DESIGN PRINCIPLES FOR AGRICULTURAL RISK MANAGEMENT POLICIES

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Design Principles for Agricultural Risk Management Policies

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Government support for agricultural risk management tools has grown substantially over the past two decades. While these tools can play a role in strengthening farm-level resilience by helping farmers to cope with the financial impact of adverse events, they also modify farmers' incentives to invest in risk-reducing measures and market tools. Policy design is critical to maximise effectiveness while minimising unintended consequences. This report reviews the accumulated experience on four types of publicly-supported agricultural risk management tools (*ex post* disaster aid, agricultural insurance, income stabilisation schemes and tax and savings measures). It suggests some basic principles on how countries can improve the design of their agricultural risk management policies, using a holistic approach and focusing on market failures. The report also highlights the need for more transparency on basic programme data, and for periodic public evaluation of existing programmes.

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What is the issue and why is it important

- Government support for agricultural risk management tools has grown considerably over the past few decades.

- Risk management programmes can contribute to a more resilient agricultural sector by ensuring that producers can cope with the negative financial impacts of adverse events, but these programmes also modify farmers' incentives to invest in risk reducing measures.

- Programme design matters for tools to be effective while minimising unintended consequences. As more countries put these types of policies in place, the accumulated experience can help contribute to improved programme design.

What did we learn?

- Nearly all OECD countries and several large emerging economies support agricultural risk management products, but the level and focus of support varies widely.

- Design considerations are specific to the choice of policy instrument.

- While subsidised insurance programmes have been promoted as a means to discipline *ad hoc* assistance, the evidence indicates that it is often politically difficult to end provision of *ad hoc* assistance even once insurance programmes are well-established.

- Many risk management programmes lack transparency on basic data and in-depth evaluation of impacts.

Key recommendations

- A holistic approach to agricultural risk management will help to ensure the complementarity of the different tools, to avoid overcompensation, and to reduce adverse selection and moral hazard behaviour.

- To the extent possible, government support for risk management should focus on addressing market failures. With the advent of remote sensing, improved weather data and forecasting, and other technologies, what may have been perceived as a market failure in the past may now be feasibly addressed through private market tools. However, heavily subsidised policy tools can crowd out private innovation in this space.

- To the extent possible, government subsidies should be restricted to covering administrative costs and, at most, losses from catastrophic risks.

- Improving data accessibility would enhance monitoring and evaluation of risk management programmes, and help other countries in their programme design.

Executive Summary

The past two decades have seen strong growth in government support for agricultural risk management products: particularly for disaster assistance, agricultural insurance, income stabilisation schemes and producer tax savings accounts. These products can play a role in strengthening farm-level resilience, in particular the capacity to cope with negative financial impacts of adverse events, but they also modify farmers' incentives to invest in risk reducing measures. Countries may benefit from guidance on how to design these policies to maximise effectiveness while minimising unintended consequences.

Looking back on the accumulated experience of publicly-supported risk management tools, some basic principles have emerged on how countries can improve the design of their agricultural risk management policy toolboxes – both overall, and in designing specific policies. Fundamentally, a holistic approach to risk management will help to ensure the complementarity of different tools, to avoid overcompensation, and to reduce adverse selection and moral hazard behaviour. Additionally, government support for risk management is best concentrated on addressing market failures, with subsidies limited to covering programme administrative costs and, at most, losses from catastrophic risks. Moreover, policy makers need to first seek to understand why producers do not participate in risk management programmes before choosing to use subsidies to encourage participation – once subsidies are introduced, they are difficult to remove. Policymakers need to be mindful that heavily subsidised instruments can crowd out private innovation, recognising that with the development of remote sensing, improved weather data and other technologies, what may have been perceived as a market failure in the past may now be feasibly addressed through private market tools.

Other recommendations emerge when considering design elements of particular policies. In particular, *ex post* disaster policies and subsidised agricultural insurance often overlap in providing compensation in the catastrophic risk layer, and although subsidised insurance schemes have been promoted as a means to discipline *ad hoc* assistance, experience has shown that it is often politically difficult to end provision of *ad hoc* assistance even once insurance programmes are well-established. This underscores the importance of developing risk management policy toolkits in collaboration with sector stakeholders to define *ex ante* the layers of responsibility in risk management and the scope of existing policy tools. With respect to income stabilisation schemes, the literature on impacts and experience remains comparatively thin, so new programmes should include a strong monitoring and evaluation component to cover this knowledge gap. Tax and savings measures can be effective in helping producers smooth income variability with comparatively fewer market distortions and externalities, but on their own, they are unlikely to prove sufficient for managing the most damaging catastrophic events. Finally, due to programme designs that typically limit account balances, matched savings accounts seem to play little role in farm risk management.

Surprisingly, a striking feature of many risk management programmes is the lack of transparency on the extent of basic data and the evaluation of these programmes. Improving data accessibility would enhance monitoring and evaluation of such programmes and provide information and experience that could be shared with other countries as they develop and improve risk management schemes of their own. Governments should also commit to assessing the impacts of these programmes beyond the take up rates, to determine if they remain appropriate for the country's risk management context, or if another tool would be more effective in achieving programme aims.

1. Introduction

Agriculture is an inherently risky enterprise. Crop and livestock production is dependent on weather, which in many regions of the world is highly variable. Droughts, excessive moisture, insect damage and plant diseases can seriously impact crop yields and pasture quality. That in turn affects feed and forage for animals, which affects production of meat and dairy products and may even cause mortality losses to animals. In addition to production uncertainty, most agricultural producers must make crop planting and herd replacement decisions without knowing what the price for their product may be at the time of harvest or animal slaughter. As a result, farm incomes are typically highly variable and exposed to potentially large losses (as well as windfall profits) in some years.

While the agricultural sector is certainly not unique in its exposure to risk – the recent impact on the world economy due to the outbreak of COVID-19 and the lockdown procedures put in place to control the spread of the disease provide a reminder of how vulnerable many industries are to unforeseen risks – governmental policies have evolved over the last century to address agricultural risks and protect producers from their consequences. At the same time, events such as COVID-19 have broadened the understanding of how shocks external to the agricultural sector can also impact agricultural activities, including through unexpected shocks to labour and input markets. Concurrently, the risk landscape for agriculture is evolving due to climate change, increasing the attention on these tools and both their utility for helping the sector to cope with these impacts, but also their potential to blunt incentives for adapting to changing circumstances. This shifting and uncertain landscape requires a sustained effort with respect to risk identification and assessment, looking beyond a simple extrapolation of the risks from the past. Changing risk profiles may require a re-evaluation of the responsibilities of both farmers and governments in how to best manage this risk over the long-term.

Over the past 40 years, increasing emphasis has been placed on policies that contribute to risk management, but which do not always promote proactive strategies for anticipating, minimising and mitigating the impacts of risks going forward (i.e. for building resilience). Many of the policies have sought to stabilise production or revenues with contingent claims instruments such disaster assistance, agricultural insurance or through producer-financed emergency savings schemes. Nearly all of the programmes receive some government financial assistance such as providing reinsurance, subsidising premium and delivery costs, or providing matching deposits savings schemes.

Recent work on strengthening resilience in the agricultural sector indicated that risk management policy tools such as disaster assistance and agricultural insurance can play a role in ensuring a resilient sector (OECD, 2020[1]). In particular, these programmes help to ensure that producers have the capacity to cope with the negative financial impacts of adverse events. At the same time, these programmes have consequences for farm-level economic incentives to invest in other risk management measures, in particular, risk-reducing measures, which may affect a farm's capacity to either absorb the impact of adverse events or adapt to a changing risk landscape. For example, these programmes may actually increase risk exposure in the short-run by encouraging planting on marginal land at higher risk for flooding.

Setting aside their implications for building resilience, government assistance levels for risk management tools have grown considerably in the recent past. For example, agricultural insurance subsidies for OECD countries have increased nearly five-fold since 2005 to over USD 10 billion in 2019 (OECD, 2020[2]). For some countries, such as the United States, insurance programmes have high participation rates among producers and have become the largest single safety net programme in terms of total producer support. Growth of insurance programmes is also not confined to OECD economies – as measured by premium

volume and insurance subsidies, the People's Republic of China (hereafter "China") and India have the second and third largest crop insurance programmes, respectively, in the world.

Yet despite their growing popularity, subsidised insurance programmes have also received much criticism. Critics point out that subsidising agricultural insurance encourages the crowding out of other arguably cheaper upstream resilience and risk management tools such as irrigation investments or risk-reducing strategies such as crop diversification (Wright and Hewitt, 1994[3]; Goodwin and Smith, 1995[4]). Research has pointed out that subsidised risk management tools can cause producers to grow crops and livestock in marginal areas, which can contribute to environmental degradation (Miller and Walter, 1977[5]; Wu and Adams, 2001[6]). And, like other trade-distorting farm subsidies, subsidised risk management policies have been criticised for distorting production decisions which can lead to distortions in world trade and global prices, potentially raising WTO implications (Glauber, 2015[7]).

This report reflects on four decades of experience with publicly-supported agricultural risk management tools, drawing out lessons learned from how these tools have been applied in a real-world setting to offer practical guidance for more effective risk management policy design. In addition to reviewing and assessing the implementation of different tools, the report also examines how different approaches to policy design and different design parameters can improve the cost-effectiveness of these tools. While these guidelines are informed by practical experience, they are supported and informed by relevant academic and governmental reports, where available. This report analyses four sets of policies:

- *Ex post disaster assistance.* Disaster assistance programmes indemnify producers after an event has occurred. In some countries, disaster programmes are statutory in that producers know in advance about whether they would be eligible for payments in the event of a disaster and the expected level of compensation (for example, US livestock assistance programmes). Such disaster programmes are analogous to free insurance programmes where the producer receives protection for free or a nominal fee. More often, however, these programmes are *post hoc* – that is, the decision about whether the government intervenes is made after the fact so that at planting time, producers are uncertain as to whether they would be protected in the event of a disaster. While these types of programmes are most commonly thought of as addressing the impacts of natural disasters, the same *ex post* approach has also been used to address the impacts of economic shocks to the sector, such as export markets closing due to animal disease outbreaks.

- *Agricultural insurance programmes.* Insurance programmes provide producers with a guaranteed level of yield or revenue, in exchange for a premium paid by the producer that is reflective of the underlying risk of the instrument. Agricultural insurance can offer protection against a single peril (such as crop hail insurance) or multiple perils. Claims can be established based on a producer's actual yield experience (where they are typically referred to as "indemnity-based" contracts) or on an indexed based contract that may be tied to a regional yield, weather outcomes or other variables that are correlated but not determined by the actual individual's performance. In this paper, we consider an agricultural programme to be insurance only if it is based on an actuarial estimation of the risk premiums.

- *Income stabilisation schemes.* Income stabilisation programmes tend to be focused on stabilising producers' incomes around an average of recent years. Discussion in this paper distinguishes between "whole farm" income stabilisation and stabilisation of individual crop revenue which is covered under agricultural insurance programmes. Income stabilisation schemes typically are concerned with providing a floor for income (and not a ceiling).

- *Tax and savings measures.* These policies help producers smooth income by encouraging them to save either through tax-deferred savings accounts or government-matched accounts, where the government matches savings deposits of the producer up to a pre-specified amount and allows producers to withdraw from the programme, often without penalty, in years when farm income falls below a pre-determined level.

The outline of this report is as follows. Section 2 discusses a number of elements that should be considered in evaluating the design of risk management programmes. These range from design features that benefit producers, such timeliness and accuracy of response, to design elements that may help to minimise adverse and sometimes unintended consequences of programmes such as production or input distortions, or that contribute to the public costs of the programme such as adverse selection or moral hazard.[1] Subsequent sections discuss each of the risk management tools in turn: Section 3 examines disaster assistance programmes; Section 4 covers agricultural insurance programmes; and income stabilisation programmes and tax-based savings programmes are examined in Sections 5 and 6, respectively. Finally, Section 7 offers some key messages on how expenditures on risk management tools have evolved over the past two decades, and Section 8 summarises the main findings of the study.

2. Designing risk management policies

A well-established finding in the economic literature is that risk-averse producers tend to produce less under uncertainty than when expected yield and price outcomes are certain (Sandmo, 1971[8]; Newbery and Stiglitz, 1981[9]). Risk management instruments such as crop insurance generally improve welfare for risk-averse producers (Just, Hueth and Schmitz, 2005[10]); and in the presence of such contingency markets, risk-averse producers will grow more (Sandmo, 1971[8]; Feder, Just and Schmitz, 1980[11]). However, reducing risk with government polices is not always welfare improving; polices may reduce risk beyond what is socially optimal to keep incentives for upstream investments in resilience and risk management, investment and innovation.

In analysing the role for governments in providing support for risk management policies, it is important to distinguish between different layers of risk facing producers. For example, normal variations in production, prices and weather do not necessarily require a specific policy response. Such risks can be directly managed by farmers as part of a normal business strategy (OECD, 2009[12]; Antón, 2015[13]). By contrast, infrequent but catastrophic events such as severe drought or flooding or an outbreak of a highly contagious disease that affect many producers over a widespread area may require a public policy response, insofar as it is beyond an individual farmer's or the market's ability to cope with the loss.[2] These infrequent and systemic events are also more likely to lead to market failures in risk management. Moreover, climate change is changing this calculation – as severe weather events become more frequent and more severe, the probability of experiencing catastrophic negative impacts is likely to rise (OECD, 2020[1]). Risk perceptions may be misaligned with changing risk profiles, creating additional challenges for resilience and for policy design (Antón et al., 2012[14]; Antón et al., 2013[15]).

In between the normal and catastrophic layers of risk lies a risk layer that can be typically managed through privately-offered risk management tools such as futures and options contracts, production contracts, single peril crop insurance, or through credit markets.[3] The development of new privately-offered instruments

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[1] Moral hazard occurs when producers change their behaviour because of the presence of the risk management programme such that the probability of a loss is increased. Adverse selection occurs when the producers knows more the underlying risk than the provider of the risk management programme, which can affect their choices on participating in the programme.

[2] Markets for catastrophic losses exist for hurricanes and other widespread natural disasters where individual losses are typically highly correlated with area losses (see Box 1 in Section 3, below).

[3] Demand for risk management tools may be higher for larger producers whose household income is dependent upon on-farm income than smaller operators whose household income is more diversified and less dependent upon on-farm income (Prager et al., 2020[153]).

based on earth observation data (for example, vegetative index) or climate variables (for example, rainfall index) provides additional ways for producers to manage production risks (Hughes, Galeano and Hatfield-Dodds, 2019[16]).

The appropriate public role in developing and promoting risk management instruments must be carefully determined. Antón (2015[13]) points out that supporting farmers through risk management tools may create a bias in the relative costs of different risk management strategies (Chambers and Quiggin, 2001[17]). Risk management instruments that benefit from subsidies are oftentimes preferred by producers because of their income support component, not because of their risk management properties. This is unlikely to lead to efficient risk management strategies because it induces adverse selection, moral hazard and riskier production decisions.

In the discussion which follows, several programme elements are considered in the design of risk management policies. While some of those elements have been addressed in previous OECD reports [for example, see (OECD, 2009[12]; OECD, 2020[18]; OECD, 2020[1])], they are worth reviewing here.

Designing risk management policies to address market failures

Farmers have numerous ways to manage price and production risks (Wright and Hewitt, 1994[3]; Goodwin and Smith, 1995[4]; Harwood et al., 1999[19]; OECD, 2009[12]). Many of these are strategies to mitigate risks and may involve little if any government assistance. For example, investments in technologies such as irrigation can reduce the adverse impacts of production risks such as drought. Diversifying crop choices may spread weather and price risks across different crops or livestock, which helps reduce overall revenue variability (sometimes at the expense of total expected revenue). For example, a hog producer may also grow feedgrains such as maize and soybeans which gives them a natural hedge against fluctuating crop prices in that when crop prices rise (or fall), the implicit costs of feed rise (or fall) as well.

Likewise, to reduce price risk exposure, producers may invest in physical storage facilities to hold crop inventories which may give them more flexibility as to when to market their crops and to take advantage of future price rises. Producers also commonly mitigate farm income risks through savings and non-farm related employment. These measures help smooth total household income by absorbing some fluctuations in farm-related income.

Farmers also may benefit from private, commercially offered risk management instruments such as futures and options markets, cash forward contracts offered by merchants, production and market contracts offered by processors, and in some cases, privately-offered agricultural insurance. Farmers may benefit from agricultural information services which can help them manage their exposure to weather and price risks. These risk strategies are largely available without government intervention or subsidies.

Thus a threshold question for the design of public risk management policies is whether the policy addresses a market failure, or whether, because of the subsidised nature of the policy, it potentially crowds out a private market or undermines incentives for an on-farm strategy which would exist in its absence. For example, governments often provide public goods such as the gathering and publication of statistical data on crop and livestock production, market news services, public research and development and crop and livestock disease monitoring and inspection (OECD, 2020[1]). It is often argued that such programmes would not be broadly available for producers in the absence of government support.[4]

Yet sometimes the question of whether a policy constitutes a public good is not as easy to answer as it might appear. For example, while private markets for single peril insurance (such as crop/hail insurance)

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[4] With the advent of satellite and other information technologies, some would challenge whether the provision of statistical data is necessarily a public good (Gardner, 1983[150]).

have existed for over 100 years, markets for privately offered multiple peril crop insurance have largely failed (Goodwin and Smith, 1995[4]; Glauber, 2004[20]). While many might argue that multiple peril insurance is uninsurable (that is, a market failure), others point out that privately offered multiple peril crop insurance is uninsurable *at a price for which most producers are willing to pay* because cheaper cost alternatives exist to manage risks (Smith and Glauber, 2012[21]).

That said, as noted in the introduction, subsidised crop insurance has become a very popular risk management tool. And as Glauber (2004[20]) notes in his study of the development of the US crop insurance programme, absence of a subsidised crop insurance programme may simply mean that governments are intervening instead through *ex post* disaster programmes. The question of whether subsidised crop insurance is addressing a market failure may be less important than political economy arguments in contexts where the realistic alternative is another government-subsidised programme (such as disaster assistance). Nonetheless, in the design of such programmes, a key concern can be to ensure that scarce public resources are into being devoted to programmes that are crowding out similar instruments that are being offered privately.

Types of losses covered by risk management policies

A range of natural hazard risks are covered by risk management programmes in OECD countries from disaster protection against drought or flooding to multi-peril yield insurance covering losses from a variety of causes (insufficient rainfall, excessive rainfall, diseases, plant pests, hail, etc.). Most OECD countries offer some protection against natural disaster risks through disaster assistance programmes and/or crop insurance programmes.

Providing protection against price and revenue declines has become a more common feature in risk management programmes in countries such as the United States. Such policies may blur the distinction between risk management policies such as insurance and more conventional price and income support programmes, particularly if risk management products such as revenue insurance are highly subsidised by the government. Moreover, price risk instruments such as futures and options markets or cash forward contracts are often offered by private agents and, to the degree that government-subsidised products may be offered as well, there may be adverse crowding out implications. These issues will be discussed in more detail in Section 4.

Portion of loss covered by risk management policy

Two important elements to be considered in the design of risk management policies are 1) how much loss must be incurred to qualify for a payment, and 2) how much of the qualifying payment will be made by the policy and how much must be absorbed by the producer. The former is typically referred to as the deductible in the insurance literature while the latter is often called the co-payment.

Moral hazard is an insurance term that refers to the risk that once insured, producers may modify their behaviour in ways that increase the probability of, or fail to guard against, loss. For example, if producers believe that they will be fully indemnified for their loss, they may be less inclined to minimise those losses than they were in the absence of insurance. Insurance providers try to minimise moral hazard exposure through underwriting language that requires producers to follow "best management practices" – although these contract provisions are often difficult to monitor and enforce.

As a result, insurance contracts will typically also include deductibles and/or co-payments to minimise moral hazard issues. In doing so, the insurance contract forces the producer to absorb the first dollar of

loss through a deductible and share in a portion of the payment of qualifying losses through the co-payment.[5]

What is the role for government?

From a public policy standpoint, there is a further issue of how much support governments should provide to promote risk management policies and practices. At a basic level, governments can provide regulatory frameworks that allow for the development of commercially offered risk management products such as futures and options markets or credit and banking facilities. There is also a role for government in facilitating the development of information about agricultural risks and their consequences and in ensuring symmetric access to information necessary for the development of private risk-sharing markets and efficient risk management strategies (OECD, 2009[12]).

More controversial is the use of public subsidies to encourage participation in risk management programmes. For example, crop insurance programmes are largely subsidised around the world although the level of subsidy varies considerably among countries. In some countries, support is limited to subsidising the relatively high costs of programme delivery (Mahul and Stutley, 2010[22]). In many countries, however, governments provide additional subsidies to cover a portion of the costs of the pure risk premium (that is, the expected value of the underlying risk protection provided by the risk management instrument).

While there is some consensus that the government role should be limited to providing protection against catastrophic losses (OECD, 2009[12]), what constitutes a catastrophic loss is less clear. The domestic support disciplines for agriculture under the World Trade Organization (WTO) provide an implicit definition of a catastrophe or disaster based on the size of the losses. They define certain types of disaster assistance, crop insurance and safety nets as exempt from reduction commitments if those measures satisfy certain criteria laid out in Annex 2 of the WTO Agreement on Agriculture (AoA) (for a more in-depth discussion on compliance with WTO domestic support disciplines, see Annex B). Included in those criteria are provisions that state that losses must exceed 30% of a historical average production or income level (Glauber, 2015[7]).

It is important to stress that the criteria laid down in the AoA were negotiated – that is, they reflect a political consensus rather than being grounded in economic analysis. Accordingly, the value of a guarantee set at 70% of expected production or income as specified in the WTO criteria may nonetheless be quite large and may vary considerably in size depending on a number of factors including, but not limited to, the type of crop, type of practice (for example, irrigated versus non-irrigated), soil quality, and climate variability in the region in which the crop is grown. The frequency of such events may also vary significantly. For example, a yield loss of 30% or more may occur with much greater frequency for a dryland wheat farmer in Australia than a wheat farmer in northern France or in the Po Valley in Italy. Thus, what is "catastrophic" is less useful as an absolute measure and more related to specific characteristics of the crop/region in question, keeping in mind that these conditions may be changing due to climate change.[6]

Other international negotiations are also affecting development of (and support for) risk management policy tools. Specifically, the 2014-2020 European Common Agricultural Policy (CAP) included provisions for

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[5] If the amount of the co-payment exceeds the expected gain of the indemnity payment, producers have fewer incentives to deviate from best management practices.

[6] An alternative definition would be to describe "catastrophic" loss in terms of the individual loss distribution. For example, catastrophic loss could be defined as the level of severity where the probability of such loss was less than or equal to some percent (e.g. 5%). As discussed in the text, that level would vary by crop and location.

support for risk management tools under Pillar II on Rural Development through the adoption of EU Regulation No 1305/2013.[7] The regulation allowed Member States to use Rural Development funds for subsidies for agricultural insurance (article 37), mutual funds compensating production losses due to climatic, sanitary and environmental risks (article 38), and on an Income Stabilisation Tool (IST) (article 39). While the original regulation indicated that public support would only be provided to instruments with a loss threshold of at least 30% of production (the same threshold as laid out in the AoA), these limits were reduced under the 2017 Omnibus Regulation (Reg 2393/2017) to 20% of losses for insurance under article 37, a new sector-specific income stabilisation tool was added with a loss threshold of at least 20%, and the maximum support for each of the three tools was raised from 65% to 70% of eligible costs. Moreover, twelve[8] EU Member States chose to dedicate some Pillar II resources to risk management tools under the 2014-2020 CAP. It should be noted that other Member States (for example, Austria, the Czech Republic, Luxembourg, Poland and Spain) instead choose to support risk management tools outside of Pillar II and through the provision of state aid to insurance premiums instead (Bardají et al., 2016[23]).

What is the role of the private sector?

Even as many OECD countries provide public support for risk management instruments, the private sector is often utilised to deliver those programmes and occasionally to share risks with the government. For example, private banks may be used to establish producer savings accounts is the case in Canada. Agents or companies may be contracted to sell insurance contracts, to adjust insurance claims, and share in underwriting profits as they do in the United States. Insurance companies may design and sell insurance products as they do in France (Mahul and Stutley, 2010[24]).

It is argued that the private sector can provide a more cost-effective mechanism for delivery or that there may be stronger incentives for private companies to enrol producers in a programme than if delivery were left to government agencies. This is often true when the risk management tool is similar to what is delivered by the private company (for example, banking services or insurance sales).

Yet, as Smith (2019[25]) and Smith, Glauber and Dismukes (2016[26]) have shown, to the extent to which such services are subsidised, the private sector may also be prone to rent seeking. As a result, private sector delivery may be more costly than anticipated, particularly if new entry in the market is limited. To the degree possible, contracts with the private sector should be competitively structured (Glauber, 2016[27]).

But the role of the private sector in risk management is not limited to companies that develop or deliver risk management tools. Indeed, policy makers should not overlook the role played by farmers themselves in managing risk. Farmers can utilise a variety of tools and strategies to manage risk at lower or no cost to taxpayers, including diversification, precision agricultural technologies, irrigation, drainage and forward contracting.[9] Recent work has underscored the necessity of farmers cultivating their own entrepreneurship skills to improve their capacities both to absorb the impacts of shocks and help them to invest and adapt their operations to the changing risk landscape in the long-term (OECD, 2020[1]).

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[7] Risk management tools were first introduced under the 2007-2013 CAP in a limited way, when provisions were made for crisis prevention and management tools such as insurance and mutual funds in the fruit and vegetable and wine sectors under the Common Market Organization (CMO) of Pillar I. Subsequently, under Reg 73/2009 after the Health Check of 2008, these measures were made available to all sectors. For more information, see (Bardají et al., 2016[23]).

[8] Belgium (Flanders region), Spain (Castilla y León region), France, Croatia, Hungary, Italy, Lithuania, Latvia, Malta, the Netherlands, Portugal (Mainland, Azores and Madeira regions), and Romania.

[9] In some instances, governments may assist those investments through grants or low-cost credit, particularly when the investments help to finance wider public goods such as water quality improvements or enhanced biodiversity.

Subsidised risk management tools and distortions in resource use

Risk management tools like disaster assistance and subsidised crop insurance have been criticised for distorting resource allocation decisions, with impacts on the environmental sustainability of the sector. By their nature, risk management tools aim to reduce risk, which often leads to increases in production. However, when those tools are heavily subsidised, they may lead to distortions in crop mix, planted area, and input usage. These distortions may have significant environmental impacts, notably on water quality, soil erosion and greenhouse gas emissions. A review of empirical research on how publicly-supported risk management tools can impact resource use is given in Annex A, but some conclusions can be drawn here.

- Studies have mostly indicated that crop insurance subsidies have statistically significant but relatively small effects on the extensive margin; that is, insurance tends to have a positive but small impact on conversion of non-agricultural land to cropland.[10]

- Subsidised crop insurance likely has larger impacts on intra-marginal decisions regarding crop choice when insured crops compete against uninsured crops, or when crops where revenue products are available compete against crops where only yield products are available.[11] Such distortions may become even larger as new products are developed, such as margin insurance and supplemental coverage, particularly if such products are not widely available across crops.

- The evidence on the impact of crop insurance on input use is related, in part, to the effects on crop choice. To the degree that crop insurance shifts plantings towards more input-intensive crops, aggregate input usage may be affected. However, studies of the effects of moral hazard on input usage suggest small impacts that are largely statistically insignificant.

- Subsidised crop insurance can also dissuade producers from adopting risk-reducing technologies (Annan and Schlenker, 2015[28]; Miao, 2020[29]; Woodard et al., 2012[30]). Miao (2020[31]) cautions that crop insurance can be viewed as a reactive tool that focuses on short-term risk mitigation because farmers are covered after losses occur whereas new technologies such as drought-tolerant varieties can be viewed as proactive tools that would benefit farmers in the long-run because the uses of such new technologies would prevent losses in the first place. The literature suggests that further economic research is needed to explore how to balance the trade-off between short-term and long-term risk management tools, with the consideration of farmers' current need for a safety net to smooth the income in every harvest season and the future need for toolboxes to combat the changing climate (Miao, 2020[31]).

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[10] See for example, Claassen et al. (2011[111]) and Claassen, Cooper and Carriazo (2011[112]). Miller and Walter (1977[5]) found that standing disaster programmes in the United States also encouraged planting in marginal areas.

[11] Under the US programme, revenue products are mostly available for crops where there are viable futures markets for price discovery purposes (for example, maize, wheat and cotton).

3. The design of *ex post* disaster policies

Most OECD countries provide some form of disaster assistance to their agricultural sectors. Although the programme mechanics are typically similar, it is important to distinguish *ex post* disaster programmes based on natural disasters (such as floods or drought) from *ex post* assistance to cover losses from economic shocks. Examples of the latter include Canada's BSE[12] Recovery Program in 2003-04 that provided support to producers to compensate for lower prices for cattle subsequent to the discovery of a case of BSE in Canada, or more recently, the Market Facilitation Program that compensated producers for trade losses caused by counter-retaliatory tariff increases linked to trade tensions (Glauber, 2020[32]).

In this section, we focus on *ex post* assistance due to natural disasters.[13] For example, in the United States, four specialised disaster programmes provide assistance for livestock and tree fruit producers under the 2018 Farm Bill. Canada provides protection through the AgriRecovery programme. Almost all European Union Member States have provided *ad hoc* agricultural disaster recovery payments in recent years (European Commission, 2017[33]). Australia has made substantial progress in disciplining *ex post* assistance for some types of hazards, with a view to encouraging better *ex ante* risk management. With respect to drought, the government no longer provides *ad hoc* disaster assistance at the federal level, but some states and territories have continued to offer *ad hoc* drought assistance, including freight and fodder subsidies (OECD, 2020[1]).

In general, the literature on *ex post* disaster assistance programmes finds that these tools are economically inefficient – partly because they incentivise producers to take on more risk than they would in the absence of such programmes based on an expectation of receiving assistance. This expectation can either incentivise producers to underinsure (Deryugina and Kirwan, 2018[34]), or curtail other risk-reducing measures, including reducing inputs or discouraging certain management practices (Schoengold, Ding and Headlee, 2015[35]; Deryugina and Kirwan, 2018[34]). Their effectiveness as a risk management coping tool can also be questionable, with assistance typically delivered at a substantial delay to the incurred impacts of adverse events because the packages must be developed, approved and rolled out before assistance can be delivered. There is typically uncertainty about the timing or coverage of the *ex post* disaster assistance, which hinders the efficient use of other risk management practices and tools. For example, the EU regulations on the provision of state aid in response to an adverse climatic event allow for an aid scheme to be established within three years of the date of the occurrence of an event, with aid required to be disbursed within four years (ADE, 2018[36]). Indeed, delays in providing assistance and long processing times were identified as a major shortcoming of Norway's Natural Damages Act in a 2014 Review (NAA, 2014[37]).

In evaluating disaster assistance programmes, a number of design elements need to be considered.

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[12] Bovine Spongiform Encephalopathy.

[13] While the text focuses on the literature related to the design of natural disaster assistance programmes, expenditures on *ex post* assistance for both natural disasters and economic shocks are considered in Section 7.

How are disaster payments triggered?

Is there a framework for determining disaster payments or are they determined on an *ad hoc*, case-by-case basis? Studies from the OECD have shown that governments are better prepared to provide disaster relief if they establish a framework in advance that defines criteria for determining whether, and what types of, assistance will be available. Programmes determined on an *ad hoc* basis are often arbitrary and inconsistent from one year to the next and are often driven by political considerations (Glauber and Collins, 2002[38]; Deryugina and Kirwan, 2018[34]). Furthermore, because the decision on whether or not to grant *ad hoc* assistance is influenced by political processes, this assistance is not well-correlated with actual damages and may result in payments to farmers beyond their actual need (Garrett, Marsh and Marshall, 2006[39]). Determining disaster payments on objective criteria known in advance can give producers and agricultural lenders more certainty at the time of planting about what may or may not be covered in the event of a drought or other catastrophe. Disaster programmes with *ex ante* criteria also can obviate the need for *ex post ad hoc* assistance.

For example, under the Livestock Forage Disaster Program, US livestock owners who have suffered grazing losses on pasture land can qualify for disaster payments if the pastureland is located in a region suffering from drought (USDA-FSA, 2020[40]). Whether the region is in drought is determined by an objective designation that is published weekly in the US Drought Monitor, a publication produced through a partnership between the National Drought Mitigation Center at the University of Nebraska, the US Department of Agriculture and the US Department of Commerce, National Oceanic and Atmospheric Administration (USDA and NOAA, 2020[41]). The US Drought Monitor uses a five-category system labelled Abnormally Dry or D0 (a precursor to drought, not actually drought), and Moderate (D1), Severe (D2), Extreme (D3) and Exceptional (D4). An example of the classification system is given below in Figure 1. Under the Livestock Forage Disaster Program, regions are eligible if they fall in the D1-D4 categories.

Figure 1. United States drought monitor
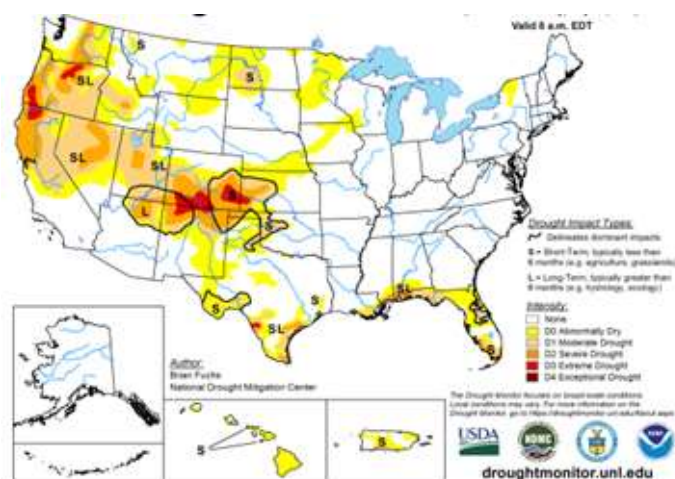
Source: United States Drought Monitor (2020), https://droughtmonitor.unl.edu/.

AgriRecovery provides Canada's government with a decision framework as to when to provide disaster payments to producers. Prior to AgriRecovery, "catastrophic" *ad hoc* assistance was granted for a variety of events, including drought, low grain prices and avian influenza (Antón, Kimura and Martini, 2011[42]). In contrast to the treatment of catastrophic events under previous policy frameworks, only certain types of

events are eligible for consideration under AgriRecovery - disease outbreaks;[14] pest infestations, extreme weather, and contamination of the natural environment. Unlike the US Livestock Forage Disaster Program, no public threshold criteria are defined; however, *ex ante* threshold criteria are defined for internal analytical purposes and the AgriRecovery framework outlines the steps to be taken to determine if an assistance package is warranted and details the criteria that must be met for each step (OECD, 2020[1]). Qualifying losses must be systemic and widespread in nature. For example, to trigger an initial assessment, the event must be judged to be non-recurring, abnormal, and result in extraordinary costs (that is, costs that farmers would not normally face, but must be incurred in order to resume operations or mitigate the impacts of a disaster, such as replanting of damaged trees). If an event meets these criteria, then a formal assessment is carried out to determine if *ex post* assistance is needed.

Lastly there are disaster programmes that are triggered on the basis of individual rather than systemic losses. For example, the US Livestock Indemnity Program indemnifies producers for livestock deaths "in excess of normal mortality caused by eligible loss conditions" (USDA-FSA, 2020[43]). The programme rules are known *ex ante* but unlike the Livestock Forage Disaster Program, payments are not triggered by regional events such as drought. In that sense, the programme is similar to an indemnity-based insurance programme for which the producer pays no premium.

Because there is no triggering mechanism other than individual losses, individual-based programmes are more likely to distort production decisions. Studies of US disaster programmes of the 1970s, by Miller and Walter (1977[5]), King and Oamek (1983[44]), and Gardner and Kramer (1986[45]) concluded that disaster assistance encouraged production of riskier crops on marginal lands due to the risk reduction it provided producers and the implicit subsidy component afforded by its protection.

As an alternative to an individual-based indemnity programme, Belasco, Cooper and Smith (2020[46]) examine a weather-based disaster programme where all producers of a crop within a county would be indemnified whenever estimated county yield for that crop fell below a guarantee. The county yield would be estimated using weather data which would allow for timely determinations of indemnities. The authors found that an area-based programme would provide catastrophic protection at a cheaper cost to more conventional crop insurance or individual-based disaster schemes, but because of the disparity between individual yields and regional yields (basis risk), yield protection for higher levels of coverage may be less than that provided under individual-based schemes.

Disaster programmes can be partially funded through fee-based assessments, where producers who pay into the fund are then eligible for payment in the event of a loss. If participation is universal, such mutual funds can potentially provide protection in the event of most widespread losses. Their success, however, can be compromised by the adverse selection problems that plague many insurance schemes: if the fee is high relative to the expected loss, there are few incentives to participate; if the expected loss is high relative to the fee, participation is high. Mutual funds can potentially help self-finance losses. However, their capacity to pool reserves may be insufficient to meet demand in the event of large-scale losses.

Timeliness and accuracy of triggering mechanisms

Ideally, triggering mechanisms should be accurate, objective, timely and cost effective. For example, if the disaster programme is triggered on catastrophic losses, a timely measure of how crop yields are affected is needed. Estimates based on statistical samples of regional and sub-regional yields may not always be available for some countries (at least not on a timely basis), but there may be alternative indicators such as rainfall and other climate variables or vegetative index values drawn from satellite data which provide

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[14] An AgriRecovery initiative of up to CAD 125 million was made available to help beef and pork producers due to processing plant closures and supply chain disruptions due to COVID-19 (Government of Canada, 2020[149]).

accurate and objective measures from which disaster determinations could be drawn. One such example mentioned in the previous section is the drought designation published in the US Drought Monitor, which is updated weekly and is widely viewed as an objective measure.

One disadvantage of basing disaster payments on area or indexed-based measures is basis risk, as individual losses are not perfectly correlated with area losses or index deviations. Nonetheless, basing a disaster declaration on a more aggregate measures may more aptly capture those crop losses that are systemic in nature, and hence, more catastrophic from a regional perspective.

Adjusting losses at the farm level is relatively costly, though those costs are reduced substantially if the disaster programme triggers payments only when the area loss is large enough and individual indemnities are calculated only once a disaster has been determined.

It should be noted that, as conditions evolve and event probabilities change under climate change, these triggers may need to be periodically analysed and adjusted. In this process, and to avoid the misalignment of risks and perceptions, actors should consider integrating findings from modelling and forecasting exercises in addition to considering past losses.

Degree of loss covered by the disaster programme

Most disaster programmes only partially indemnify losses. For example, under the US Livestock Indemnity Program, indemnification rates are determined annually based on 75% of the average fair market value of the livestock (USDA-FSA, 2020[43]). *Ex ante* moral hazard problems are less an issue for disaster triggered by systemic area losses; the disaster determination decision acts much like a deductible. However, indemnification rates that exceed the net market return from harvesting and selling the crop or animal may encourage *ex post* moral hazard after a disaster determination has been made [see (Mieno, Walters and Fulginiti, 2018[47]; Yu and Hendricks, 2020[48]; Wu, Goodwin and Coble, 2020[49])]. For example, a producer may have less incentive to harvest a crop if the indemnity rate is higher than the harvest price minus harvest costs. To minimise moral hazard, disaster programmes should base payment rates on transparent and market-based rates, and payment formula should include deductibles and/or co-payments.

Compatibility and integration with other risk management programmes

Disaster programmes should serve a particular niche in the overall farm safety net and not overlap with other risk management tools. In some countries, disaster assistance is the primary form of risk management or is available only for crops which are not eligible for other risk management tools like crop insurance. For example, the United States offers producers of uninsured crops, coverage under its Non-insured Crop Disaster Assistance programme (USDA-FSA, 2019[50]). Under the Canada Business Risk Management Platform, the suite of risk management instruments are constructed as complementary programmes addressing different segments of risk (OECD, 2020[1]; Office of Audit and Evaluation, 2017[51]). Disaster payments under the AgriRecovery programme take into account payments from other risk management programmes such AgriInvest and AgriInsure (Office of Audit and Evaluation, 2017[52]). In Italy, *ad hoc, ex post* compensation is available through the National Solidarity Fund (FSN) only where the damage is caused by an event not elaborated by the National Risk Management Plan.

If producers believe that the government will bail them out in the event of a disaster, they may be willing to forego participation in existing insurance programmes or to engage in other risk reducing and managing practices. Throughout the 1980s and 1990s, the US Congress passed supplemental *ad hoc* disaster legislation which provided disincentives to purchase crop insurance. To mitigate this effect, Congress allowed insureds to be indemnified under disaster legislation and in some disaster programmes, insureds were indemnified at a higher payment rate. This resulted in a double indemnity payment that sometimes over compensated producers for their losses and likely exacerbated moral hazard issues (Glauber,

2013[53]). Other countries have reinforced the incentives to insure by restricting eligibility for disaster programmes to producers who have signed up for insurance (Antón and Kimura, 2011[54]). At the same time, the literature has indicated that an expectation of receiving additional *ad hoc* assistance on top of insurance indemnities can incentivise producers to under-insure (Deryugina and Kirwan, 2018[34]). Policy design certainly has an impact on the scale of these interactions, but policy makers should be aware that offering both *ad hoc* assistance and subsidised insurance can result in higher public expenditure than would be incurred by offering only a single tool (Liesivaara and Myyrä, 2017[55]) and it could lead to over-compensation and moral hazard.

Box 1. Sovereign risk insurance to finance disaster relief

Arrow and Lind (1970[56]) demonstrate that when the risks are publicly borne, the social cost of risk-bearing is insignificant. However, as pointed out by Ghesquiere and Mahul (2010[57]), a key assumption for this result to be true is that returns from a given public investment are not correlated with other significant investments or components of national income. Experience suggests that the government's risk neutrality does not hold for most developing countries: small islands are too small to diversify their risks; the high level of indebtedness of some countries does not allow them to access post-disaster credit and thus limits their ability to distribute losses between generations; and budget processes in many countries do not allow governments to reallocate budget post-disaster, creating a liquidity crunch.

Various new instruments have become available that allow governments to more easily access international financial markets, enabling them to transfer their risk in order to better manage the budget volatility resulting from natural disasters (Cummins and Mahul, 2009[58]; Ghesquiere and Mahul, 2010[57]). Examples include catastrophe (CAT) bonds that were developed in the 1990s in the wake of Hurricane Andrew in Florida and the Northridge earthquake in California and sovereign risk pools like the Africa Risk Capacity (Clarke and Hill, 2013[59]; Kramer, Rusconi and Glauber, forthcoming[60]). These instruments are indexed instruments tied to observable weather phenomena such as droughts or hurricanes. Like indexed insurance instruments in general, there exists basis risk, but since these risks are aggregate at the national or regional level, the instruments may offer smaller nations with limited national reserves a hedge against large catastrophes.

Ghesquiere and Mahul (2010[57]) point out that the experience with CAT bonds suggests that governments interested in strengthening their response capacity to natural disasters will generally have to combine a number of financial instruments and policies that complement each other.

Mexico's CADENA programme offers one example of how sovereign risk insurance can be used to finance disaster relief. The programme is administered through Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and was introduced in 2003 to provide relief to smallholders when weather-related crop failures occurred (FAO and Red Cross Red Crescent Climate Center, 2019[61]). To incentivise the scale-up of the insurance, the federal government subsidises up to 90% of the premiums, which are paid by the state government. Indemnity payments are triggered once precipitation falls below a predetermined level and are paid out to the state government, which distributes direct transfers to farmers in the affected area. While initially focused on crop insurance against drought, CADENA has gradually expanded the types of weather shocks covered, as well as incorporating index-based livestock insurance into the programme (De Janvry, Ritchie and Sadoulet, 2016[62]).

Evidence suggests that insurance payouts allow farmers to cultivate larger areas of land in the subsequent growing season and lead to welfare gains due to higher household expenditure. While there are still challenges related to whether the payouts sufficiently cover the actual losses incurred by farmers CADENA's funding model has ensured the sustainability and longevity of a subsidised insurance scheme protecting vulnerable smallholders from climate risks (De Janvry, Ritchie and Sadoulet, 2016[62]).

Box 2. Takeaways on designing effective disaster payment programmes

- Disaster programmes should be aimed at providing protection for catastrophic systemic losses. A large deductible will discourage moral hazard and be less likely to influence crop mix and to discourage other risk management practices.

- The indicators to determine whether disaster payments should be made should be objective, well defined, to the extent possible measurable, and known to producers at the time planting and other production decisions are made.

- Indicators should reflect systemic loss within a well-defined region. The size of the region should be large enough so that it captures systemic risk across producers, but no so large that it introduces large basis risk.

- Loss thresholds should be set so that disaster events would trigger with relatively low frequency (for example, a 1 in ten-year event).

- Index-based loss thresholds can help to add predictability to disaster declarations, as they clearly specify the damage criteria *ex ante*, and remove political factors and uncertainties from the loss declaration process

- Indicators based on area yield or revenue losses are more focused on measuring economic loss, but those measures are likely to be less timely and accurate than weather-based measures such as rainfall or temperature.

- Individual loss determination formula should include deductibles and co-payments to minimise moral hazard issues post-disaster determination decision.

- Indemnities are in theory best based on individual loss. However, basing indemnity payments on indexes is cheaper to administer, and indemnities can be disbursed more rapidly than payments based on individual losses because index-based formula require no loss adjustment. There is a trade-off between minimising basis risk and reducing transaction costs and time delays.

- So as not to discourage participation in insurance markets, disaster payments should be restricted to producers who have signed up for insurance whenever available, or to productions that are not insurable in the market. Alternatively, if uninsured producers are indemnified under a disaster programme, they should be required to purchase insurance in the subsequent crop year.

- To defray the costs of disaster programmes, a mutual fund could be established where producers would have to contribute some fee prior to planting to be eligible for disaster payments.

- Disaster assistance payments should not overlap with other risk management programmes (should not indemnify the same loss as another programme). Disaster payments should avoid overcompensation of losses, particularly when they top up insurance indemnities or other programmes.

4. Agricultural insurance

Publicly-supported agricultural insurance programmes have grown rapidly in popularity over the past 20 years among OECD countries, as well as large emerging economies such as "China" and India. In its comprehensive survey of agricultural insurance programmes in 2007, the World Bank reported more than 100 countries offered agricultural insurance programmes (Mahul and Stutley, 2010[22]). In the United States, multiple peril crop insurance was first offered in the late 1930s and has grown to be the single largest safety net programme in terms of government outlays, overshadowing the more traditional price and income support programmes (Glauber, 2013[53]; Glauber, 2015[7]). Large insurance programmes exist in Japan and Canada and many European countries like Spain, France and Italy (Smith and Glauber, 2012[21]; European Commission, 2017[33]). Agricultural insurance programmes are also growing in Latin America, including in Chile, Colombia, Brazil and Mexico (Swiss Re, 2016[63]), and have been widely promoted in developing countries as risk management tools (Miranda and Farrin, 2012[64]). China, which had a limited programme at the time of the World Bank survey, has since grown to be the second largest programme in world (Glauber, 2015[7]) and producer subsidy statistics suggest that India's programme is a close third in terms of insurance subsidies (OECD, 2020[2]).

Agricultural insurance was once largely limited to single peril insurance (for example, crop/hail insurance) or multiple peril insurance which indemnified losses based agricultural crop yields. Now producers are offered insurance products which may be based on weather outcomes such as rainfall totals or temperature, offer protection against declines in revenue, or guarantee net revenue margins. Such innovations have sometimes blurred the distinction between protection against natural disasters and providing price and revenue support, particularly when such products are highly subsidised by governments.

Adverse selection and moral hazard

Like other lines of insurance, agricultural insurance programmes typically aim to be actuarially fair (that is, indemnities paid equal premiums collected on average).[15] Agricultural insurance markets often face poor actuarial performance, however, in part, due to problems of adverse selection and moral hazard (Wright and Hewitt, 1994[3]; Goodwin and Smith, 1995[4]). Adverse selection problems arise when the insureds know more about the underlying risks they face than those establishing insurance rates. Adverse selection tends to be minimised for single peril or index-based insurance since the loss is typically relatively easy to determine and measure. For example, with crop/hail insurance, actuaries can readily calculate the probability of a severe loss due to a hailstorm. Likewise, with an index-based product like rainfall insurance, rates can be based on extensive time series of meteorological data. At the same time, climate change may pose challenges to the degree that weather distributions change over time (for example, temperatures rise or rainfall patterns become more erratic). Failing to capture those trends in rates can exacerbate adverse selection problems (Antón et al., 2012[14]; Antón et al., 2013[15]).

Multiple peril crop insurance poses particular adverse selection problems for insurers because producers tend to know more about the individual risks affecting their crop production than does the insurer. Thus, in

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[15] In commercial insurance markets, premiums are typically set to cover delivery and other overhead costs as well.

the absence of subsidies, producers tend to purchase insurance if underpriced and not purchase the insurance if overpriced.[16] An adversely selected insurance pool will lead to net losses as indemnities over time will exceed premiums collected. Raising premium rates for all insureds will only exacerbate actuarial problems since the insurer is now left with a smaller, but still adversely-selected, pool of policies.

Improved individual loss data can help improve rates and help insurers to better discriminate across insureds through more accurate risk classification. Accordingly, producers facing higher production risks would pay higher premium costs than those facing lower risks. In the absence of better risk classification, adverse selection problems can be addressed by broadening the insurance pool. Some countries have made crop insurance purchases mandatory for participants in credit or other government programmes (Miranda and Farrin, 2012[64]). In Colombia, for example, since 2013, insurance coverage is mandatory for all agricultural credit backed by the public development bank Financing Fund for Agriculture (FINAGRO) (García Romero and Molina, 2015[65]), while in Poland crop insurance is obligatory for farmers receiving EU payments (Wąs and Kobus, 2018[66]).

Most countries have made insurance more attractive to participants through premium subsidies. As noted above, under the risk management toolkit of the European Union under the 2014-2020 CAP, insurance policies can be subsidised at up to 70% of premiums. In the United States, premium subsidies helped to drive the growth of the US crop insurance programme, with about 85% of eligible crop production now enrolled. Crop insurance rates (including the portion paid by the government) have tended to exceed premiums paid since the mid-1990s (Glauber, 2013[53]). Continued enrolment in the crop insurance programme has also resulted in an extensive database which has improved rate setting (Glauber, 2004[20]).

As with disaster assistance, moral hazard poses actuarial problems for insurers. Insurers attempt to minimise moral hazard problems through underwriting rules and through contract design. Underwriting rules such as establishing best management practices are useful for addressing moral hazard behaviour but they are often costly to monitor and enforce.[17] To minimise moral hazard, most insurance policies have either a deductible (that is, the producer must pay for losses up to an agreed upon level at which point the insurance begins to cover) and/or a co-payment where the insurer pays for only a portion of the indemnity (the rest being absorbed by the insured). For example, under the United States crop insurance programme, deductibles are often set at least 25% for crops for which actuarial experience may be limited.

Addressing adverse selection and moral hazard through index products

In most OECD economies such as the United States, Japan, Canada, France, Italy and Spain, agricultural insurance is generally characterised by indemnity-based programmes that provide crop and livestock coverage against named perils, multiple perils, and, more recently, price and revenue risks. Individual-based coverage is expensive because of the high cost of administering contracts and adjusting losses. Moreover, as discussed in the previous section, individual-based policies are prone to moral hazard and adverse selection problems, which add to the monitoring costs (Kalra, 2013[67]).

With such high costs, the larger agricultural insurance programmes are unsurprisingly found in developed countries and emerging economies. The high costs of contracting with large numbers of dispersed smallholders when there are fixed costs to contracting and poorly developed legal institutions for enforcing

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[16] Subsidies mitigate against adverse selection by encouraging participation. The US crop insurance programme is actuarially sound with a loss ratio below 1.0, but the government pays over 60% of premium costs, on average. The programme ran considerably higher loss ratios when the programme subsidy rate was less than 30% (Glauber, 2004[20]).

[17] Goodwin and Smith (1995[4]) and Smith and Glauber (2012[21]) point to the high costs of monitoring as a fundamental reason multiple peril crop insurance is considered prohibitively expensive without subsidies.

contracts have led many to conclude that conventional, indemnity-based insurance does not work for smallholder farmers in developing countries (Hazell, 1992[68]). To address these concerns, index-based insurance products based on specific perils or events (for example, regional yield loss, drought, or flood) and recorded at a regional level (for example, by regional weather stations) have been promoted. Examples of such products include area-yield insurance, where premiums and indemnities are based on the average yield in a region, weather-based indices, such as rainfall insurance, where producers receive a payment if rainfall in the region falls below a designated level (Skees, Hazell and Miranda, 1999[69]; Carter, 2013[70]), and more recently, insurance based on normalised differences in vegetation index (NDVI) drawn from satellite data (Turvey and McLaurin, 2012[71]). Such contracts typically minimise moral hazard and adverse selection issues (Miranda, 1991[72]) and can be provided at lower cost because loss adjustment and monitoring costs are so much lower. These products are increasingly being developed and made available in OECD member countries, including in Austria, Canada, France, Germany, Spain, Switzerland and the United States (Vroege, Dalhaus and Finger, 2019[73]). The increasing availability of geo-localised data from different sources, including remote sensing technologies, and the increasing capacity and accessibility of digital technologies to combine large and diverse datasets is an opportunity to further develop these instruments.

The primary drawback of index products is the existence of basis risk; that is, the degree to which the regional yield or weather variable is correlated with the individual farm yield. Basis risk can act to limit demand for producers whose yields are poorly correlated with the aggregate index as such insurance offers insufficient risk protection. Glauber (2015[7]) notes an exception in India's Weather Based Crop Insurance Scheme (WBCIS), an index-based insurance programme that has grown considerably since its introduction in 2007 to include more than 9 million Indian producers in 2010–11, with a combined commercial premium volume of about USD 260 million (Clarke et al., 2012[74]; Mahul, Verma and Clarke, 2012[75]). However, the high rate of participation is likely due to the fact that the programme is heavily subsidised, and participation is mandatory if producers participate in government credit programmes.

Government support for agricultural insurance programmes and the extent of private sector involvement

Because of those costs and in the absence of subsidies, demand for insurance products is low, which is why private unsubsidised markets for multiple peril insurance have generally failed (Wright and Hewitt, 1994[3]; Goodwin and Smith, 1995[4]) and why the larger insurance programmes in the United States, Canada, and Japan are generally highly subsidised.[18] In their comprehensive review of agricultural insurance programmes, Mahul and Stutley (2010[22]) found that almost two-thirds of the countries surveyed reported that they subsidised premium costs. Those countries accounted for more than 90% of total premiums, at an average subsidy rate of 47%. For example, the public costs of the US programme are projected[19] to average USD 8.2 billion annually over FY 2021 to FY 2030, an expenditure of almost 80 cents for every USD 1 premium written (CBO, 2020[76]).

Government support for agricultural insurance varies among countries and can cover a wide range of assistance, including support for delivery services, premium rate setting and contract underwriting, providing reinsurance and premium subsidies. Many countries, such as France, allow private insurance companies to design policies, set rates (including expense loading to cover their delivery costs) and to adjust losses. Private companies effectively compete on these services to attract producers. The

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18 Private (unsubsidised) insurance markets have developed for named perils (for example, crop hail insurance), where risks are more easily diversified across space and the costs of monitoring for moral hazard are low.

19 Based on long-run historical averages.

government then provides a premium subsidy to the producer to cover a portion of the total premium costs. In Spain, the government subsidises premium costs for the private sector, but also supplements private reinsurance for the companies through a stop-loss mechanism which covers catastrophic losses (Mahul and Stutley, 2010[22]; Antón and Kimura, 2011[54]; Smith and Glauber, 2012[21]). In Mexico, the government both subsidises premiums and provides reinsurance coverage through the public insurance company, Agroasemex (World Bank, 2013[77]). In Brazil, the government subsidises insurance premiums of accredited insurance companies (PSR programme) and of government programmes for small and medium farmers (GS and PROAGRO) (OECD, 2020[78]; Souza and Assunção, 2020[79]).[20] The Netherlands introduced limited premium subsidies on a temporary basis for multiple peril insurance in 2010, but these subsidies ceased in 2016, after it emerged that these policies were crowding out private hail insurance (European Commission, 2017[80]).

Mutual insurance companies, including small farmer agricultural insurance mutual funds, such as in Mexico (Mahul and Stutley, 2010[24]) are another way of delivering insurance. Shareholders (producers) in a mutual fund can improve monitoring, reduce moral hazard and adverse selection, and share in the profits of the company and thus potentially lower the costs of insurance. However, the pool of farmers in the mutual fund needs to be sufficiently large and diverse.

In the United States, private companies deliver, service and provide loss adjustment for policies, and share a portion of the underwriting risks with the federal government. The government sets rates and underwriting guidelines for all insurance contracts, subsidises on average 60% of the premium costs, and subsidises delivery of crop insurance through direct reimbursement of the company's administrative and operating expenses as well as providing reinsurance protection to cover a portion of the underwriting losses (Glauber, 2016[27]).

Subsidies have been instrumental in boosting participation in crop insurance programmes (Glauber, 2004[20]; Glauber, 2013[53]; European Commission, 2017[80]). Figure 2 shows how area enrolment in the US crop insurance programme grew as premium subsidy rates grew larger from the late 1980s to current times.[21] The subsidy rate reflects the portion of the risk premium paid by the government. It does not reflect the implicit subsidies for delivery costs paid by the government. Over the period 1989-2016, producers received about USD 2.20 in indemnities for every USD 1 collected in producer premiums (Smith, Glauber and Goodwin, 2017[81]). Over FY2021-FY2030, the Congressional Budget Office projects that premium subsidies will average between USD 6 billion and USD 7 billion.

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20 These subsidies are part of an integrated system that combines agricultural zoning tools and government support for insurance and credit. In order to be eligible for the support programmes, the farmer needs to follow the guidelines of the Brazilian Climatic Risk Agricultural Zoning (ZARC), which indicates regions and sowing windows according to their chances or probabilities of yield loss caused by adverse meteorological events (Souza and Assunção, 2020[79]). With this integrated system the government attempts to mitigate the problem of adverse selection by levelling the information and providing technical support to the farmer while reducing the cost of insurance with government support. According to EMBRAPA, ZARC has enabled a significant reduction in agricultural activity risks in Brazil, and the economic impacts associated with savings with compensation payments in programmes where ZARC is mandatory are estimated at nearly BRL 69 billion (USD 13.4 billion) from 1996 to 2019 (Minitti, 2020[155]).

21 Much of the growth in insured area after 2015 (22.5 million hectares) has been because of enrolment in the index-based Pasture, Rangeland and Forage programme.

Figure 2. Participation in the US crop insurance programme, 1989-2019
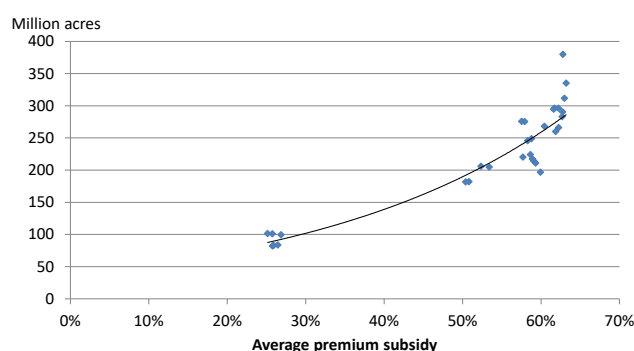
Source: USDA-RMA (2020).

Like other producer support measures, government insurance subsidies, particularly those which cover a portion of the risk premium, can potentially distort production decisions and adversely impact prices in world markets. A large literature[22] has looked at the impact of subsidised crop insurance on crop mix, resource use and production and has concluded that there is a small but significant distortionary impact on production (Annex A).[23] One conclusion drawn from those studies is that subsidies should be limited to the extent possible to delivery costs rather than subsidising the underlying fair risk premium.[24] Subsidising the fair risk premium essentially amounts to an income transfer in that the expected indemnity exceeds the pure premium costs.[25]

While there is an extensive literature on an analysis of the effects on subsidies on producer behaviour, subsidised delivery mechanisms have received far less attention. In the United States, delivery costs[26] (including the sharing of net underwriting gains and losses in the federal reinsurance agreement) cost over USD 2.7 billion annually and account for about one-third of the total costs of the programme (CBO, 2020[76]). In the US crop insurance programme, the government establishes premium rates. Because the

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[22] While extensive, this literature is overwhelmingly based on experiences from the United States. As indicated by Barnett (2014[84]), this imbalance is partly due to the fact that data regarding the performance of the US programme is publicly available, while data regarding the performance of MPCI programmes in other countries is more difficult to access.

[23] Other analyses have questioned whether scheme design may even lead to more damages as a result of a lack of incentives for damage prevention. See, for example, (Natural Damage Insurance Committee, 2019[85]).

[24] Here a distinction is made between the fair premium rate and the fully loaded premium paid by the insurer. The fair premium is equal to the expected indemnity payment. The fully loaded premium includes administrative and operating costs of the insurance company, including loss adjustments.

[25] Recent research (Bulut, 2018[154]) suggests that producers may limit their expenditures on crop insurance such that faced with reduced subsidies, would opt to lower coverage so as not to incur a proportionate increase in premium costs.

[26] Delivery costs under the US crop insurance programme refer to payments to Approved Insurance Providers to cover administrative and operating expenses associated with delivering the programme, such as the marketing of policies, application processing, premium collection or claims adjustment. More generally, all insurance programmes have transaction costs associated with marketing, assessing risk and calculating premiums, assessing the damage and calculating the indemnities: this transaction costs are added on the top of the "fair" premium to calculate the premium that is finally payed by the insured.

private companies cannot compete directly on premium rates, they often compete for books of business by offering independent crop insurance agents sales commissions that reflect the underlying profitability of the insurance policies (Smith, Glauber and Dismukes, 2016[26]). Smith (2019[25]) concludes that benefits to producers and insurance companies have resulted in political coalitions between farm interest groups and crop insurance lobbyists to obtain policy changes that benefit both at the expense of taxpayers. Crop insurance companies counter that they face large exposure through the reinsurance treaty with the government (Grant Thornton, 2014[82]).[27] Glauber (2016[27]) points out that allowing companies to compete on premium rates would pass any excess profits to producers. Alternatively, Smith, Glauber and Goodwin (2017[81]) have suggested that private sector companies could bid to sell and service policies and have the government act as sole reinsurer.

Making actuarial databases available to the public would also enhance competition and improve public oversight.[28] The Risk Management Agency of the US Department of Agriculture maintains a publicly-available actuarial database and a programme performance database dating back to the 1980s that allows comparison of performance across regions, commodities and insurance products. Few other countries offer this transparency, (a fact noted by Ker et al. (2017[83]) and Barnett (2014[84]), among others). This lack of transparency was noted as a drawback in evaluating the performance of Norway's Damage Pool Insurance scheme, for example (Natural Damage Insurance Committee, 2019[85]).

Box 3. Takeaways on designing effective publicly-supported crop insurance programmes

- Governments should avoid offering subsidised insurance products in markets where privately offered products are available.

- Premium ratings should be transparent and data driven to minimise adverse selection issues and to maintain an actuarially sound programme. Ideally, premium rates are based on accurate farm-level data regarding yields, planted area, rainfall, soil types and other factors that can affects rates. To the degree possible, databases on premiums, indemnities and subsidies should be made available to the public for research and oversight, and potentially increasing fair competition among private insurance companies.

- Ideally, subsidies should be limited to delivery costs and such that the fair premium rate falls below the expected indemnity payment. Subsidising fair premium rates encourages production distortions and can distort risk management decisions. Hazell, Sberro-Kessler, and Varangis (2019[86]) argue that if risk premia are initially subsidised to help encourage participation, they should be phased down over time or contain an explicit sunset clause. The history of agricultural subsidies would suggest that, once introduced they are difficult to terminate.

- However, subsidised programmes do exist and there are ways to make those programmes more effective and less distortionary:
  - If risk premia are subsidised, they should not favour one crop over another; subsidies should be decoupled where possible.

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[27] Under the US programme, the government sets premium rates and participating insurance companies cannot turn down producers for coverage even if they believe that the premium rate set by the government is not sufficient to cover the expected indemnities of the producer. The Standard Reinsurance Agreement allows companies to place more risky policies in an assigned risk fund which has a more limited exposure, but nonetheless, they retain a limited amount of liability (Glauber, 2016[27]).

[28] Hughes (2018[151]) argues that better farm level data would facilitate the development of drought insurance.

5. Income stabilisation schemes

Income stabilisation programmes aim to provide protection if farm income falls below some threshold value. Included in the discussion here are revenue insurance schemes such as those offered in the United States, where producers pay subsidised premiums for revenue protection. Like other insurance products, premium rates are established based on the expected indemnity. In other countries like Canada,[29] income stabilisation schemes are available to protect producers whenever incomes fall below a threshold but for which no actuarial premium is calculated and collected, even if a fee could be charged.[30] These programmes resemble more traditional income support programmes. Because prices tend to be negatively correlated with yields and costs, revenue or income losses are typically less variable and require fewer indemnities than crop insurance (OECD, 2011[87]).

Revenue insurance is now offered by a number of countries, the most prominent of those being the United States where revenue policies account for over 70% of current crop insurance liability (Smith, Glauber and Goodwin, 2017[81]). Italy offers revenue insurance for durum and soft wheat (OECD, 2020[1]). In addition, some OECD countries offer margin coverage which indemnifies producers if their net margins (revenues minus costs) fall below a threshold level. Some programmes, such as Canada's AgriStability programme are integrated with the other suite of business risk management programmes and base indemnity payments after taking into account payments received under other programmes (such as AgriInsure) (Office of Audit and Evaluation, 2017[51]; OECD, 2020[1]).

While such programmes are often referred to as income stabilisation schemes, they are more accurately concerned with guaranteeing a minimum revenue or income.

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[29] Although fees for Canada's AgriStability programme are not actuarially sound, they do scale based on coverage.

[30] A uniform fee could recoup some or all of expected indemnity costs, assuming mandatory participation.

Design features of income stabilisation schemes

A number of design elements are important to consider when designing revenue programmes.

- Is the scheme based on whole farm revenue/income or does it guarantee commodity-specific revenue/income?

  Because crop (and livestock) revenues are typically not perfectly correlated, the variance of total farm income will be less than the sum of the individual commodities. This means that the costs of insuring income will be less when measured on a whole farm basis than if the agricultural products were insured individually. However, in some regions where farm production is often very specialised (for example, row crop production in the US corn belt) whole farm protection may offer less advantages over commodity-specific protection.

  Providing protection on a whole farm basis is also less distortionary from the standpoint of favouring one crop over another. From the studies in Annex A, commodity-specific crop insurance products tended to be most distortionary when subsidised insurance is available for some crops but not others.

  Following the same argument, the cost of insuring whole farm household income (including off-farm income) would also be in general lower than protecting income from a single activity. In that case, the programme could be part of wider social safety nets, even of accounting for the specificities of farming compared to other sources of income. The information from the income tax and social security systems would be crucial.

- *Does the scheme guarantee revenue, costs-of-production, or net revenue (revenue minus costs of production)?*

  The United States has offered commodity-specific revenue insurance since the 1990s (Glauber, 2013[53]). The products guarantee up to 85% of the expected revenue at planting and have an additional feature that indemnifies crop losses at the higher of the futures price at planting or at harvest. Revenue products accounted for almost 85% of total area enrolled in the programme in 2019 (USDA-RMA, 2020[88]). Commodity-specific revenue products are also available on an area basis though participation in those products is more limited, about one half million hectares enrolled in 2019 compared with over 82 million hectares enrolled in individual-based revenue plans (USDA-RMA, 2020[88]). Italy offers revenue coverage for common wheat and durum wheat but limits guarantees to no higher than 70% of the expected revenue.

  In 2019, Italy introduced an income stabilisation tool (IST) available for selected agricultural products including fruits and vegetables, durum wheat, cow's milk, olive cultivation, and poultry (OECD, 2020[1]). The IST is part of the risk management toolbox under Pillar II of the CAP, and uses a cost index to calculate individual farm losses and indemnities in the event that there is no public information on farm income (such as a fiscal declaration). It has a 20% deductible (that is, the calculated losses must fall 20% before the IST pays an indemnity) and the premiums are subsidised up to 70%.

  In recent years, the United States has introduced margin-based insurance policies for livestock that calculate the margin based on the difference between the output price (for example, the price of swine) and input costs (for example, the costs of corn and soybean meal). In 2017, a crop margin insurance programme was introduced that is area-based. Margin insurance can be purchased by itself, or in combination with the more traditional yield or revenue insurance policy. However, if combined, the indemnity payment is offset by the indemnity payment under the yield or revenue policy. In 2019, about 172 000 hectares were enrolled as a stand-alone policy and 429 000 hectares enrolled in combination with other insurance plans (USDA-RMA, 2020[88]).

Canada's AgriStability programme provides whole-farm support (in contrast to AgriInsurance, their commodity-based crop insurance programme), for large margin declines (a decline of 30% or more relative to a farm's historical reference margin) (OECD, 2020[1]). Under AgriStability, producers can be indemnified for up to 70% of the reference margin which is determined as a five-year Olympic average (where the high and low values are omitted).

● *How is the guarantee established?*

Realised revenue is relatively straightforward to measure (quantity times price) but to avoid moral hazard issues (and thus ensure producers have incentives to market their crops and livestock at the highest prices) plans often base the realised revenue on published prices (as opposed to actual receipts). For example, US revenue insurance and margin contracts are calculated using futures contracts at harvest. Estimating expected prices to establish the insurance guarantee may be difficult if there is no organised futures market as there are in some countries. In the United States, for example, revenue products are largely limited to those commodities for which there are actively traded futures contracts. Revenue products based on past prices may inadvertently overestimate (or underestimate) expected prices at the time of insurance or programme enrolment. Establishing a revenue guarantee based on prices that are above (below) expectations may bias insurance rates downward (upwards) and thus encourage adverse selection.

Estimating costs for calculating margins presents large adverse selection problems if actual cost receipts are used. Insurance products such as the crop margin protection insurance in the United States minimise adverse selection by using cost indices based on best management practices (for example, appropriate input application rates).

Lastly, just as was discussed for prices, establishing guarantees for whole farm revenue on historical farm revenue or income may encourage moral hazard or adverse selection (or both). Underwriting rules may minimise those problems. However, if producers are locked into crop mixes reflecting historical allocations, they may be prevented from responding to market prices in their planting decisions. In regions where historical crop rotations are prevalent (for example, corn-soybean rotations in the US corn belt) historical values may be reasonable, but even there, overly strict rules about how much producers can deviate from historical allocations can potentially bias crop choice, essentially coupling production decisions to the risk management instrument.

● *Does the revenue include payments from other government programmes (for example, crop insurance or price and income support payments)?*

Explicitly accounting for payments (and costs) from other government programmes when calculating revenue (or net margins) for indemnification purposes avoids double payment for losses. As discussed in Section 3, *ad hoc* disaster payments in US programmes in the 1980s and 1990s invariably paid for losses that were covered by crop insurance policies. Producers in effect received double payments. Not only was that a costly practice, it also encouraged moral hazard (Glauber and Collins, 2002[38]). The current crop margin programme in the United States and Canada's AgriStability programme explicitly include indemnity payments made and premium costs paid by producers under the crop insurance programme. Further, payments under these programmes are linked in a producer's income tax obligations.

Accounting for other payments and programs can affect the timeliness of payments. For example, crop losses must be calculated, or, if revenues are considered, prices must be determined as well. Payments under an income stabilisation scheme could be delayed until after season average prices are determined—potentially long after harvest.

- *Is it possible to link the income stabilisation programme to tax declarations?*

  Income stabilisation programmes tend to require large amounts of data from the producer in order to determine payment eligibility and calculate payments. However, much of the same data is already provided by farmers in yearly income tax declarations. By linking the income tax files to the income stabilisation programme and using the tax information to estimate income losses, programme transparency and predictability could be improved (Antón, Kimura and Martini, 2011[42]).[31]

Box 4. Key takeaways in the design of income stabilisation schemes

- Similar to crop insurance, subsidies for revenue insurance should ideally just cover delivery costs or be restricted to covering production risks only. Subsidising price or revenue risks potentially crowd out private markets (such as futures and options markets or cash forward markets) and may be highly distorting.

- To the extent possible, revenue guarantees should be based on expected prices and not past prices and incomes. Where possible, contracts should utilise private markets (such as futures markets or production contract prices) to establish proxies for expected prices. In the absence of future markets or reliable price information on forward contracts, revenue or income insurance may not be sustainable.

- To avoid moral hazard issues, insurances covering the cost of production should be based on a cost index rather than actual producer costs. The cost index should be constructed using publically available input price data and established good management practices regarding input usage.

- In designing whole farm policies, underwriting rules need to be implemented that minimise moral hazard but allow for producers to make planting and farm management decisions based on current price expectations and not be locked into historical planting decisions.

- Apart from AgriStability in Canada, there is little experience on income stabilisation schemes (particularly as the income stabilisation tool available under the CAP's risk management toolbox has only recently been made available in a small number of European countries). When designing these schemes it is important to dedicate sufficient resources to monitoring and evaluating the results.

- When designing income stabilisation schemes, the possibility to integrate them – with the appropriate adjustments – into economy wide social security or tax systems should be considered. Opportunities to use farmers' data from these sources should also be explored.

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[31] Tax declarations and final tax statements for agriculture often have a significant time lag, which could prevent timely payments. Because there is often significant scope to adjust tax relevant annual farm accounting positions to shift tax burdens between years, the usefulness of annual tax information for loss estimation may be limited and introduce significant moral hazard issues.

6. Tax and savings measures

OECD (2020[18]) treats taxation issues in agriculture more broadly. In this section, the focus is on tax policies which serve as risk management tools to smooth income, but it is recognised that tax incentives may be created to encourage producers to adapt risk-reducing technologies (for example, tax credits for irrigation investments or accelerated depreciation schedules to encourage investments (Williamson and Stutzman, 2016[89]; Polzin, Wolf and Black, 2018[90]).

Tax measures to smooth taxable income over time

Some countries (for example, Austria, Canada, France, Germany and the United States) allow farmers to use cash accounting rather than accrual methods.[32] Cash accounting recognises revenues and expenses at the time physical cash is actually paid or received (OECD, 2020[18]). This gives farmers flexibility on when to report revenue and expenses for tax purposes.

Income averaging allows farmers the flexibility to smooth their variable taxable incomes, which helps to reduce their tax burden. As pointed out in OECD (2005[91]), under systems that tax income one year in arrears, businesses where income fluctuates from year to year (as can be in the case in agriculture) may have to confront situations where their tax bills for high income years must be paid in a low-income year, amplifying the fluctuation in post-tax disposable income. This problem may be exacerbated in tax systems with highly progressive tax rates. A number of countries offer income averaging measures for their farmers including Australia, Canada, France, Germany, Ireland, Norway, the United Kingdom, and the United States (OECD, 2020[18]). Other countries such as the Netherlands offer income averaging, but it is not specific to agriculture.

Tax deferral schemes

Tax deferral schemes allow producers to place income in a savings account and defer payment of taxes until a later period. The main benefits of a tax deferral scheme are improving liquidity when incomes are low (through savings) and tax progressivity [by depositing income in the deferred tax accounts when income (and marginal tax rates) are high and withdrawing savings when income (and marginal tax rates are lower)].

Australia's Farm Management Deposit (FMD) scheme allows primary producers (with no more than AUD 100 000 of non-primary production income) to defer their income tax liability (National Rural Advisory Council, 2012[92]; OECD, 2020[18]). Primary producers are able to claim deductions for primary production income that they deposit in an FMD with an Authorised Deposit-taking Institution (ADI) in the year it is earned. Funds must be held for at least 12 months. The FMD is included as assessable income in the year it is withdrawn or is deemed to have been withdrawn. Farmers may hold multiple accounts subject to an overall limit on deposits made under the FMD of AUD 800 000 (OECD, 2020[18]).

The scheme provides farmers with early access provisions if they made their FMD in the previous financial year, have held their FMDs for at least six months and can demonstrate that an area of their farming property has been affected by rainfall deficiency for six consecutive months. To be eligible, the rainfall

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[32] In Germany, this possibility is an exception open only for small farms, which do not exceed specific limits with respect to revenues and economic size, is thus relevant for less than 10% of total agricultural output.

must be within the lowest 5% of recorded rainfall for their property for that six-month period (Department of Agriculture, Water and the Environment, 2020[93]). These provisions ensure an FMD can be accessed without losing associated taxation benefits and help farmers recover from lower production or profitability.

Available since 1999, the FMD scheme has been very popular among Australian farmers.[33] In the recent Taxation in Agriculture report, the OECD (2020[18]) reports that as of June 2019, there were 53 790 accounts and the total amount deposited was AUD 6.8 billion. In June 2004, when the previous report was prepared (OECD, 2005[91]) there were 43 309 accounts and the total amount deposited was AUD 2.6 billion.

New Zealand offers an income equalisation scheme that provides producers in agriculture, forestry, and fishery industries with a means to defer income taxes (New Zealand Department of Inland Revenue, 2021[94]). Businesses pay the income into a special account, which earns interest at 3% on amounts left on deposit for more than 12 months. The interest paid becomes part of the deposit for tax purposes. The government holds the deposit for up to five years, with the deposit being tax deductible in the year in which it is made. Any withdrawals (including interest) are generally assessable (counted as taxable income) in the year businesses apply to withdraw them. In normal circumstances, an amount may not be withdrawn unless it has been on deposit for at least 12 months. Just after 31 March each year, taxpayers who have reserve scheme deposits are sent a statement showing their current balance and any interest credited to the account.

As of 1 January 2019, France has implemented its new annual tax deduction for precautionary savings scheme (DEP) (OECD, 2020[18]). Similar to Australia's FMD scheme, farmers can make tax deductions provided that the income deducted is placed in a savings account (although unlike Australia's scheme French farmers are only obligated to deposit between 50% to 100% of the money deducted). Savings can be used in the following ten years on all business expenses, at which point they become taxable.

Producer savings accounts

Canada's AgriInvest programme is a self-managed savings account into which a producer deposits after-tax funds and receives matching government contributions (Office of Audit and Evaluation, 2017[51]). The funds can be used to cover small income declines or to make investments in risk management or to help improve market income. The design intent of the programme is to cover shallow losses between 85% and 100% of expected net revenue (Antón, Kimura and Martini, 2011[42]).

Under the AgriInvest programme, a producer can contribute up to 100% of their Allowable Net Sales (ANS)[34] with the first 1% matched by the government, not to exceed CAD 10 000. Since 2009, AgriInvest has been federally administered and accounts are held by financial institutions in all provinces except Québec.[35] For AgriInvest, the maximum allowable ANS is CAD 1 000 000 and the maximum account balance is currently capped at 400% of the ANS. Producers can withdraw funds at any time through their financial institution.

There are two funds in the AgriInvest savings account. Producer deposits are held in fund 1 and the government contributions are held in fund 2. Because fund 1 holds producer after-tax deposits, withdrawals

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[33] The Farm Management Deposit Scheme is a successor to two prior income deferral schemes: the Income Equalisation Deposit Scheme, introduced in 1976, and the Farm Management Bond Scheme, introduced in 1992 (National Rural Advisory Council, 2012[92]).

[34] Allowable Net Sales are the net sales of most primary agricultural commodities except those covered by supply management (dairy, poultry and eggs).

[35] In Quebec, the programme is delivered by La Financière agricole du Québec (Office of Audit and Evaluation, 2017[51]).

from fund 1 are not taxable. Government contributions (fund 2) and interest earned on both funds are not taxed until withdrawn and are taxed as investment income.

Based on a 2014 survey, 89% and 88% of allowable market sales were covered in 2013 and 2014 respectively (Office of Audit and Evaluation, 2017[51]). The average annual AgriInvest contribution by producers was CAD 2 490 and total contributions averaged CAD 259 million per year during 2013-14. Government contributions as a percentage of maximum matchable contributions were 92% in 2013/14 and 91% in 2014/15 (Office of Audit and Evaluation, 2017[51]).

Annual government costs of AgriInvest (including both federal and provincial shares) averaged CAD 263 million over 2013-17, compared to CAD 322 million over 2007-12 (OECD, 2020[2]). AgriInvest account balances have grown to almost CAD 2 billion in 2014/15. However, in recent years, the rate of increase in account balances has slowed due to an increase in withdrawals and reduced contributions due to programme changes, such as the reduced payment rate (a reduction in matching contribution from 1.5% to 1%) and government maximum contribution (from CAD 15 000 to CAD 10 000) (OECD, 2020[1]).

The programme is widely used by Canada's farmers, with 75% of producers participating in the programme in 2014 (Office of Audit and Evaluation, 2017[51]). However, the average annual contribution is quite low, ranging from CAD 2 000 to CAD 3 500 between 2007 and 2014, and the average account balance is estimated at CAD 23 000 (Del Bianco, 2018[95]; Office of Audit and Evaluation, 2017[51]).

One criticism of the programme has been that despite the matching funds provided by the government contributions, on average farmers are not accumulating individual AgriInvest balances that are high enough to deal with catastrophic losses (Office of Audit and Evaluation, 2017[51]). However, as pointed out by Antón, Kimura and Martini (2011[42]), the intention of the programme has been to cover shallow losses (up to 15% of expected net revenue), not to address catastrophic losses. Another criticism has been that producers do not draw down AgriInvest funds during periods of shock or income decline, suggesting that while farmers have participated in the programme to take advantage of the matching contribution, AgriInvest plays little role in helping farmers to manage income risk (Antón, Kimura and Martini, 2011[42]). This may point to the fact that matched savings accounts have limited use as risk management tools.

Box 5. Guidelines for policy design of tax-deferrals and savings schemes

- Tax deferrals and subsidised savings schemes are a form of subsidised self-insurance. These programmes are typically used to cover only shallow losses.

- Furthermore, there is evidence in developed countries with well-developed financial markets, that high subsidies on saving accounts may lead to the scheme being used as a means to maximise government support. Subsidies on the top of the tax benefits of the scheme (such as matching government funds) should be limited to avoid these rent seeking effects.

- How large should the cap on balances be? Limiting account balances may limit the ability to use the fund in any way other than to cover shallow losses or hamper the ability to cover back-to-back losses if there are periods of lingering drought for example. Both FMD and AgriInvest have raised those caps over time to reflect growing farm size and farm revenue. On the other hand, if uncapped, a producer may deposit enough to capture the full government match and use the account more as a retirement account.

- Unsubsidised savings accounts with no or very limiting matching funds from the government, but with generous tax-free or tax deferral design and high limits on the total balance of the account, will reduce the costs of the policy and are likely to have greater success in encouraging the build-up of farm savings to be used for risk management purposes.

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7. The evolution of expenditures on risk management tools

Regardless of the form taken, interest in risk management policies has grown over time, and expenditures have grown in parallel. At the same time, efforts to systematically track or analyse this growth have been fragmented, typically either focusing on a single risk management tool (such as insurance), or otherwise limited to a policy inventory without quantitative analysis. However, using policy information already captured within the OECD Producer Support Estimate (PSE) database, it is possible to identify the risk management policies discussed above and construct a database thereof in order to draw some broader conclusions about their use (Box 6).

Box 6. The Risk Management Tools Database

In order to provide quantitative information on risk management expenditures, a database of risk management tools was constructed using information already available in the OECD PSE database. Each country's inventory of policies was reviewed, and policies that fit the criteria described in Section 2 were included and classified accordingly. A similar exercise was undertaken in Chapter 3 of (OECD, 2009[12]).

At the same time, some important caveats should be noted when interpreting the expenditure data contained within the database:

- The database strives to be comprehensive in covering all risk management programmes reported in the PSE. However, if a programme is not reported, then expenditures are not captured. In one example, many countries allow farmers to use general tax averaging provisions for risk management purposes, but these policies are not specific to agriculture, and thus are not captured within the PSE.

- Countries have implemented a wide variety of programmes that contribute to the accomplishment of risk management or resilience-building objectives that are not classified within the PSE, or that do not fall under the current programme classification, and are thus not captured in the current database. These expenditures include programmes for animal disease prevention (captured under GSSE spending), or, as an example of a PSE programme that does not fit under the current classification, the Mexican subsidies for price hedging instruments under ASERCA.

- Long-standing programmes that either compensate solely for low prices or that establish price floors are not included in the database. While such policies are countercyclical with prices and do arguably serve a risk management function, including these policies would necessitate the inclusion of any policy that acts as market price support, including tariffs and other border measures. This was the approach taken in (OECD, 2009[12]).

- Some programmes in the PSE include expenditures on measures with multiple components, but it is not always possible to break down the expenditure further to isolate exact amounts spent on the risk management tool in particular. In these cases, the programme was classified using the best available information. Examples include the India cattle development programme, which includes funding for insurance and was included.

- In some cases, the distinction between income or revenue insurance programmes and income or revenue stabilisation programmes can be ambiguous. For the purposes of this database, only programmes where premiums are actuarially based are classified as insurance programmes.

- *Ad hoc* assistance for animal disease outbreaks is classified according to the nature of the losses for which the expenditures are actually compensating. When assistance compensates for export market losses associated with the presence of a disease, it is classified as *ad hoc* assistance for economic shocks. If the assistance compensates for actual production losses in the form of either mandatory culls or natural losses from disease, the assistance is classified as *ex post* natural disaster aid.

- *Ex post* natural disaster aid need not always be delivered in the form of direct aid. Any programme that provides some sort of compensation in response to a natural disaster was included in the database, including assistance for drilling boreholes in times of drought or emergency assistance for providing livestock feed during either flood or drought events.

The data indicate that since at least 2000 – as border measures and price guarantee programmes were dismantled following the Uruguay Round – governments increased expenditures on a variety of risk management policies: *ex post* natural disaster aid, *ad hoc* assistance for economic shocks similar in form to disaster aid, insurance subsidies, income and revenue stabilisation policies, and tax and savings measures. Expenditures on these programmes have more than doubled, from around USD 15 billion per year in 2000 to an average of USD 33 billion per year in 2017-19. While the composition of this assistance fluctuates from year-to-year depending on weather and market conditions, nearly all of the growth has been in insurance programmes, as more governments offer insurance subsidies, and as more producers subscribe to subsidised insurance policies (Figure 3).

Figure 3. Government expenditures on risk management tools, 2000-2019
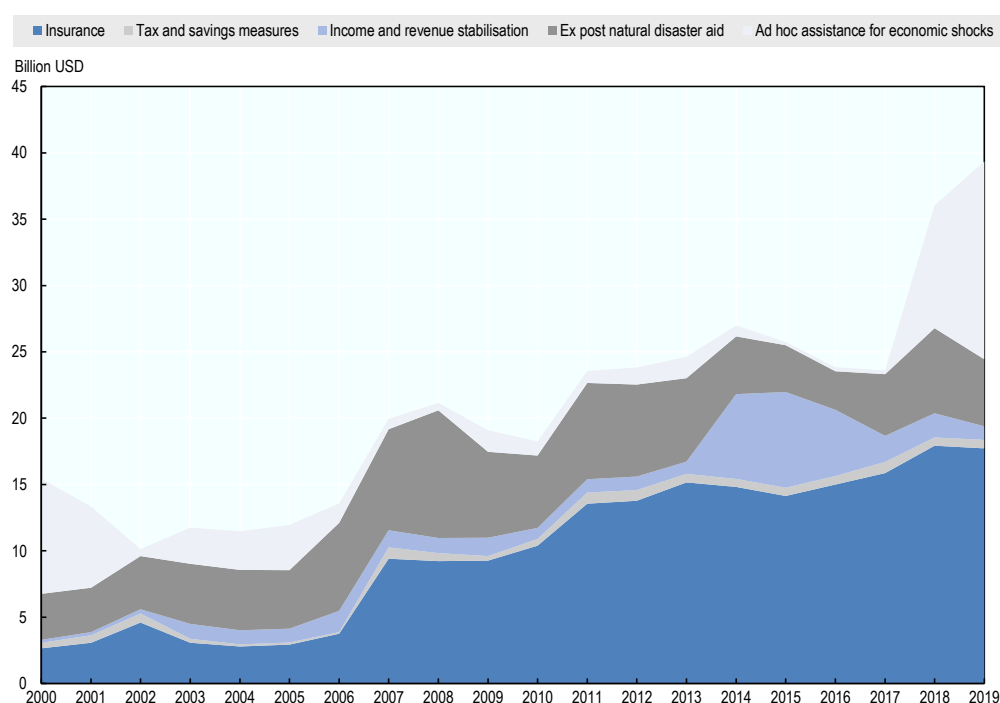
Note: Expenditures represented are from all countries available in the PSE database.
Source: Authors' calculations based on OECD (2020), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

At the same time, these expenditures are largely concentrated in a handful of countries – partially reflecting the political context of how certain countries choose to deliver support, and also somewhat related to the overall value of agricultural production (Figure 4). In particular, the United States has a long history of supporting risk management tools, with insurance programmes typically accounting for the bulk of expenditures. China's expenditures on risk management tools have experienced the highest growth over the period, increasing more than tenfold from USD 560 million per year in 2000 to more than USD 7 billion per year in 2019. While early growth came in the form of natural disaster aid, in 2017-19, nearly three-quarters of China's risk management expenditures could be attributed to insurance. Expenditures on risk management tools have also typically exceeded USD 1 billion annually in Canada and the European Union, although expenditures in Canada have fallen somewhat from levels seen in the late 2000s. Since 2015, risk management expenditures in India have exceeded USD 1.4 billion as well. Spending in remaining countries tends to rise and fall with the incidence of major natural disasters, but increasing spending on risk management tools can be observed in some countries, including Korea, Mexico and Turkey.

Even in countries with large insurance programmes, substantial *ex post* natural disaster payments continue (Figure 5). Summing expenditures on insurance or disaster assistance for the countries with the largest agricultural insurance programmes (in descending order, the United States, China, the European Union, India, Canada, Japan and Brazil), average expenditures on natural disaster assistance has changed little since 2000. Accordingly, if these insurance programmes were primarily intended to replace natural disaster assistance packages, that objective has yet to be achieved uniformly (though some countries have had greater success in this area than others).

At the same time, these large absolute figures somewhat mask the relative importance of these programmes in either overall country expenditures, or in relation to farm income. Accordingly, normalising risk management programme expenditures as either a percentage of the PSE or of gross farm receipts can give some indication on the relative size of these programmes.

With respect to the PSE, some countries dedicate a large proportion of their expenditures on agriculture toward risk management instruments (Table 1). In most cases, in countries where producer support is lower than the OECD average, spending on risk management tools makes up a relatively high share of support. In particular, from 2017 to 2019, Australia, Canada, and the United States all directed more than 30% of their producer support to risk management tools. At the same time, the form of this assistance varies. The overwhelming share of Australia's risk management assistance comes from its Farm Management Deposit Scheme and tax averaging programme; Canada's support is split between insurance, income and revenue stabilisation and tax and savings measures; while support in the United States over that period was largely focused on insurance and *ad hoc* assistance for economic shocks. Over the same period, Brazil spent 15% of producer support on insurance programmes. Surprisingly, although China is the second largest spender on risk management tools, those expenditures amounted to less than 5% of its total producer support in 2017-19. Moreover, while risk management tools may constitute a large portion of producer support in some countries, they typically account for only a small portion of farm income. In fact, expenditures on risk management tools exceeded 1% of gross farm revenue during 2017-19 in only Australia, Canada, Norway and the United States.

Figure 4. Government expenditures on risk management tools by country, 2000-19

A. Top 5 countries relative to the rest of the world

B. Expenditures in selected additional countries
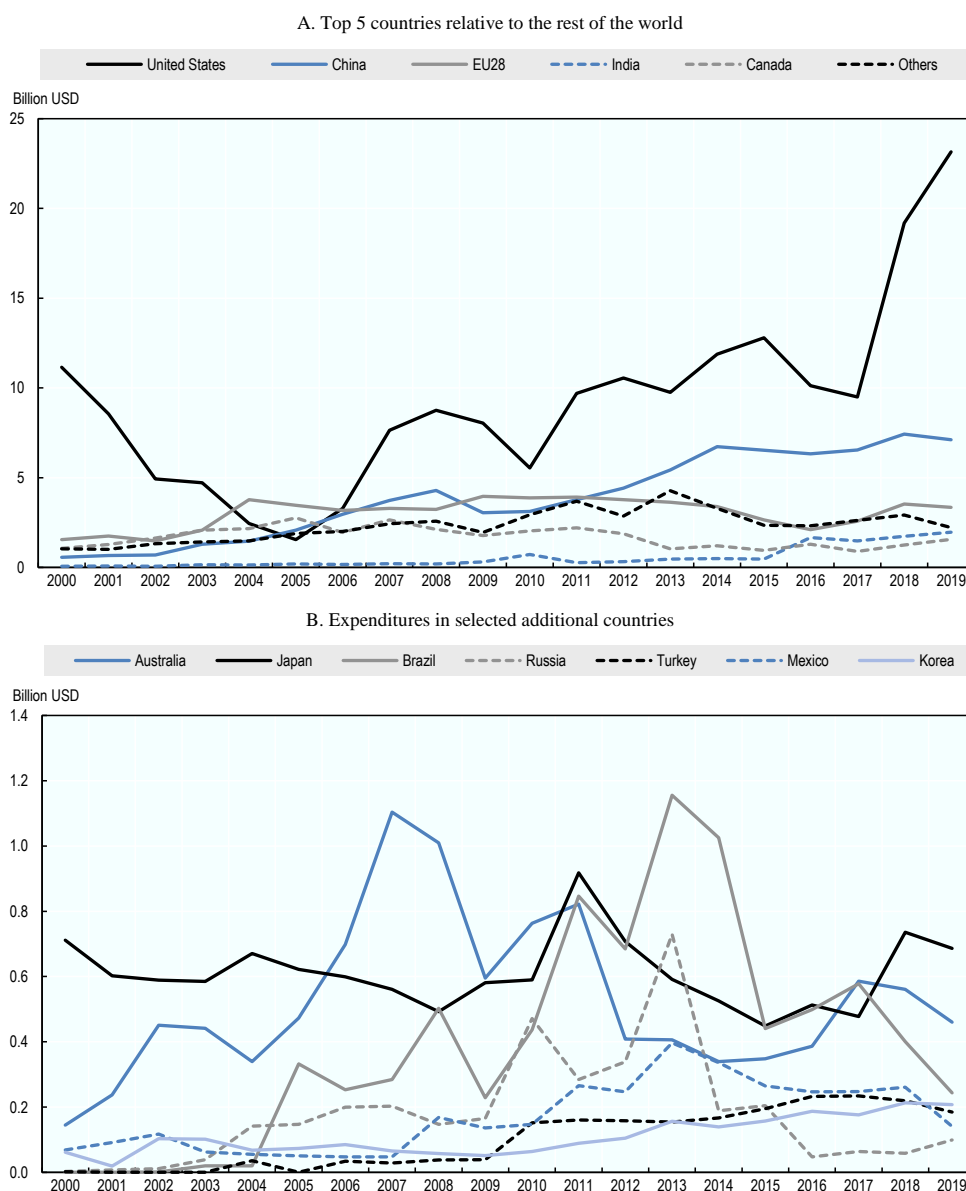
Notes: In Panel A, the category "Others" includes all remaining countries in the PSE database (of which 7 are presented individually in Panel B).
Source: Authors' calculations based on OECD (2020), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Figure 5. Expenditures on insurance and *ex post* natural disaster aid in selected countries
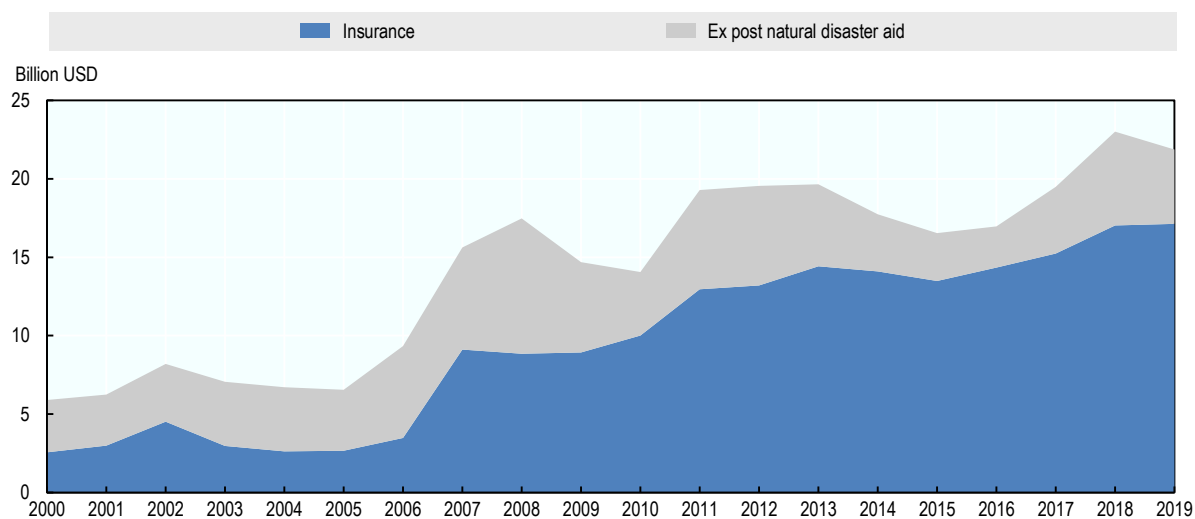
Note: Values represent total expenditures summed for the United States, China, the European Union, India, Canada, Japan and Brazil
Source: Authors' calculations based on OECD (2020), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

Table 1. Expenditures on risk management tools as a share of PSE, 2017-19

Share of PSE (in %)						
	Insurance	Tax and savings measures	Income and revenue stabilisation	*Ex post* natural disaster aid	*Ad hoc* assistance for economic shocks	Grand total
OECD						
Australia	0.0	41.7	0.0	8.4	0.0	50.1
Canada	14.4	6.8	8.3	0.7	2.2	32.4
Chile	2.6	0.0	0.0	5.5	0.0	8.1
Colombia	0.4	0.0	0.0	0.0	0.0	0.4
EU28	1.9	0.0	0.0	1.1	0.1	3.1
Iceland	0.0	0.0	0.0	0.0	0.0	0.0
Israel	4.2	0.0	0.0	0.0	0.0	4.2
Japan	1.2	0.0	0.4	0.1	0.0	1.7
Korea	0.9	0.0	0.0	0.0	0.0	0.9
Mexico	1.3	0.0	0.0	2.6	0.0	3.9
New Zealand	0.0	0.0	0.0	1.4	0.0	1.4
Norway	2.2	0.0	0.0	0.2	0.0	2.4
Turkey	2.2	0.0	0.0	0.0	0.0	2.2
United States	14.9	0.0	1.8	5.3	18.6	40.5
Non-OECD						
Argentina	0.0	0.0	-0.1	-0.2	0.0	-0.2
Brazil	15.1	0.0	0.0	0.0	0.0	15.1
China	2.7	0.0	0.2	0.8	0.0	3.7
Costa Rica	0.0	0.0	0.0	0.0	0.0	0.0
India	-7.4	0.0	0.0	0.0	0.0	-7.4
Indonesia	0.0	0.0	0.0	0.1	0.0	0.1
Kazakhstan	0.4	0.0	0.0	0.8	0.0	1.2

Share of PSE (in %)	Insurance	Tax and savings measures	Income and revenue stabilisation	*Ex post* natural disaster aid	*Ad hoc* assistance for economic shocks	Grand total
Philippines	0.8	0.0	0.0	0.0	0.0	0.8
Russia	0.0	0.0	0.0	0.9	0.0	0.9
South Africa	0.0	0.0	0.0	1.9	0.0	1.9
Ukraine	0.0	0.0	0.0	0.0	0.0	0.0
Viet Nam	-0.1	0.0	0.0	0.0	0.0	-0.1
Grand total	3.9	0.2	0.4	1.2	1.9	7.5

Source: Authors' calculations based on OECD (2020), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-pcse-data-en.

8. Conclusions

Over the past 20 years, there has been an exponential growth in government support for agricultural risk management products. This has resulted in wide diversity of risk management products across both OECD countries and large emerging economies such as Brazil, India and China. The level of governmental support varies significantly from countries which focus largely on *ex ante* mitigation measures, such as research and development, to countries that provide large levels of support through agricultural insurance, disaster assistance, income stabilisation schemes and producer tax savings accounts.[36] From this wide cross-section of experiences, some conclusions specific to particular tools, and recommendations on how they may be used in a comprehensive risk management policy toolbox, include:

- A holistic approach in necessary to ensure the complementarity of the different tools, to avoid overcompensation, and to reduce adverse selection and moral hazard behaviour. Policy makers should consider not only how different risk management tools interact with each other, but also how the wider policy environment affects incentives and producer decision-making.

- *Ex post* disaster policies and subsidised agricultural insurance often overlap in providing compensation in the catastrophic risk layer. While subsidised insurance schemes have been promoted as a means to discipline *ad hoc* assistance, experience has shown that it is often politically difficult to end provision of *ad hoc* assistance even once insurance programmes are well-established. This underscores the importance of developing risk management policy toolkits in collaboration with sector stakeholders to define *ex ante* the layers of responsibility in risk management and the scope of existing policy tools. Policymakers and sector actors need to understand how programmes are or are not meeting the risk management needs of stakeholders, and collaboratively develop *ex ante* frameworks to address identified gaps to avoid resorting to *ad hoc* assistance.

- In developing risk management products, governments should ensure that such products do not overlap one another in terms of loss coverage. For example, Canada's AgriStability programme takes into account payments received under its AgriInsurance programme when calculating indemnity payments. Indemnifying producers multiple times for the same loss is costly and potentially encourages moral hazard.

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[36] See Australian Department of Home Affairs (2018[152]) for a discussion of *ex ante* measures.

- The literature on the impacts and experience of income stabilisation schemes remains comparatively thin, as they have to date been used in very few countries. New programmes should include a strong monitoring and evaluation component to contribute to cover this knowledge gap.

- Tax and savings measures can be effective tools for helping producers smooth income variability with comparatively fewer market distortions and externalities. On their own, however, they are unlikely to prove sufficient for managing the most damaging catastrophic events.

- Matched savings accounts seem to play little role in farm risk management, as the programme design typically couples high subsidy rates in the form of matching funds and low limits in the total balance. It is preferable to privilege tax advantages over matching funds.

Recommendations relevant to specific tools aside, some more general observations can be drawn that may help governments in designing their risk management policy approach:

- Government support for risk management should be concentrated on addressing market failures. This message is not new and has been well articulated in previous OECD reports, for example, (OECD, 2009[12]; OECD, 2020[1]). Heavily subsidised market instruments can crowd out private innovation. Moreover, with the development of remote sensing technologies, improved weather data and widespread availability of CTI technologies, what might have been perceived as a market failure 40 years ago (for example, the lack of commercially offered crop insurance) now may be more feasible (through indexed contracts for example). The problem is that it is now difficult for private products to compete if they face heavily subsidised government products. Government programmes should explore potential opportunities and create incentives for technological innovation to reduce the costs of risk management tools.

- To the extent possible, government subsidies should be restricted to covering administrative costs and at most, covering catastrophic risks. Most OECD countries reported some form of disaster outlays paid to producers in 2019 in part reflecting the reality that disasters often require a response that is as much political as it is economic.

- Based on the past experience of a number of OECD countries, when attempting to increase participation in risk management programmes, it would be prudent for countries to better understand why producers do not participate in risk management programmes first before resorting to subsidies to encourage participation. Often it is because producers have other, less costly options to reduce risk exposure. Additionally, the wider policy environment may also reduce the attractiveness of risk management tools. The unfortunate lesson of many countries is that once subsidies are introduced for risk management products, they are difficult to remove. Subsidies can exacerbate moral hazard problems with risk management products and can distort production choices and input use. Those distortions can have major adverse externalities affecting the environment, climate, nutrition and trade.

- If premiums are subsidised, they should be restricted to coverage of catastrophic risks and not cover price risks which are better provided by private markets such as futures and cash forward markets and production contracts. Subsidising price risks can have impacts on production that are equivalent to providing coupled price support and can crowd out private markets.

- Adverse selection problems in crop insurance and other risk management products are best addressed through proper risk classification methods, including better data measurement. The development of weather and earth observation data such as normalised difference vegetation index and crop forecast models can help underwriters better discriminate risks facing producers.

- A striking feature of many risk management programmes is the lack of transparency on basic data surrounding those programmes. While countries report outlay data to the OECD and WTO, much

less is known about participation and performance data across farms, crops and livestock.[37] Improving data accessibility would enhance monitoring and evaluation of such programmes and provide information and experience that could be shared with other countries as they develop and improve risk management schemes of their own.

- Although all OECD countries have used government-supported risk management tools in the past decade, there remain comparatively few public assessments on the performance of these tools beyond the take up rates by farmers – particularly with respect to their cost-effectiveness as tools to help producers manage risk. Along with improving programme data transparency, governments should dedicate resources to assess periodically these programmes to determine if they are appropriate for the country's risk management context, or if another tool would be more effective in achieving programme aims. These assessments would also provide the required evidence for the design of better instruments in the country and abroad.

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[37] The US Risk Management Agency is an exception with its comprehensive data query system easily accessible through its website portal, https://www.rma.usda.gov/en/Information-Tools/Summary-of-Business.

Annex A. A review of the impacts of publicly-supported risk management tools on production

This annex reviews the economic literature on the effects of agricultural insurance and disaster assistance on production. There is less available evidence on the impacts of other risk management tools and on the impacts of tools on the overall risk management strategies at farm level.

Economic research on crop insurance can be traced at least as far back as Valgren's 1922 study of private insurance markets. However, the amount of research on the effect of crop insurance on production has increased dramatically over the past 20 years, paralleling the growth of insurance programmes in the United States and the world (Smith and Glauber, 2012[21]; Miranda and Farrin, 2012[64]; Glauber, 2015[7]). In general, the interest in developed countries such as the United States largely comes from concerns that subsidised insurance has distorted planting decisions and/or input use. Ironically, oftentimes the research in developing countries is to see whether agricultural insurance is effective in boosting production and input use.

A well-established economic result is that risk-averse producers tend to produce less under uncertainty than when expected yield and price outcomes are certain (Sandmo, 1971[8]; Newbery and Stiglitz, 1981[9]). Insurance generally improves welfare for risk-averse producers (Just, Hueth and Schmitz, 2005[10]); and in the presence of such contingency markets, risk-averse producers will grow more (Sandmo, 1971[8]; Feder, Just and Schmitz, 1980[11]).

Two issues arise. First, is the fact that in the absence of subsidies, few producers purchase crop insurance largely because crop insurance is costly and there are typically cheaper ways to diversify risks (Wright and Hewitt, 1994[3]; Smith and Goodwin, 1996[96]). Just, Calvin and Quiggin (1999[97]) found that for producers participating in the Federal crop insurance programme, risk aversion was a minor part of their incentive to participate. Rather, their decision to participate was driven by the size of the expected benefit (due to premium subsidies).

Papers by Babcock (2015[98]) and Du, Feng and Hennessy (2014[99]) point out that if producers are participating in the crop insurance programme primarily to "harvest" subsidies, they are not acting optimally for risk management (that is, they are choosing optimal levels of coverage to maximise subsidies). Their studies conclude that farmers' decisions about how much crop insurance to buy are not generally consistent with either expected profit or utility maximisation. Farmers do not pick coverage levels that maximise expected subsidy nor do they demand full insurance coverage. However, over time, producers have tended to sign up for higher coverage levels where the per unit subsidies tend to be higher. Glauber (2013[53]) shows that the average coverage levels for most row crops have grown significantly and continuously since the late 1990s when subsidies were increased for higher coverage levels.

The second issue concerns behavioural problems associated with insuring agricultural production and revenue, namely moral hazard and adverse selection (Ahsan, Ali and Kurian, 1982[100]; Nelson and Loehman, 1987[101]). Adverse selection problems arise when risks vary across insurance buyers and buyers know more about the risks they face than does the insurer who sets the rates (Hirshleifer and Riley, 1992[102]). Moral hazard problems arise when insured producers alter their behaviour after purchasing insurance to affect their likelihood of collecting an indemnity (Chambers, 1989[103]). Both adverse selection and moral hazard can increase the likelihood for lower production and/or input use.

Ramaswami (1993[104]) contrasts the positive effects crop insurance can have on production due to the risk reduction effects with the negative effects on production due to moral hazard. Chambers and Quiggin (2001[17]) extend these results to conclude that the risk-reduction effects tend to boost inputs that are more risk complements like chemical fertiliser while producers may use less risk substitutes like pesticides because of the moral hazard effects. Innes and Ardila (1994[105]) concluded that production-revenue-

stabilising schemes (such as pure crop insurance) can elicit an increase in farmer output, thus exacerbating environmental externalities. However, if "land risk" dominates "production risk", land-value stabilising insurance elicits lower output thus mitigating environmental externalities.

Impact on land use

Empirical work on insurance has focused primarily on the effects of the US crop insurance programme on planted area and the effects of insurance on input use. In an analysis of Nebraska corn producers, Wu (1999[106]) concluded that farms that purchased insurance were more likely to produce soybeans and less likely to produce forage crops, which, in turn, meant increased chemical use. Using a simulation model with regional acreage supply equations, Young, Vandeveer and Schnepf (2001[107]) found that planted acreage for major field crops was only 0.4% higher due to subsidised insurance. Increased plantings of wheat and cotton accounted for about three-fourths of the increase. Goodwin, Vandeveer and Deal (2004[108]) examined Midwestern corn and soybean producers and wheat and barley producers in the Northern Plains and found that a 30% decrease in premium costs were likely to increase barley acreage by about 1.1% and corn acreage by less than 0.5%. Soybean and wheat acreage showed no statistically significant impact. Wu and Adams (2001[6]) analysed corn and soybean producers in the Corn Belt and found that the introduction of subsidised revenue insurance altered cropping patterns and that effects of those acreage changes were likely to involve environmental consequences, as the counties most prone to acreage shifts were also those with higher potential for environmental damage.

A number of studies have examined the effects of crop insurance on broader land use patterns such as conversion of pastureland to cropland. Using USDA's National Resource Inventory survey data, Lubowski et al. (2006[109]) concluded that the increase in crop insurance subsidies changed land use measurably, but modestly. The change in premium subsidies in the mid-1990s increased cultivated cropland area (1997) by an estimated 2.5 million acres, or 0.82%, with the bulk of this land (1.8 million acres) coming from uncultivated crops and pasture. That estimate rose by about 12% (380 000 acres) if shifts from forests, range, and CRP land were also considered. Lubowski, Plantinga and Stavins (2008[110]) concluded that government payments caused a 2% increase in planted area between 1982 and 1997 but that this increase was more than offset by land put into the Conservation Reserve Program. The analysis did not differentiate between insurance payments and other price and income support payments.

A number of recent studies have focused on land use in the Northern Plains states, in particular the so-called Prairie Pothole region, where there is evidence of conversion of pasture and rangeland to cropland over the past 20 years. Studies by Claassen et al. (2011[111]) and Claassen, Cooper and Carriazo (2011[112]) found evidence that crop insurance increased the conversion of grassland to cropland, though the impacts were generally small. Feng, Hennessy and Miao (2013[113]) found that over the period 1986 to 2011, higher crop insurance participation contributed to few fewer acres offered under the Conservation Reserve Program. Similar results from Miao, Hennessy and Feng (2016[114]) suggest that 3% of insured land in the Prairie Pothole Region would not have been converted from grassland if there had been no crop insurance subsidies.

More recently, Ligon (2012[115]) analysed the impact of crop insurance on specialty crops and concluded that the introduction of crop insurance had a large and positive impact on tree crops, but a negligible and impact on non-tree crops.

Impacts on fertiliser and other input use

While no studies have directly analysed the effects of crop insurance on yield, much research has been done on the effects of crop insurance on input use. Horowitz and Lichtenberg (1993[116]) examined moral

hazard and concluded that crop insurance encouraged producers to take on more risky behaviour and use more "risk-increasing" inputs like fertiliser and pesticides. A number of studies contradicted their findings regarding fertiliser use (Quiggin, Karagiannis and Stanton, 1993[117]; Babcock and Hennessy, 1996[118]; Smith and Goodwin, 1996[96]). Mishra, Nimon and El Osta (2005[119]) found that wheat producers who purchased revenue insurance are more likely to use less fertiliser but about the same amount of pesticides than those who did not purchase revenue insurance. By contrast, Chang and Mishra (2012[120]) found some increase in fertiliser and chemical expenditures in their analysis of 2003 survey data of US farmers. Weber, Key and O'Donaghue (2015[121]) analysed farmers who had expanded crop insurance coverage from 2000 to 2012, but found insignificant differences in land use, crop mix, fertiliser and chemical use compared to farms who decreased coverage or had no change in coverage over the period. Similar conclusions can be found in (Roberts, Key and O'Donoghue, 2006[122]). Lastly, Annan and Schenkler (2015[28]) analysed county crop insurance participation and planted area and from 1981 to 2013 and concluded that the federal crop insurance programme gives farmers a disincentive from engaging in possible adaptation strategies to cope with extreme heat thereby exacerbating potential losses.

Impacts on erosion

Related to the land use studies, a number of studies have focused on the impact of crop insurance on erosion. Goodwin and Smith (2003[123]) concluded that federal crop insurance and disaster assistance programmes had little impact on soil erosion over 1982-92 (in contrast to price and income supports). Walters et al. (2012[124]) had similar conclusions that environmental impacts of the crop insurance programme were generally negligible over 1993-2002. Schoengold, Ding and Headlee (2015[35]) found that crop insurance was associated with greater use of no-till practices, implying that there may be unintended impacts of changes to agricultural policies like disaster payments and crop insurance on the use of on-farm conservation practices.

Goodwin and Smith (2013[125]) have questioned whether the results of earlier studies continue to be relevant given that subsidy levels are much higher now than when earlier research was conducted and revenue policies have largely replaced yield coverages. For example, Goodwin, Vandeveer and Deal (2004[108])examined the effects of insurance subsidies over the period 1986-1993, prior to enactment of major legislation in 1994 and 2000 which dramatically increased subsidy levels, and prior to the introduction of revenue insurance (Glauber, 2004[20]). In 1993, government subsidies as a percentage of total premium costs averaged 25% to 27% for the crops examined in the study compared to 60% to 63% for those crops in 2014 (Table 6). Average subsidies ranged from USD 1.33 to USD 2.12 per acre in 1993, compared with USD 15.12 to USD 27.70 per acre in 2014.

Recent studies by Walters et al. (2012[124]) and Claassen, Langpap and Wu (2016[126]) find negligible effects of crop insurance on land use though the latter found more significant impacts on crop choice and crop rotation. Yu, Smith and Sumner (2018[127]) also found significant effects on area though the impacts were small. Yet while the levels of support for insurance products have increased substantially, the relative share of subsidies across crops has remained largely the same, at least for those crops that are offered similar types of insurance products. With improvements in ratemaking due in part to the wealth of farm-level data, premium rates are more in line with underlying risks which means that relative rates should not favour one insured crop over another (Glauber, 2013[53]). Further complicating analyses is the fact that since price elections for most of the major row crops are now based on futures market prices, per-acre premiums (and subsidies) tend to be correlated with harvest price expectations.

Studies of effects of agricultural insurance outside of the United States

While research on production effects of insurance programmes outside of the United States is limited, similar conclusions have been drawn on the questions of land use, input use and environmental impacts. OECD (2006[128]) found that crop insurance subsidies had small but positive effects on Spanish producers' planting decisions. Turvey (2012[129]) found that insured Manitoba farmers will take on more risks than uninsured farmers. Capitanio, Adinolfi and Santeramo's (2014[130]) study of Italian farmers suggest that input use would increase with insurance adoption, although they do not distinguish between types of inputs. Similarly, Möhring et al. (2020[131]) found that insurance was associated with higher pesticide expenditures in France and Switzerland. A study of Chilean wheat farmers by Salazar et al. (2019[132]) identified a potential adverse selection problem in the Chilean insurance programme, as their results indicated that farmers who adopted modern irrigation were less likely to adopt agricultural insurance, such that adopters of insurance had a higher risk profile than non-adopters.

A handful of studies were identified that explicitly examined the effectiveness of these programmes at reducing risk. Enroljas et al. (2014[133]) found that insurance was associated with higher crop income returns in France, but that insured farmers experienced higher crop income volatility than non-insured farmers in both France and Italy, indicating a moral hazard effect. Dietrich's (2017[134]) investigation of insured tobacco farmers in Colombia found that indemnified farmers were less likely to resort to liquidation of other household assets in the event of a shock, suggesting that the programme functioned as an effective coping mechanism. Results from Chung (2016[135]) indicated that Korea's crop insurance programme stabilised the farm income for producers of apples, pears and sweet persimmons, with the programming resulting in an estimated net social benefit of USD 21.4 million. Park and Kim (2017[136]) found that participation in Korea's crop insurance programme raised farmer income, but the effect of insurance on farm income volatility was not statistically significant. And in their analysis of the performance of a weather index insurance product in Mexico, Fuchs and Wolff (2016[137]) concluded that municipalities that adopted the product had higher per capita expenditures and income for rural households than municipalities where the product was not available.

Other recent literature has focused on factors that are associated with insurance adoption or the reasons for limited uptake of such tools [for example, Wąs and Kobus (2018[66]) examined this question using data on Polish farmers, Zubor-Nemes and Tóth (2020[138]) used data from Hungary, Juvančič (2013[139]) discussed the factors behind low adoption in Slovenia, and Santeramo et al. (2016[140]) investigated farm entry and exit decisions on the insurance market in Italy], with few indications on how effective the programmes have been at helping producers manage risk, or their effects on input use or the environment. This could be due to either a lack of data, or due to the fact that the possibility to use Rural Development funds to subsidise risk management tools was opened under the 2014-2020 CAP, and brought renewed interest to the question of how to encourage participation in such programmes.

Additional findings from outside of OECD countries also contributed to the literature. In an analysis of Indian rice producers, Varadan and Kumar (2012[141]) found that crop insurance encouraged crop specialisation among Tamil Nadu farmers but it was unclear from the analyses whether all crops were provided insurance or just rice. When insurance was introduced for Malian cotton producers, Elabed and Carter (2014[142]) found it resulted in a 15% increase in the area in cotton, and a 14% increase in the expenditure on seeds per hectare. Similarly, Karlan et al. (2014[143]) found that insurance leads to larger agricultural investments on the farm and, as a result, increased production. Cai (2016[144]) examined the introduction of crop insurance to China tobacco farmers and concluded that insurance resulted in a 16% increase in production. Zhong, Ning and Xing (2007[145]) concluded that crop insurance resulted in a small but significant increase in input use by China cotton growers.

Annex B. WTO domestic support disciplines

The WTO Agreement on Agriculture seemingly encourages the development of risk management programmes in lieu of more trade- and production-distorting programmes, such as price supports or production-linked subsidies. However, as Glauber (2015[7]) notes, criteria in Paragraphs 7 (on income insurance and safety nets) and 8 (on crop insurance and disaster assistance) of Annex 2 appear to be poorly fitted for many risk management programmes. For example, both paragraphs use a three-year or five-year Olympic average (where the highest and lowest entries are discarded) as the base period for determining losses in a current year. From an actuarial perspective, longer time series produced a more accurate yield estimate that was thought to minimise adverse selection problems caused by producers who might buy insurance when a three-year average was high relative to their expected yield and not buy when it was lower than their expected yield (Skees and Reed, 1986[146]).[38] Furthermore, efficient insurance would take account of additional factors with an incidence on yield trends such as disruptions from climate change. Similarly, criteria in Paragraph 8 would seem to bias reporting toward natural disaster programmes rather than insurance programmes. For example, Paragraph 8(a) states that eligibility "shall arise only following a formal recognition by government authorities that a natural or like disaster…has occurred or is occurring;" however, such language is less appropriate for insurance programmes. Indemnity-based insurance losses are, by their nature, idiosyncratic; indeed, even in years with bumper crops, individual farms may suffer losses. Thus, requirements for a public declaration of disaster would seem to preclude insurance programmes from qualifying under Paragraph 8.

Given the variance of Annex 2 criteria with the provisions of insurance programmes of selected WTO members, how have WTO members notified their risk management programmes? Paragraph 7 has been little used by WTO members. Based on members' most recent domestic submissions as of June 2020 only Australia, Canada, and the European Union have made consistent use of the provisions. Australia notifies tax savings from its whole-farm based Farm Deposits Management scheme, a tax deferral savings account on which farmers may draw in low income years to meet their business costs in times of natural disasters (National Rural Advisory Council, 2012[92]). Canada notifies its AgriStability programme, a margin-based indemnification scheme. The European Union is the only other WTO member to consistently notify some support under Paragraph 7.

Many WTO members have notified support under Paragraph 8 for disaster assistance, but the main issue surrounding these notifications is a lack of transparency. Few of the programmes notified appear to be agricultural insurance-type programmes, but rather are programmes responding to ad hoc disasters. However, it is not clear that many countries actually meet all of the criteria, based on the numerous questions and answers exchanged at during the Review Process of regular meetings of the WTO's Committee on Agriculture.[39]

Most OECD countries that have notified crop insurance outlays to the WTO, including the United States, Canada, Korea, and the European Union (which notifies for all its member states) have notified those outlays as amber box outlays (Table B.1). The exceptions are Chile, Israel and Turkey, which notify their subsidies under Paragraph 8, and Japan, which notifies subsidies for those insurance policies at coverage

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[38] Basing yield guarantees on a longer time series may penalize producers who have adopted higher yielding production technologies. The US crop insurance programme offers producer endorsements where yield guarantees are adjusted by regional trends in crop yields (Sherrick and Schnitkey, 2011[148]).

[39] Agriculture-related information notified by WTO members and questions and responses provided in the context of the Review Process carried out by the Committee on Agriculture can be found at http://agims.wto.org/.

levels of 70% or less under Paragraph 8 but notifies subsidies for policies with coverage levels in excess of 70% as amber (Ito and Dyck, 2002[147]). Mexico has notified its subsidies under Paragraph 6.2 (developmental measures that are exempt from reduction).

As discussed earlier, there has been significant growth in agricultural insurance markets in developing countries over the past several years. Based on recent WTO notifications, Brazil notifies agricultural insurance subsidies under Paragraph 8, while India has notified its insurance subsidies as amber box outlays. China, which paid premium subsidies totalling almost USD 3 billion in 2012, has yet to include agricultural insurance subsidies as part of its domestic support notifications.

The WTO criteria have become even more out of step in light of changes in agricultural insurance programmes, especially those in the United States. In addition to revenue products, the United States has developed area-based products based on average county yields and margin products for livestock and dairy based on the difference between input and output prices. Index insurance products are also available, based on weather or vegetative growth indexes. Those new kinds of products are even further removed from the WTO criteria developed over 20 years ago.

Table B.1. Notification of risk management programmes to the WTO by OECD countries and selected other WTO members

WTO Member (year of most recent notification to WTO)	Amber box	Annex 2			Article 6.2
		Government services (para 2)	Income insurance/ safety nets (para 7)	Natural disasters (para 8)	
OECD countries					
Australia (2017)	Drought concessional loans; relief payments		Farm Management Deposit scheme	Disaster assistance; emergency loans	n.a.
Canada (2016)	Revenue payments (Quebec); AgriInsurance; AgriInvest; AgriRecovery		AgriStability		n.a.
Chile (2015)				Crop insurance subsidies	
Colombia (2016)					
European Union (2017)	Crop insurance premium subsidies		Income insurance	Disaster assistance	n.a.
Iceland (2016)				Livestock disaster assistance	n.a.
Israel (2018)				Crop insurance subsidies; disaster assistance	n.a.
Japan (2016)	Crop insurance subsidies; income stabilisation			Crop insurance subsidies; disaster assistance	n.a.
Korea (2015)	Crop insurance subsidies			Disaster assistance	
Mexico (2018)				Disaster assistance	Crop insurance subsidies
New Zealand (2019)				Disaster assistance	n.a.
Norway (2018)				Disaster assistance	n.a.
Switzerland (2018)				Disaster assistance	n.a.
Turkey (2013)				Agricultural insurance subsidies	

WTO Member (year of most recent notification to WTO)	Amber box	Annex 2			Article 6.2
		Government services (para 2)	Income insurance/ safety nets (para 7)	Natural disasters (para 8)	
United States (2017)	Crop insurance subsidies; disaster assistance	Crop insurance delivery expenses		Disaster assistance	n.a.
Selected other WTO Members					
Brazil (2018)	Crop insurance subsidies			Warranty crop fund	
Russia (2017)	Crop insurance subsidies			Disaster assistance	n.a.
India (2018)	Crop insurance subsidies			Disaster assistance	
China (2016)				Disaster assistance	n.a.

Note: n.a. = not applicable
Source: WTO, 2020 (available at https://agims.wto.org/).

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