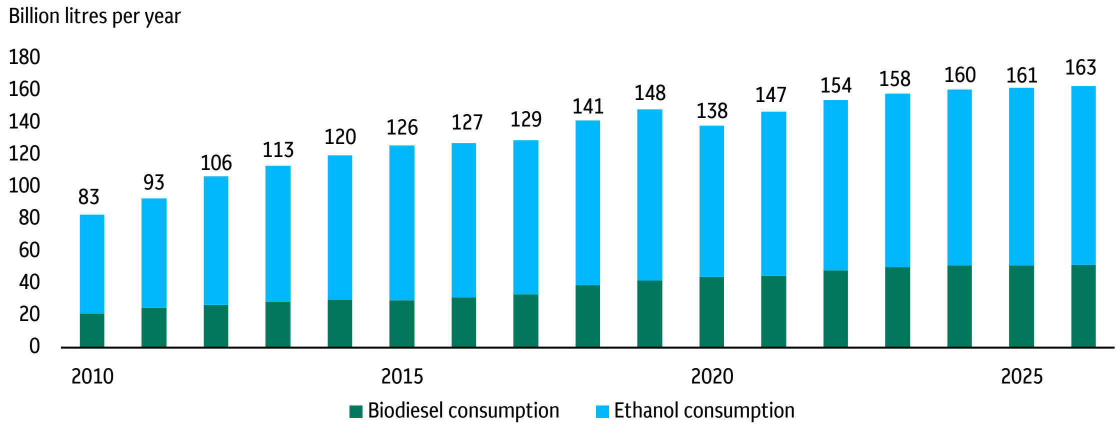
Source: OECD/FAO, "OECD-FAO Agricultural Outlook 2021-2030" (July 2021).

10. Compared to the base period average of 2018-2020. OECD/FAO, "OECD-FAO Agricultural Outlook 2021-2030" (July 2021).

Demand driver no.3 – Fuel

Decarbonising the transport sector is vital to combatting climate change, and biofuels from sustainable feedstocks are essential to reducing greenhouse gas (GHG) emissions, particularly in hard-to-electrify transport sectors[11] such as aviation, trucking, and shipping. Biofuels such as ethanol are made from the sugars found in grains such as corn, sorghum, and barley.[12] Most biofuels are currently consumed through blending with fossil fuels at low percentages (typically less than 10 per cent). We expect biofuel consumption to grow as an increasing number of governments have been considering, implementing, or strengthening policies that accelerate biofuel demand. For example, India has set a target of 20 per cent for ethanol blending by 2025, five years earlier than the original plan.[13] At the global level, this translates into a 9 per cent increase[14] in ethanol consumption and a 15 per cent increase[15] in biodiesel consumption, according to International Energy Agency (IEA) estimates (Figure 5). This growing need for biofuels will likely mean greater demand for grains, oilseeds and, by extension, land.

Figure 5:
Global biofuel consumption is expected to further drive demand for grains and land



Source: IEA (December 2021). Notes: Biodiesel and ethanol are the two most common biofuels in use.

11. For more details on the challenges of decarbonisation for transportation sector, see pages 20-24 of our recent paper, "Pathways – The path to net zero: The challenges and opportunities for real assets investors" (November 2021).
12. US Energy Information Administration, "Biofuels explained".
13. IEA, "Renewables 2021", Biofuels report extract (December 2021).
14. Compared to 2021.
15. Compared to 2021.

Supply: Downward pressure on arable land

While land demand is set to rise for the aforementioned reasons, the supply of arable land remains under pressure. Historically, urbanisation, pollution, and soil degradation from excessive tillage have contributed to limiting the amount of land available for agriculture. Since the mid-1980s the supply of arable land globally has barely increased in absolute terms (Figure 6), while on a per capita basis it has fallen by around 35 per cent (Figure 7).

Looking ahead, according to UN projections, arable land per person is expected to decline by around 37 per cent over the next 30 years (Figure 7). Sustainable farming practices are increasingly being used to counteract this trend. No-tilling policies that enrich the carbon content of the soil, and the use of different crop seed varieties to boost production with fewer inputs, play a crucial role in preserving arable land. Well-targeted investments in technology may also be crucial for improving agricultural productivity.

Figure 6:
Global arable land hasn't increased since the mid-1980s...

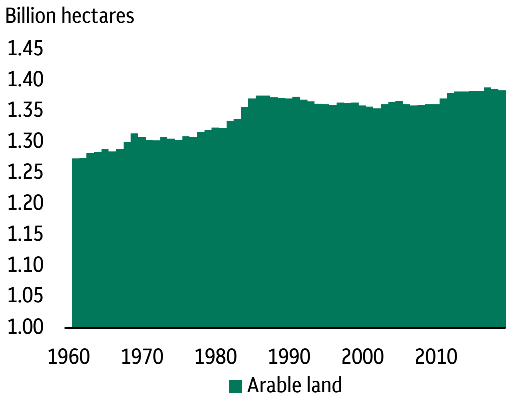
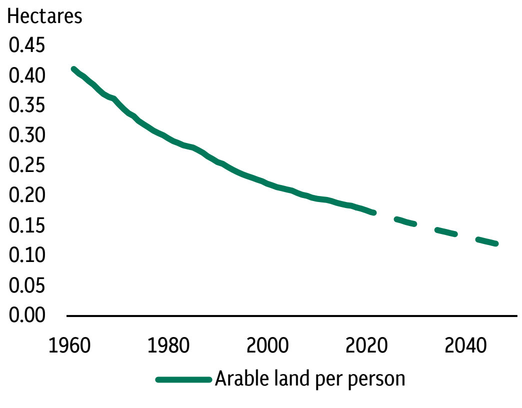


Figure 7:
...while arable land per capita is declining and expected to continue to do so



Sources: FAO; UN Department of Economic and Social Affairs, Population Dynamics (2018).

Productivity – A key driver of income gains over the long run

With arable land demand exceeding supply, this creates a strong incentive to improve farmland productivity. One way to measure agricultural productivity is by using total factor productivity (TFP).[16] Put simply, if total output is growing faster than total inputs, then the total productivity of the factors of production is increasing. In the decades prior to 1990, most agricultural output growth came from intensifying input use. Between 1960 and 1990 the increase in inputs accounted for an average of 55 per cent of the total agricultural output growth. However, since 1990, growth in TFP accounted for most of the growth in world agricultural output, with the largest increases in productivity observed in middle-income countries (Figures 8 and 9). Since 1990, growth in TFP has accounted for an average of 68 per cent of the total agricultural output growth (compared with just 24 per cent in the pre-1990 period), with growth in overall productivity for middle-income countries increasing from 0.7 per cent pre-1990 to 1.9 per cent in the period since then.[17]

Going forward, we expect technological solutions such as global positioning system (GPS) satellites and precision farming to continue to play a prominent role in boosting productivity and lowering GHG emissions. Overall, these factors should increase the value of farmland by supporting its income generating potential.

Figure 8:
TFP has become the main driver behind the agricultural output growth since 1990...

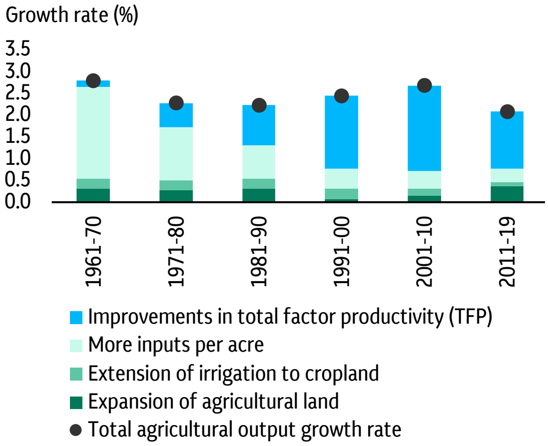
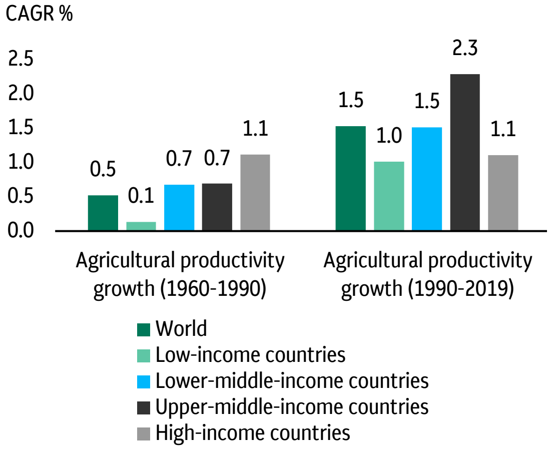


Figure 9:
...with the largest increases taking place in middle-income countries



Source: USDA Economic Research Service, International Agricultural Productivity data product (2021).

16. TFP measures the amount of agricultural output produced from the combined set of land, labour, capital, and material resources employed in farm production.
17. USDA Economic Research Service, International Agricultural Productivity data product (2021).

Nature-based solutions: Net zero increases demand for agricultural land

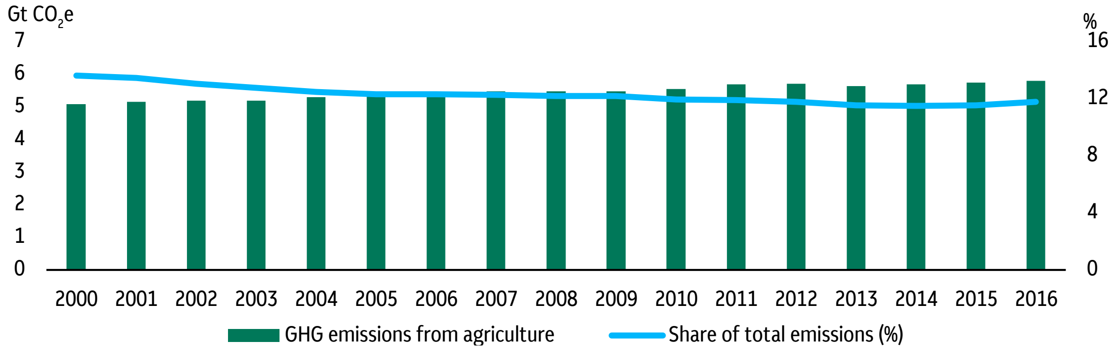
Agriculture is set to play a crucial role in the transition to a net zero carbon world. While reducing GHG emissions worldwide remains a key priority, removing carbon from the atmosphere is likely to be required to offset unavoidable emissions. The agriculture industry is well positioned to generate negative emissions through carbon sequestration, in addition to reducing direct emissions.

Nature-based solutions (NbS) offer a way to sustainably manage naturally occurring assets while generating social and economic benefits. This can enable farmers to offset difficult-to-remove emissions and create a new source of income in the form of carbon credits, supporting farms' medium-to-long-term value growth.

Agriculture – Strong emissions abatement potential

Agriculture is a contributor to climate change and generates about 12 per cent[18] of the world's total GHG emissions (Figure 10). That said, agriculture is different from other sectors in that it is very land-intense, and land has inherent carbon-absorbing potential that can enable the sector to be part of the solution to the climate challenge. In this sense it stands in stark contrast to the hard-to-abate sectors such as transportation (e.g. shipping, aviation) and heavy industry (e.g. steel, cement).[19] The term "nature-based solutions" is used to describe naturally occurring processes that work by either avoiding GHG emissions or removing carbon from the atmosphere. In this note, we will focus on the NbS opportunities in generating negative emissions (i.e. removing carbon) through carbon sequestration.

Figure 10:
Agriculture generates about 12 per cent of the world's total GHG emissions



Source: Our World in Data (2016). GHG emissions including agriculture, forestry, and land use account for 18.4 per cent of total emissions.

Carbon removal's role in reaching net zero

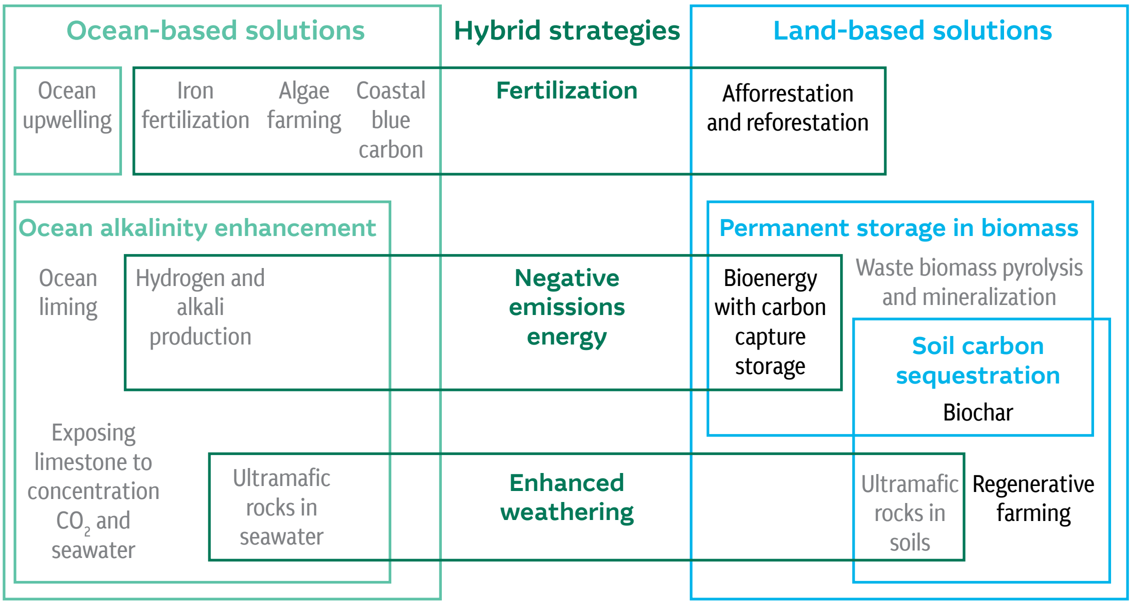
Carbon sequestration is a process of capture and long-term storage of atmospheric CO_2 in carbon sinks such as soils, forests, and oceans. To limit global warming to 1.5 degrees Celsius, net annual GHG emissions need to fall by 23 GtCO_2e by 2030 (compared with 2019 levels) and to net zero by 2050.[20] Estimates of the amount of carbon sequestration and removal required to achieve net zero vary[21] but all point to a crucial role for natural carbon sequestration strategies in removing unavoidable emissions from the atmosphere over coming decades. The theoretical

18. GHG emissions including agriculture, forestry, and land use account for 18.4 per cent of total emissions.
19. For more details on the challenges of decarbonisation for these sectors, see pages 28-32 of our recent paper, "Pathways – The path to net zero: The challenges and opportunities for real assets investors" (November 2021).
20. Taskforce on Scaling Voluntary Carbon Markets, Phase 1 – final report (2021).
21. In addition to the IPCC's estimates, the Taskforce on Scaling Voluntary Carbon Markets calculates that out of the 23 GtCO2e annual reductions in 2030 approximately 2 GtCO2e may need to come from carbon sequestration and removal while at the other end of the spectrum The National Academies of Sciences, Engineering, and Medicine estimates that global carbon removal of 10 GtCO2e per year is required by 2050, which accounts for about a quarter of global GHG emissions in 2019 (although less than a quarter of business as usual emission in 2050). Estimates also vary by country. According to the World Resources Institute, the US may need to remove about 2 GtCO2e every year by mid-century to reach net zero, which accounts for about 30 per cent of US 2017 GHG emissions.

potential of carbon removal solutions should be sufficient to enable us to reach net zero, but scaling up is required to reach that potential. Natural carbon sequestration strategies can be ocean-based, land-based, or hybrid (Figure 11). Land-based carbon removal solutions are the most mature[22] NbS in the market. According to the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report,[23] afforestation and reforestation annual carbon removal has a potential[24] of 3.7 $GtCO_2e$, soil carbon sequestration in croplands could remove 1.6 $GtCO_2e$, while soil carbon sequestration in pasture lands could remove 0.7 $GtCO_2e$.[25] Land-based NbS strategies can involve a combination of different approaches. Many NbS allow carbon offset programmes to be implemented in conjunction with, rather than in place of, agriculture production. Regenerative farming, for example, is a set of farming and grazing practices that may include the use of cover crops, diverse crop rotations, and the use of grazing to provide nutrients and break up soil.[26]

Well-designed NbS may also provide several important environmental co-benefits above and beyond carbon sequestration. For example, they may improve biodiversity, the health of waterways, and the productivity of food production systems. However, it is important to remember that NbS will only function reliably when implemented in combination with actions that reduce GHG emissions and never as a substitute.

Figure 11:
Examples of carbon removal NbS strategies



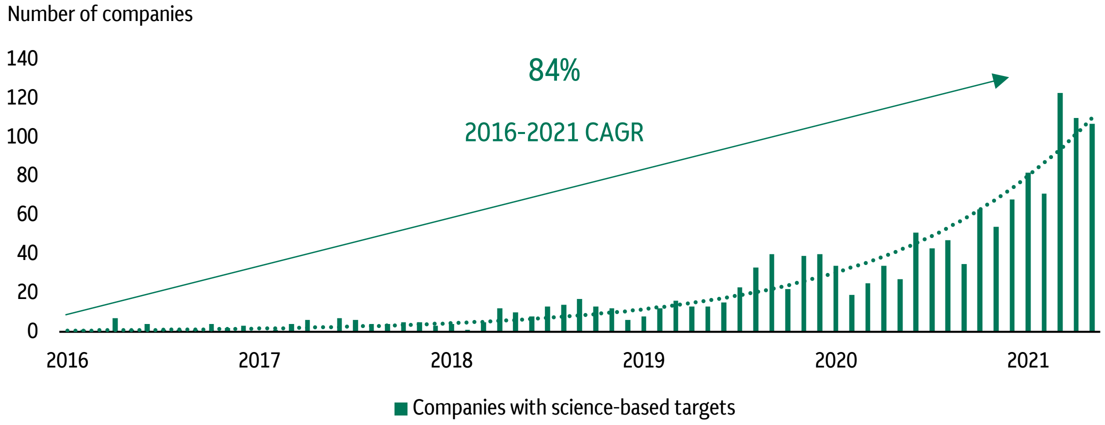
Source: BloombergNEF (October 2021). Note: Grey text indicates solutions that are less mature.

22. According to BloombergNEF (BNEF) (2021).
23. The report can be found here.
24. Median potential calculations are based on technical and sustainable potentials (Roe et al., 2019).
25. IPCC's Sixth Assessment Report, "Climate Change 2021: The Physical Science Basis" (2021), page 1392.
26. BNEF, "Climate-Tech Innovation Series: The Carbon Cycle" (October 2021).

Carbon credit markets – Poised for growth

Around the world, governments and organisations are increasingly addressing the climate crisis by committing to carbon neutrality or emissions reduction targets. More than 70 per cent[27] of Paris Agreement signatories have submitted new or updated national action plans called nationally determined contributions (NDCs). At the same time, corporate decarbonisation commitments have been rising rapidly in recent years. For example, the number of companies setting emissions reduction targets through the Science Based Targets initiative (SBTi)[28] has grown at a compound annual growth rate (CAGR) of 84 per cent between 2016 and 2021 (Figure 12). NbS can play an important complementary role to these emission reduction plans to help governments and corporations achieve decarbonisation targets.

Figure 12:
Number of companies with SBTi targets is growing rapidly



Source: Science Based Targets initiative (2021).

A carbon credit (also, carbon offset) is a certified tradable instrument that represents an emission reduction, or removal of one tonne of CO_2 or equivalent amount of GHGs. Demand for carbon credits comes from two main sources: regulatory compliance and voluntary commitments. In regulatory compliance systems, companies are required to purchase carbon offsets by national or regional emission reduction regulations such as the EU Emissions Trading System (ETS), UK ETS, or the California Cap-and-Trade Program. Voluntary demand originates from companies that voluntarily commit to carbon neutrality or net zero targets. With corporate sustainability commitments ballooning, we expect significant growth in demand for carbon offsets from voluntary commitments. The voluntary carbon credit market may potentially reach a value of up to $US50 billion[29] by 2030.

27. Climate Watch (2021).
28. Science-based targets are emissions reduction targets that are in line with the Paris Agreement – limiting global warming to well-below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit warming to 1.5 degrees Celsius.
29. Taskforce on Scaling Voluntary Carbon Markets (TSVCM), the Institute of International Finance (IIF), McKinsey.

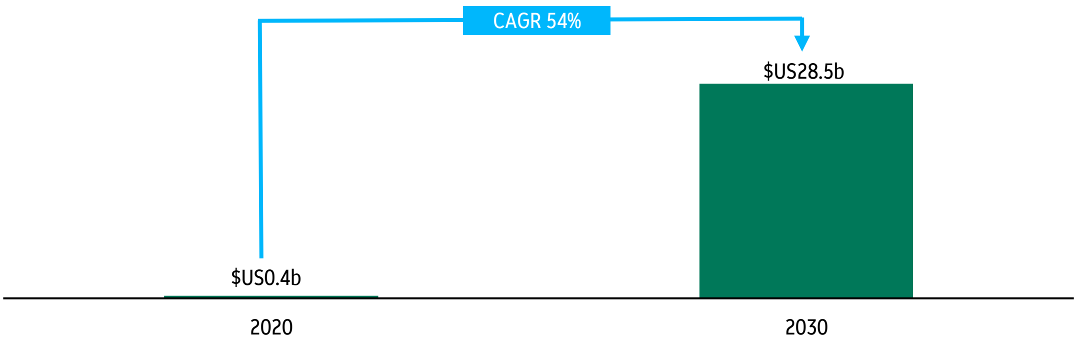
Carbon credits based on NbS – Strong growth expectations

In Australia, a range of NbS opportunities can be credited by the Clean Energy Regulator (CER) with Australian carbon credit units (ACCUs). Each ACCU represents one tonne of CO_2 equivalent net abatement (through either emissions reductions or carbon sequestration) achieved by eligible[30] activities. ACCUs can then be sold to the Emissions Reduction Fund (ERF). The CER is in the process of developing an Australian Carbon Exchange that should make the trading of ACCUs simpler, supporting rapidly increasing demand from the corporate sector.[31] Eligible NbS opportunities may include sequestering carbon from the atmosphere through planting native vegetation, sequestering and storing carbon in soil, implementing human-induced regeneration (HIR)[32] and reducing the emissions intensity of ruminant livestock systems. New methodologies are also emerging across feed additives, blue carbon, soil carbon, and biodiversity "stacking" (read on for further details).

In addition, many NbS offer lower capital requirements and a more competitive marginal cost of production compared with other carbon removal methodologies such as technology-based solutions (e.g. direct air carbon capture or carbon capture, utilisation, and storage). According to BloombergNEF (BNEF), afforestation and soil carbon sequestration have the lowest[33] cost of capture.

Overall, NbS carbon credits could account for a substantial part of the global voluntary market by 2030, potentially reaching a value of up to $US28.5 billion[34] (Figure 13).

Figure 13:
Annual value of global voluntary carbon credit market from NbS is expected to reach $US28.5 billion by 2030

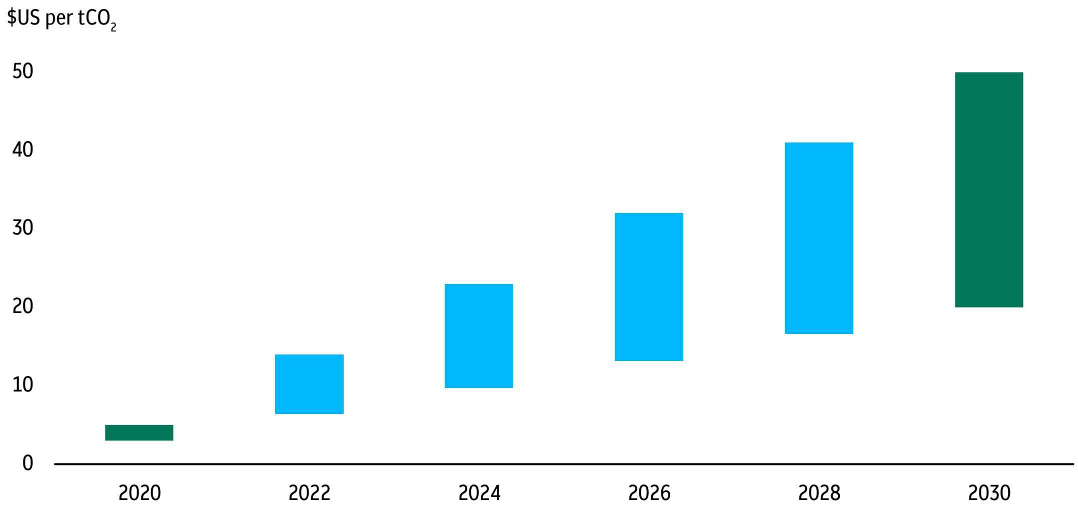


Source: Trove Research, "Future Demand, Supply and Prices for Voluntary Carbon Credits – Keeping the Balance" (June 2021).

30. There are a number of requirements that must be satisfied before a project can be declared an "eligible offsets project", and there are ongoing requirements in undertaking an eligible offsets project.
31. Australian Government, "About the Emissions Reduction Fund" (September 2021).
32. As per definition of the Australian Government. The human-induced regeneration (HIR) method is designed to achieve forest cover by carrying out eligible activities that encourage regeneration of Australian native tree species that are indigenous to a project's local area.
33. BNEF, "Climate-Tech Innovation Series: The Carbon Cycle" (October 2021).
34. Based on a mid-point forecast provided by Trove Research in "Future Demand, Supply and Prices for Voluntary Carbon Credits – Keeping the Balance" (June 2021).

The growing demand for NbS is forecast to place significant upward pressure on carbon credit prices. The average price for voluntary carbon credits is expected to grow from \$US3.5-5.4/tCO_2e in 2020 to \$US20-50/tCO_2e by 2030[35] (Figure 14). Some NbS removal credits may command a price premium to the average carbon credit price due to the potential for positive environmental co-benefits such as improving biodiversity, the health of waterways, and the productivity of food production systems, and societal co-benefits such as creating sustainable jobs. It is also important to note that removal offsets may experience higher demand and a price premium compared with offsets that avoid emissions as several initiatives such as SBTi push for using only removal offsets to achieve net zero targets.[36]

Figure 14:
Forecast range for average carbon credit prices by year



Source: Trove Research, "Future Demand, Supply and Prices for Voluntary Carbon Credits – Keeping the Balance" (June 2021).

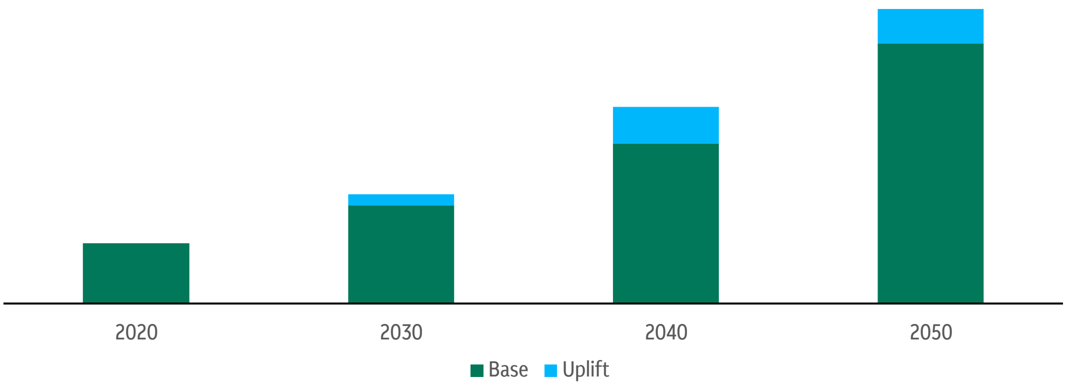
35. Trove Research, "Future Demand, Supply and Prices for Voluntary Carbon Credits – Keeping the Balance" (June 2021).
36. BNEF, "Long-term carbon offsets outlook" (2022).

NbS impact on farmland – A positive effect via two channels

NbS may not only help farm operators abate GHG emissions but may also offer economic benefits through carbon offsets. First, implementing NbS provides an opportunity for farm operators to generate a new income stream and enhance revenues. In Australia, the relatively low cost of land and high ratio of arable area per capita means this is a large opportunity. The evolving regulatory environment in Australia looks favourable for farmland. For example, the Ministry for Energy and Emissions Reduction announced a new set of priorities for method development, including an "integrated farm method".[37] When it is adopted, it may allow separate land-based activities to be combined or "stacked" on the same land. It may, for example, allow stacking of carbon and biodiversity projects, incentivising improved biodiversity while increasing carbon capture.

Second, the expected increase in demand for NbS projects and carbon offsets may place upward pressure on farmland values[38] (Figure 15). As explored earlier, farmland is a finite resource that is depleting on a per capita basis. According to the IPCC's decarbonisation scenario, limiting global warming to 2 degrees Celsius, under a medium shared socio-economic pathways,[39] would increase forest cover by 160 million hectares, croplands by 60 million hectares, and decrease pastures by 140 million hectares by 2050.[40] The growing tailwinds supporting NbS may introduce further competition for arable farmland - which is a finite resource - and potentially result in capital appreciation of farming assets.

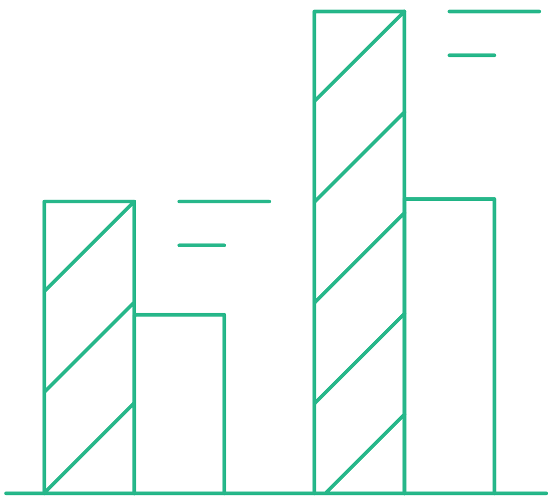
Figure 15:
NbS carbon credits are expected to have an uplift on land prices



Source: Illustrative impact of land appreciation, indicative of Macquarie Asset Management estimates only.

37. Australian Government, Clean Energy Regulator, "Method development" (October 2021).
38. For illustrative purposes only.
39. Shared socio-economic pathways (SSP) refer to future socio-economic development on climate change mitigation, adaptation, and land use. SSP2 assumes that medium population growth, medium income, technological progress, production, and consumption patterns are a continuation of past trends, and only a gradual reduction in inequality occurs.
40. Relative to 2010 levels, as published in the IPCC report, "Climate Change and Land" (January 2020). Data refer to SSP2 and Representative Concentration Pathways (RCP) 2.6. The report can be found here.

Agriculture's performance: Consistent returns, diversification benefits, and an inflation hedge aspect



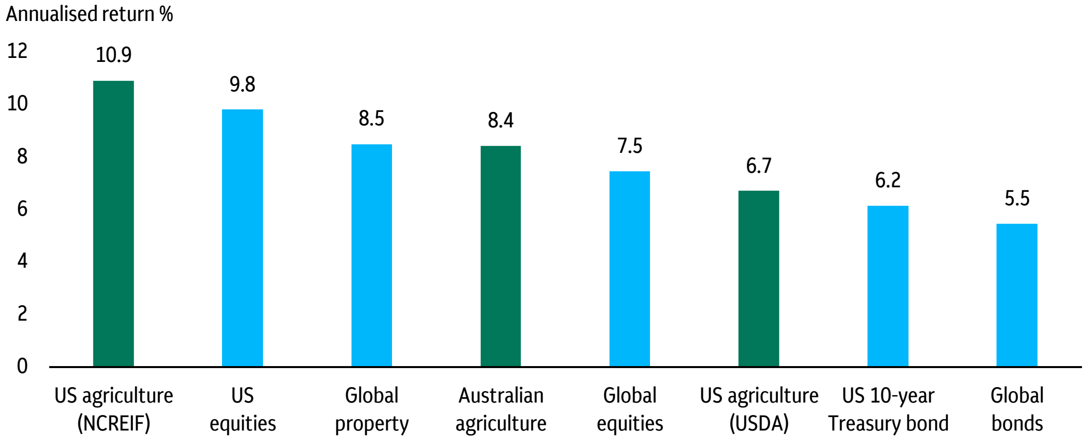
Australian agriculture delivered consistently strong returns over the period from 1991 to 2020. Particularly remarkable, however, is the stability of those returns – the volatility is on par with bonds. Australian agriculture also has negative or low correlations with other asset classes. Our analysis shows that when added to a portfolio of global equities, bonds, and property, it can improve returns while also lowering volatility.

Overall returns – Strong historical performance

Benchmarks for agriculture vary by quality, investment universe, and region. The most widely quoted benchmark for agriculture is the US National Council of Real Estate Investment Fiduciaries (NCREIF) Farmland Index. Its performance has historically been impressive as the index universe includes only income-generating farmlands acquired for investment purposes. A restricted universe such as this may distort returns, however. To overcome this limitation we have included the US Department of Agriculture (USDA) data that cover a broader universe of US farmlands. We also note that US farmers often receive government support, which may not be as readily available in other regions.

Since Australian farmers receive limited subsidies, the Australian market arguably represents a mostly "clean" benchmark. For Australian farmland we have used detailed data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)[41] to construct an index of total returns. Figure 16 below compares the Australian[42] and US agriculture returns with other major asset classes. Over the period 1991 to 2020, Australian agriculture[43] delivered an 8.4 per cent annualised return, better than both global equities and bonds, largely on par with global property, but below US equities. US agriculture showed a return of 6.7 per cent (USDA) and 10.9 per cent (US NCREIF Farmland Index) over the same period.

Figure 16:
Australian agriculture has delivered returns above global equities and bonds and on par with global property



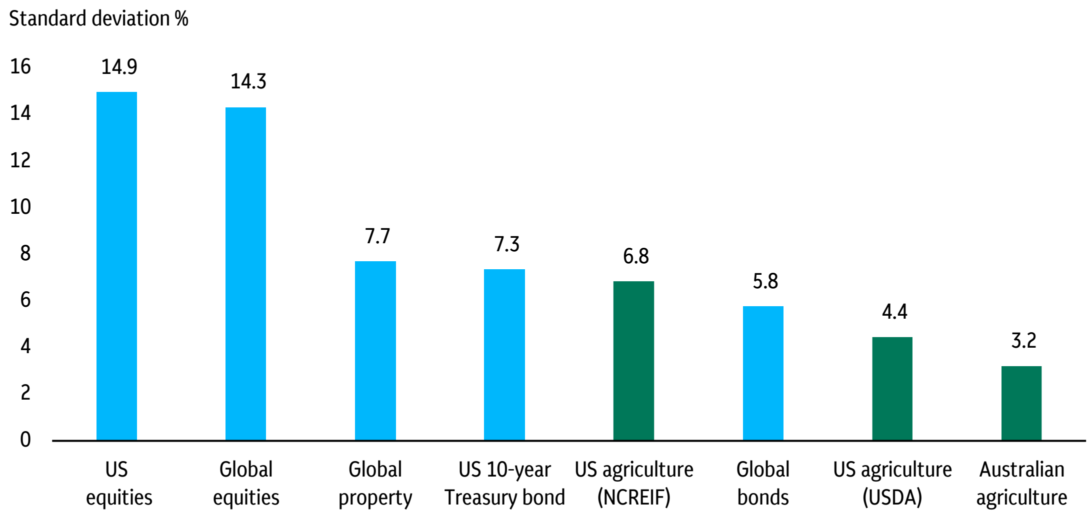
Sources: Bloomberg, ABARES, NCREIF, USDA. Period from June 1991 to June 2020. Notes: Australian agriculture returns refer to large farmland where gross turnover exceeds $US1 million. USDA data calculated as of December each year. US equities: S&P 500® Index; Global equities: MSCI World Index; US 10-year Treasury bond: S&P US Treasury Bond Current 10-Year Index; Global bonds: Bloomberg Global Aggregate Index; Global property: unleveraged index constructed as a weighted annual average total return across the office, industrial, and retail sectors for the US, Europe, and Asia Pacific regions.

41. ABARES data available here.
42. We have not included the ANREV Australia Farmland Index in this analysis as the data are available only from 2015.
43. Based on ABARES data. Australian agriculture refers to large farmland where gross turnover exceeds $US1 million.

Volatility – On par with bonds

The real strength of agriculture, though, is the consistency of the returns, as shown in Figure 17. Australian and US agriculture (USDA) exhibit the highest return stability compared with other asset classes. The US NCREIF Farmland Index shows higher volatility than other agriculture but still substantially less than listed equities. The consistency of agriculture's returns tends to be underpinned by its stable income return profile. The income return of Australian agriculture[44] using ABARES data was estimated at an average 5.6 per cent with a 1.9 standard deviation over the period 1991 to 2020.

Figure 17:
Australian agriculture has exhibited low volatility of returns, below global bonds



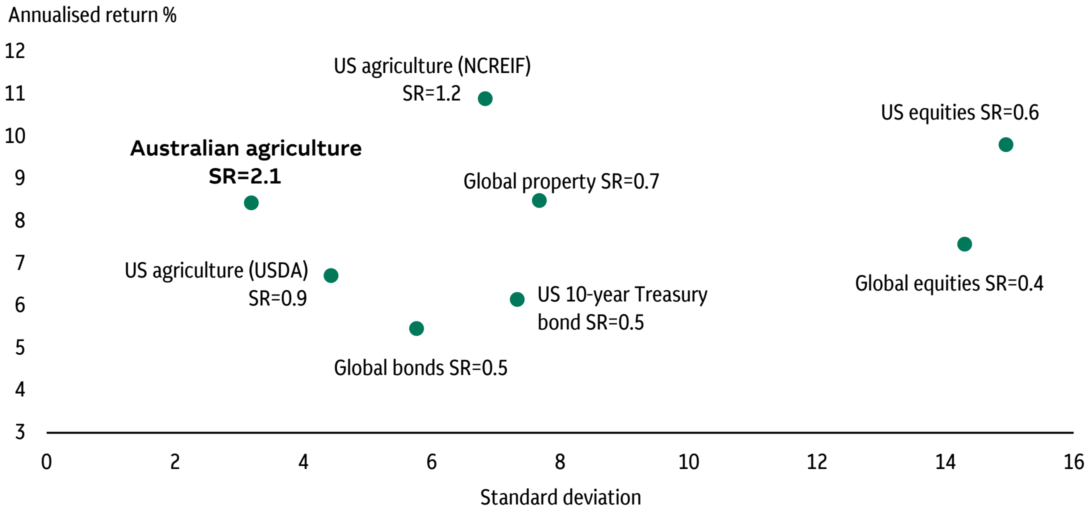
Sources: Bloomberg, ABARES, NCREIF, USDA. Period from June 1991 to June 2020. Notes: Australian agriculture returns refer to large farmland where gross turnover exceeds $US1 million. USDA data calculated as of December each year. US equities: S&P 500 Index; Global equities: MSCI World Index; US 10-year Treasury bond: S&P US Treasury Bond Current 10-Year Index; Global bonds: Bloomberg Global Aggregate Index; Global property: unleveraged index constructed as a weighted annual average total return across the office, industrial, and retail sectors for the US, Europe, and Asia Pacific regions.

44. Based on ABARES data. Australian agriculture refers to large farmland where gross turnover exceeds $US1 million.

Risk-adjusted performance – Agriculture leads the way

In our analysis, agriculture – both Australian[45] and US – delivered more robust annualised returns for their corresponding levels of risk than any other asset class from 1991 to 2020. Like other private market asset classes, the lower levels of liquidity and fewer market transactions (as compared with listed equities and bonds) may induce some valuation smoothing and therefore reduce volatility and support risk-adjusted returns. But this is unlikely to be the full story, as agriculture's land-rich asset composition and steady yield tend to provide a solid base for returns and return stability.

Figure 18:
Agriculture has exhibited strong risk-adjusted performance relative to other asset classes



Sources: Bloomberg, ABARES, NCREIF, USDA. Period from June 1991 to June 2020. Notes: Australian agriculture returns refer to large farmland where gross turnover exceeds $US1 million. USDA data calculated as of December each year. SR = Sharpe ratio calculated using a 3-month US Treasury yield as a risk-free rate. US equities: S&P 500 Index; Global equities: MSCI World Index; US 10-year Treasury bond: S&P US Treasury Bond Current 10-Year Index; Global bonds: Bloomberg Global Aggregate Index; Global property: unleveraged index constructed as a weighted annual average total return across the office, industrial, and retail sectors for the US, Europe, and Asia Pacific regions.

45. Based on ABARES data. Australian agriculture refers to large farmland where gross turnover exceeds $US1 million.

Agriculture's correlations with other assets – Low or negative

Figure 19 below shows the correlation matrix. Australian agriculture has exhibited a negative correlation with global equities, US equities, and 10-year US Treasury bonds, zero correlation with global bonds, and some correlation (0.26) with global property. Such correlations suggest that Australian agriculture could offer important diversification benefits to a portfolio. In particular, it may help support the stability of a portfolio during volatile equity markets.

Figure 19:
Australian agriculture shows negative correlations with equities market

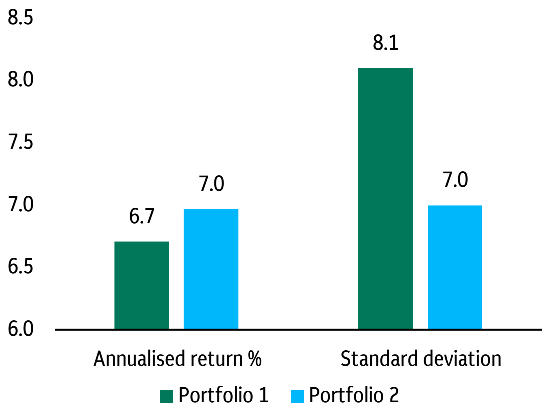
	Global equities	Global bonds	Global property	US equities	10-year US Treasury bond	Australian agriculture
Global equities	1.00	-0.10	0.53	0.91	-0.44	-0.06
Global bonds	-0.10	1.00	-0.27	0.01	0.62	0.00
Global property	0.53	-0.27	1.00	0.41	-0.25	0.26
US equities	0.91	0.01	0.41	1.00	-0.20	-0.12
10-year US Treasury bond	-0.44	0.62	-0.25	-0.20	1.00	-0.17
Australian agriculture	-0.06	0.00	0.26	-0.12	-0.17	1.00

Sources: Bloomberg, ABARES, NCREIF, USDA. Period from June 1991 to June 2020. Notes: Australian agriculture returns refer to large farmland where gross turnover exceeds $US1 million. USDA data calculated as of December each year. US equities: S&P 500 Index; Global equities: MSCI World Index; US 10-year Treasury bond: S&P US Treasury Bond Current 10-Year Index; Global bonds: Bloomberg Global Aggregate Index; Global property: unleveraged index constructed as a weighted annual average total return across the office, industrial, and retail sectors for the US, Europe, and Asia Pacific regions.

Portfolio benefits – Agriculture is a stabilising influence

Given the low correlation to other asset classes, adding Australian agriculture to a portfolio of bonds, equities, and property may improve overall portfolio performance. Figure 20 below attempts to quantify the benefits. Portfolio 1 is 50 per cent global equities, 40 per cent global bonds, and 10 per cent global property. Portfolio 2 adds a 10 per cent allocation to Australian agriculture, reducing the allocations to all other asset classes by 3.33 percentage points each. This produces an uplift of 30 basis points in annualised portfolio return and a reduction in the standard deviation of portfolio returns from 8.1 to 7.0.

Figure 20:
Adding Australian agriculture to a global portfolio of equities, bonds, and property could improve portfolio volatility

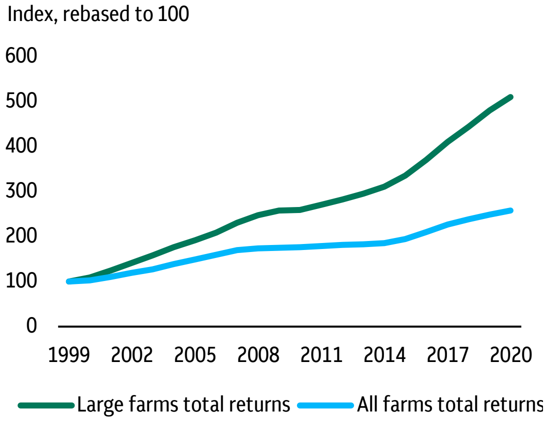


Sources: Bloomberg, ABARES. Period from June 1991 to June 2020. Notes: Australian agriculture refers to large farmland where gross turnover exceeds $US1 million. Analysis assumes annual rebalancing (excluding fees and transaction costs).

Benefits of scale – Economies of scale, improved efficiency, and cost reduction

In agriculture, the benefits of scale can be large. Looking at Australian farms' performance, large farms have produced stronger total returns than small and medium-sized farms (Figure 21). There are two principal reasons for the difference in performance. First, larger farms can reduce costs due to greater economies of scale. Since a large proportion of farm costs are fixed, increasing the size of a farm can reduce per unit costs. Second, large farms may improve productivity by deploying large-scale technologies in farm infrastructure, professionalising management, and improving the efficiency of water usage and other inputs. Altogether, these can contribute to reduced costs and increased profitability.

Figure 21:
Larger farms tend to generate higher returns



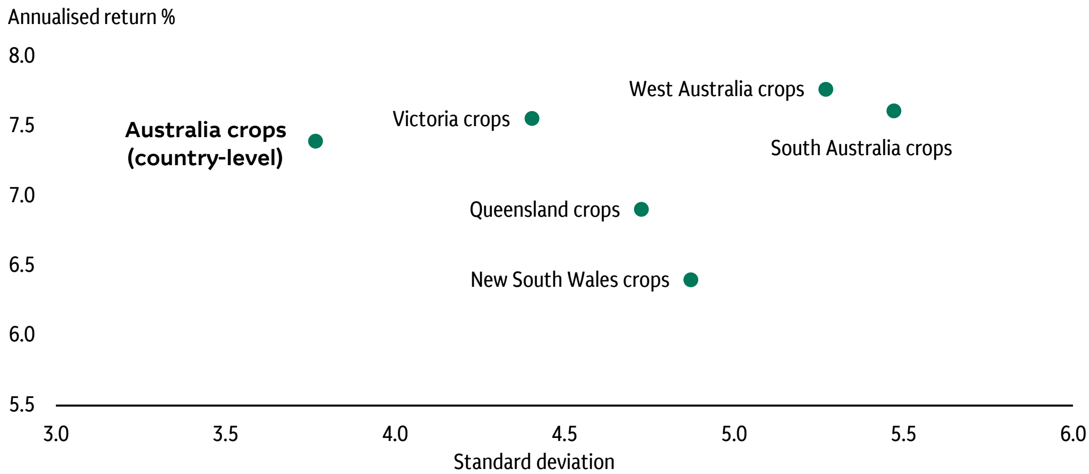
Source: ABARES. Period from June 1999 to June 2020. Notes: Large farms refer to farms with gross turnover more than $US1 million.

Australia's crops – Diversification benefits of geographically diverse lands

The Australian grains industry comprises 13 agroecological zones[46] with distinct climate, cropping, and market characteristics. The diversity of crops and different harvesting seasons across the states in Australia can help stabilise the returns of a crops portfolio. For example, Queensland – located in the northeastern part of Australia – enjoys a warmer climate due to its proximity to the tropical climatic zone. Due to favourable conditions, 95 per cent[47] of sugar produced in Australia is grown in Queensland. Wheat – a crop that generally prefers cooler temperatures – is mainly produced in the western and southern regions. Therefore, investing across Australia's geographically diverse lands may help stabilise revenues and income return throughout the year.

The ABARES data set, by providing returns for each of the different states and at the national level, enables an assessment of the significance of this geographical diversification effect. Figure 22 shows the data. At the national level the standard deviation of returns is 3.8, whereas the standard deviations by region are South Australia 5.5; West Australia 5.3; New South Wales 4.9; Queensland 4.7; and Victoria 4.4.

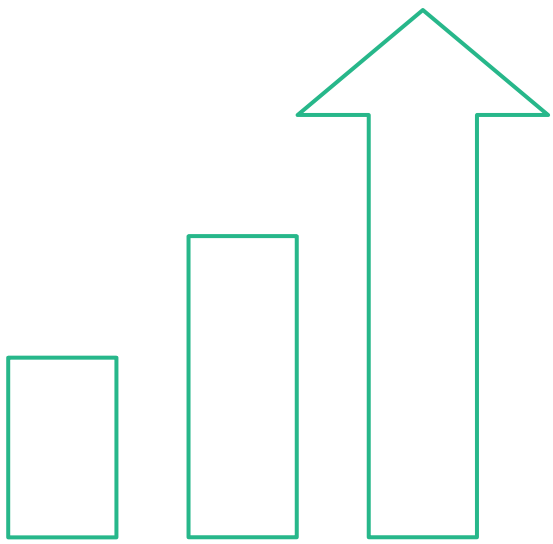
Figure 22:
Benefits of investing across geographically diversified Australian states



Sources: ABARES. Period from June 2001 to June 2020. Australian agriculture refers to large farmland where gross turnover exceeds $US1 million.

46. Australian Government, Grains Research and Development Corporation.
47. https://www.awe.gov.au/agriculture-land/farm-food-drought/crops/sugar.

Agriculture as an inflation hedge: The revenue line is closely linked to inflation



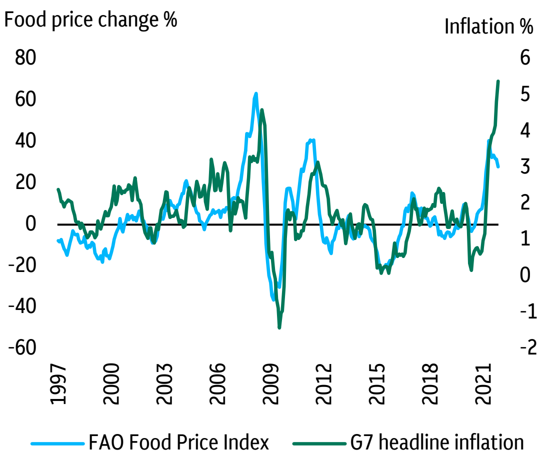
Headline inflation across the Group of Seven (G7) has been rising rapidly as the global economy recovers from the COVID-19 pandemic. With inflationary pressures growing, real assets with inflation hedge potential have received strong interest from investors. Intuitively, agriculture should be well positioned due to its direct link to food and commodity prices. In this section we examine how farmland performance has historically related to inflation, and we explore in detail:

- how agricultural commodity prices correlate to Consumer Price Index (CPI) inflation
- how farmland value growth changes during high inflation periods
- how inflation affects the revenue line, costs, and incomes of farm businesses.

Farmland revenues – Rising food prices drive both inflation and farmland revenues

Historically, there has been a strong correlation between food prices as measured by the FAO Food Price Index (FFPI) and G7 headline inflation (Figure 23). The correlation between food prices and inflation is estimated at 0.59 over the period of 1997 to 2021. The correlation increases to 0.77 if a three-month lag is applied. Food prices have a high correlation with headline inflation for two reasons: first, food prices contribute directly to headline inflation as part of the consumer basket; second, they are more volatile than most other prices and so account for a disproportionate share of the volatility of CPIs.

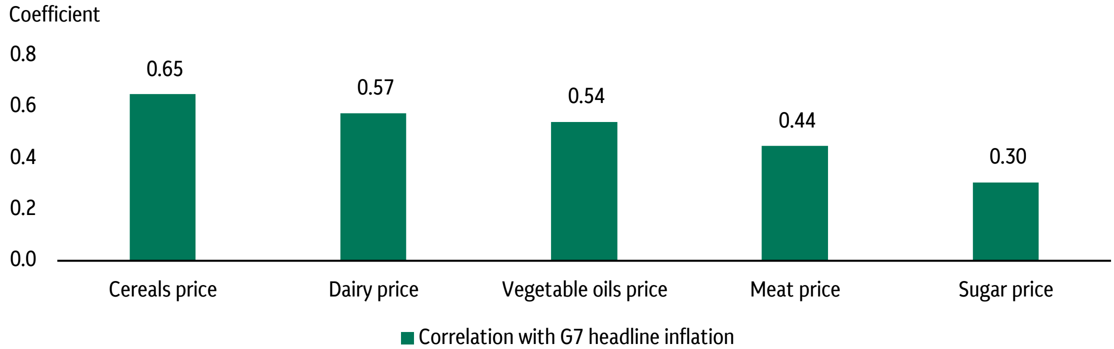
Figure 23:
Strong historical correlation between food prices and inflation, particularly with a three-month lag



Sources: FAO, Macrobond (February 2022). Based on monthly data.

The FFPI measures monthly changes in international prices of a basket of food commodities. It consists of the weighted average of five commodity groups: cereals, vegetable oils, dairy, meat, and sugar. When these groups are examined separately, cereals (e.g. wheat, maize, sorghum) have the strongest correlation coefficient[48] (0.65) with headline inflation, followed by dairy (0.57) and then vegetable oils (0.54) (Figure 24).

Figure 24:
Cereals may provide a stronger inflation hedge than other FFPI food groups

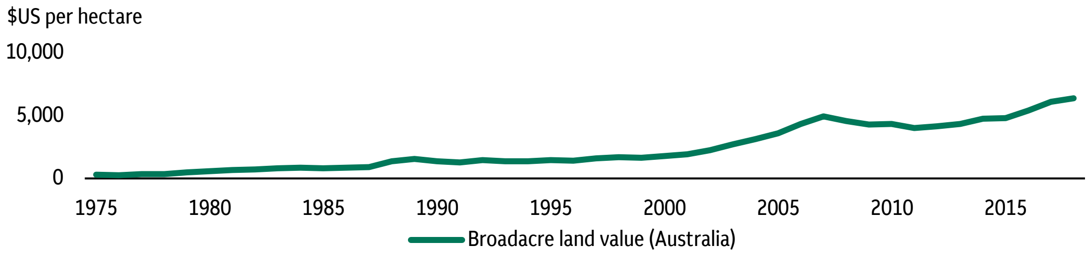


Sources: FAO, Macrobond (February 2022). Notes: Based on monthly data. Correlations calculated on a lag of three months.

Australia's farmland value – Appreciates more rapidly when inflation is high

Figure 25 shows the value of broadacre land in Australia as provided by ABARES analysis of the broadacre-only CoreLogic dataset.[49] The value of broadacre land increased at a CAGR of 7.2 per cent over the period from 1975 to 2018. To put this in perspective, this is 1.5 times Australia's annual inflation rate over the same period.

Figure 25:
Australia's broadacre land value increases almost 20 times from 1975 to 2018



Source: ABARES "Measuring Australian broadacre farmland value" report (2019).

48. Calculated using a three-month lag.
49. ABARES, "Measuring Australian broadacre farmland value" report (2019).

Figure 26 compares broadacre land value growth in years when inflation is above average (high) with value growth when inflation is below average (low). In periods when inflation is high, broadacre land value has grown 11.8 per cent on average, whereas in periods when inflation is low it has averaged 5.9 per cent. Put simply, average land value growth is twice as strong when inflation is high than when it is low.

To investigate further, we look at the broadacre land value growth using the different inflation thresholds of 4.7 per cent year-over-year (YoY), 6.5 per cent[50] YoY, and 8.3 per cent[51] YoY (Figure 27). The land value has grown on average by 11.8 per cent, 12.1 per cent, and 13.8 per cent, respectively, when inflation exceeded these thresholds. The fact that the increase in land values accelerates as the inflation threshold rises is additional evidence that the asset class offers a relatively good hedge against higher inflation.

Figure 26:
Australia's broadacre land value average growth doubles when inflation is high...

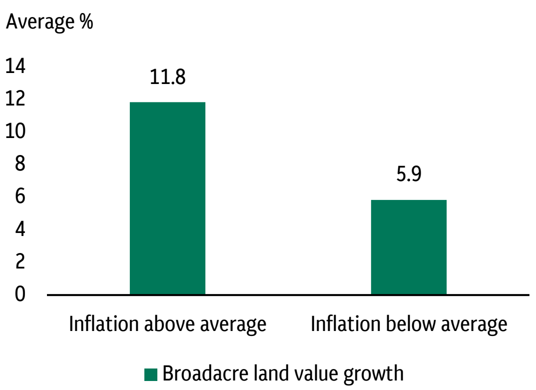
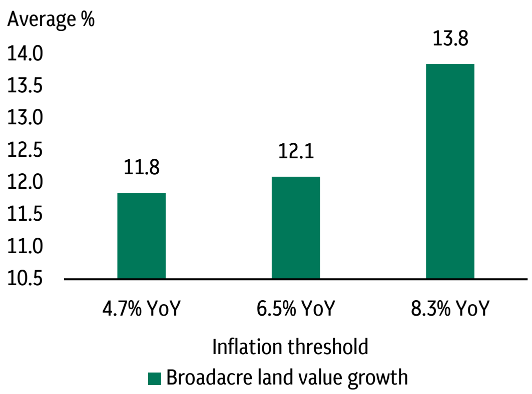


Figure 27:
...and increases when inflation rises above thresholds



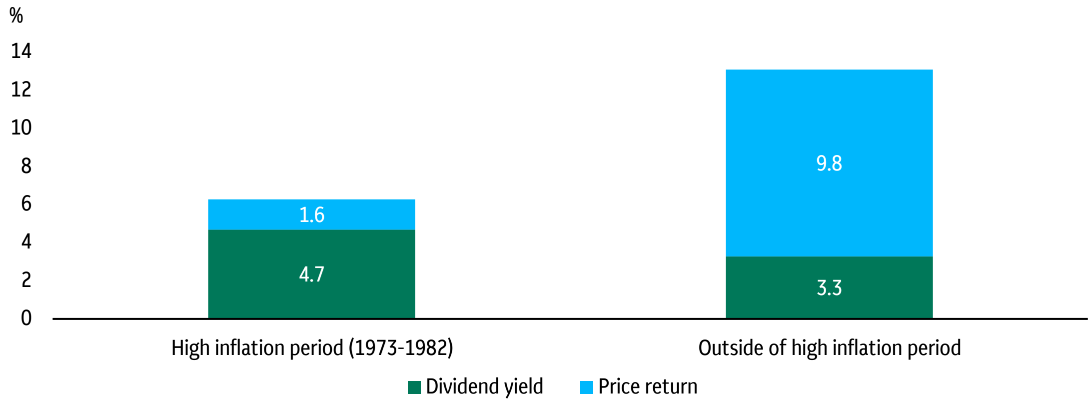
Sources: Macrobond, ABARES. Analysis period from 1975 to 2018.

50. Half of the standard deviation away from the average growth.
51. One standard deviation away from the average growth.

The high inflation period of the 1970s – US farms did experience an increase in revenue and income growth

In a paper[52] last year, we examined the performance of asset prices in the high inflation period of the 1970s (precisely 1973-1982). What we found was that in the period of high inflation, yield and income became much more important as a driver of total returns than in normal times (that is, when inflation is not high). This can be most clearly seen in listed equities, where the dividend yield accounted for 75 per cent of the total return in the high inflation period, compared with just 25 per cent in normal times (Figure 28). The result was similar for bonds, where the price return contribution was negative through the high inflation period.

Figure 28:
Dividend yield accounted for most of the return on US equities in the high inflation period



Source: Macrobond (February 2022).

This aligns with theoretical priors – in a period of high inflation, discount rates are likely to be increasing, placing pressure on multiples and asset prices, so an asset's ability to offset this headwind through income growth will be key to its ability to maintain a healthy total return. Its ability to deliver income growth will, in turn, depend on the tightness of the link between its revenue line and inflation, and its ability to control costs.

52. See "Pathways – Core infrastructure: Its inflation hedge characteristics and the search for yield" June 2021, pages 15-16.

As we discussed in the beginning of this section, there is a good correlation between inflation and food commodity prices. The critical question here is: did this flow through to revenue and earnings for US farms in the 1970s? Revenue growth clearly shifted upward during the high inflation period, averaging 9.1 per cent per year, almost three times the 3.3 per cent it averaged outside of the high inflation period (Figure 29). Interestingly, crop sales increased more rapidly than livestock sales, with crops averaging 12.4 per cent growth in the high inflation period while livestock averaged 7.6 per cent (Figure 30). This is consistent with the observation noted earlier that cereals correlate more closely with headline inflation than with other commodities.

Figure 29:
Farm revenue growth shifted upward during the period of high inflation

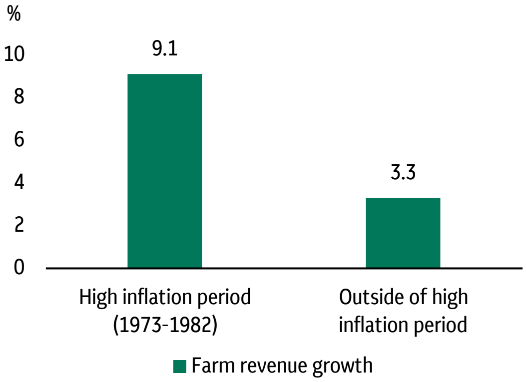
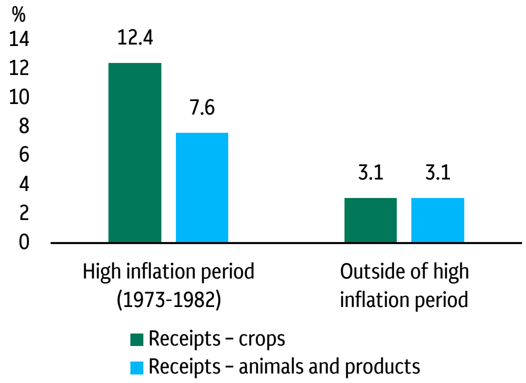


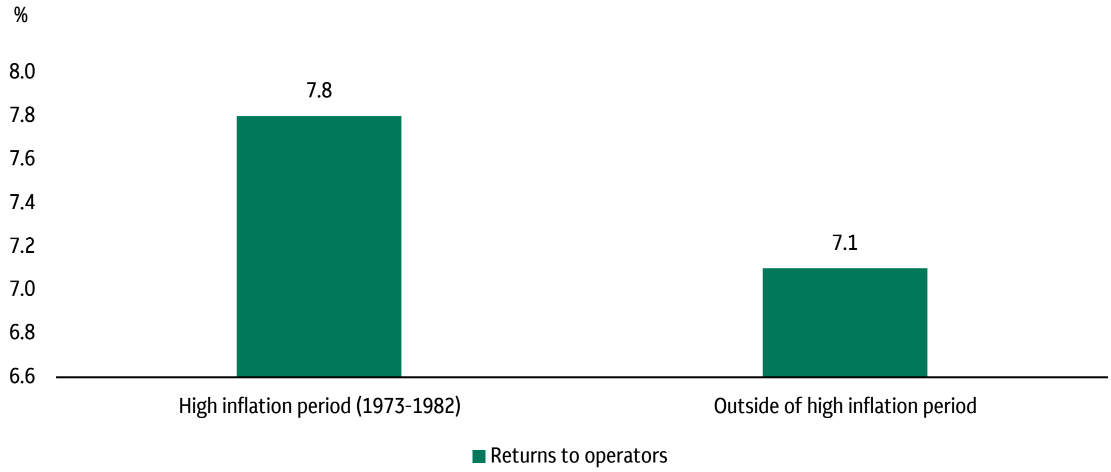
Figure 30:
Crops increased even more rapidly than livestock



Sources: US Department of Agriculture, Macrobond (February 2022).

Costs also increased rapidly during this period, with fuel, fertiliser, labour, and interest costs all moving higher. This meant that it was mainly the operating leverage that drove the increase in earnings growth from 7.1 per cent outside of the high inflation period to 7.8 per cent during high inflation (Figure 31).

Figure 31:
Agriculture's earnings growth accelerated in the high inflation period



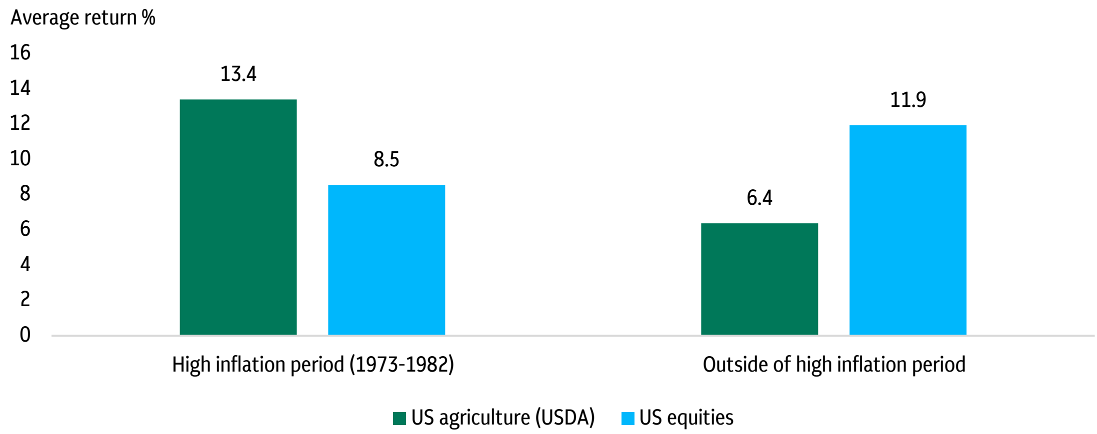
Sources: USDA, Macrobond (February 2022).

Several conclusions come from this analysis:

- In a period of high inflation, agriculture is very likely to see a substantial increase in revenue growth. If the historical data are a guide, this may be more pronounced for crop farming than livestock, but it is sizeable for both.
- Costs also tend to rise though, so firms that can control cost growth by locking in the price of key commodity inputs early, by taking out long-term financing arrangements before interest rates rise, through professional management, or by the judicious deployment of productivity enhancing capital, are likely to perform relatively well.

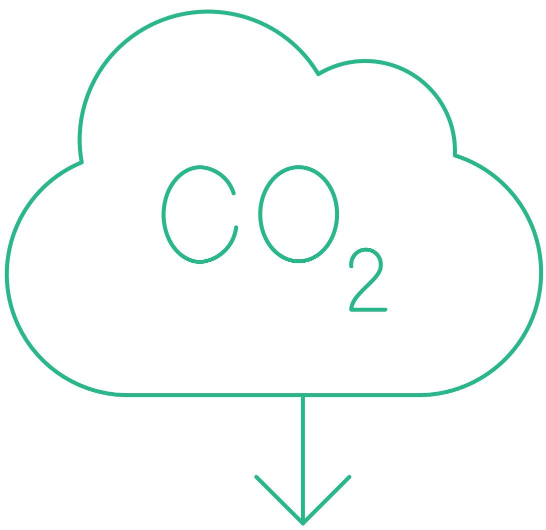
Finally, Figure 32 below examines the total return performance of US agriculture and US listed equities. For US agriculture, total returns more than doubled to 13.4 per cent during the high inflation period (from 6.4 per cent outside of this period). By contrast, returns on listed equities slowed to 8.5 per cent in the high inflation period from 11.9 per cent in normal times.

Figure 32:
Overall, agriculture exhibited stronger inflation hedge properties than equities during the high inflation period



Sources: Bloomberg, USDA, Macrobond (February 2022).

Conclusion: Robust fundamentals, an inflation hedge, and a decarbonisation opportunity



In this paper we have examined agriculture as an asset class, with a focus on the issues relevant for investors – farmland demand and supply dynamics; the impact the drive to net zero could have on incomes; long-run returns; the diversification benefits of an investment allocation to agriculture; and its inflation hedge characteristics. There are several key conclusions from this analysis:

- **Robust long-term fundamentals.** Growing populations and rising real incomes are set to increase demand for food and high-quality proteins which, by extension, places upward pressure on demand for land. At the same time, arable land per capita continues to decline. This land demand-supply imbalance is likely to drive productivity and farmland values over the long run.
- **Nature-based solutions.** Carbon removal from the atmosphere is likely to be required to achieve net zero GHG emissions by 2050. NbS offer carbon sequestration solutions in lands and oceans. At the same time, implementing NbS may lead to a new income stream (via carbon credits) for farm operators and add another layer to the already strong demand for arable demand.
- **Healthy historic returns.** Since 1991, Australian agriculture[53] has delivered an 8.4 per cent annualised return, higher than both global equities and bonds, largely on par with global property but below US equities.
- **Return stability.** The volatility of agriculture's returns has been lower than other asset classes and is similar to bonds. In short, agriculture has delivered equity-sized returns at bond-like stability.
- **Low correlations.** Australian agriculture has exhibited a negative correlation with global equities, US equities, and 10-year US Treasury bonds, zero correlation with global bonds, and some correlation (0.26) with global property.
- **Diversification benefits.** Adding agriculture to a pre-existing portfolio of global equities, bonds, and property, could increase portfolio returns and lower the volatility of those returns.
- **Inflation hedge properties.** Historical data are consistent with the notion that the asset class offers a relatively good hedge against higher inflation. There is a strong correlation (0.77 with a three-month lag) between food prices and headline inflation. In Australia, land value growth has been twice as strong when inflation is above average than when it is below average. In the US during the high inflation period (1973-1982), farms' revenue growth almost tripled. Costs also increased rapidly, however, with the result that most of the observed uplift in income growth was due to operating leverage.

53. Based on ABARES data. Australian agriculture refers to large farmland where gross turnover exceeds $US1 million.

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Pathways

For more information, or to speak to the authors of this issue, Aizhan Meldebek, CAIA and Eleanor Heathcote-Morris, please contact your Macquarie Asset Management Relationship Manager.