iFEED Implication Statements (IS) on crops pest and diseases across the four ``AFRICAP countries.

Countries	Summary of trends from CSs in respect of crop pests and diseases	Implication Statements
Tanzania	Trends from the present day suggest that crop pests and diseases (CPD) induce 20-60% losses in annual crop yields. The impact is higher in lowland farming areas which mainly focus on food crops such as Maize, Cassava, and Beans. Highland farming systems experience significantly lower pest pressures and cultivate a more diverse range of crops, including clove, cardamom, banana, yam, cassava, and maize. Under a high climate risk scenario in 2050, climate projections indicate an average increase in temperature by 2.5°C compared to 2010. Climate risks scenarios also consist of increases in the number of extremely wet and dry days. Under high technological adoption, agricultural land area is projected to expand. Therefore, it is likely that small-scale farms, which are the dominant production model, would transform into more intensive commercial farming systems. Following technological adoption, the currently diverse and heterogeneous agricultural landscape may change to more homogenised agricultural systems focusing on fewer agricultural commodities. Findings from stakeholder workshops suggest an increase in the agricultural expansion (landscape homogenisation)	**<u>Low climate risk (RCP 2.6)/ Low technology, LT)</u>** **IS1:** CPD induced yield losses contribute to a significant yield gap (~40% annual yields), which can be reduced by adopting management practices such as mulching, spacing, crop diversification, integration with spices and agroforestry. **IS2:** Biodiversity plays an important role in managing CPD pressures and is supported by management practices such as crop diversification and agroforestry. **IS3:** CPD pressures in lowland systems are higher compared to the highlands, or more heterogenous and diversified agricultural systems, because biodiversity, food production and ecosystem services have better synergies compared to lowland or more homogenous agroecosystems. **<u>High climate risk (RCP8.5) / low technology (LT)</u>** **IS4:** Increase in overlap and climatic suitability of crops and pests resulting in increased crop exposure to CPD impacts causing more significant net losses in annual yields. **IS5:** Increases in CPD prevalence, impact, and generation times at high altitudes, increasing CPD induced yield losses in food crops such as maize and cassava. **IS6:** Higher risk of crop failure in highland cash crops such as banana and yam, and spices – clove due to higher CPD diversity and prevalence after climate-driven CPD migration from lowlands. **IS5:** Decrease in the number of pest species in lowland areas as the climate becomes suboptimal, assuming current crop cultivation remains the same and maybe too extreme for the survival of some CPD species, leading to migration towards highland ecosystems.

	and a moderate decrease in crop diversity (farm-level homogenisation). Under such high climate risk and technological adoption scenarios, pest pressures are likely to increase due to climate change, especially in the highland farms; biocontrol by natural enemies will decline due to homogenisation and loss of biodiversity at the landscape and farm-scales affecting environmental sustainability and food system resilience.	**IS6:** Loss of ecosystem services, such as biocontrol and pollination, due to climate-driven mismatches between the life cycles of crop pests and their natural enemies, and crop-pollinator interactions affecting the quantity and quality of agricultural produce. **IS7:** Reduced mean annual yields and an increased yield instability due to climate shocks will be aggravated due to interactions of climate shocks with the increased intensity and frequency of CPD outbreaks. **IS8:** Increased risk of new CPD emergence in new highland habitats, e.g., insect species not currently classified as dominant pests or not known to cause outbreaks before, would become pests and create outbreaks due to changes in population dynamics triggered by climate shifts. **IS9:** Increase in investments for pest management using chemical pesticides by local and regional stakeholders, including farmers, organizations, and governments, causing an increase in costs of agricultural production, reduced profit margins, increase in food prices, and reduction in available income to allocate other household needs. **<u>Low climate risk (RCP 2.6)/ High technology (HT)</u>** **IS10:** Loss of landscape-level heterogeneity (agricultural expansion) under a high technology scenario will negatively impact the biocontrol services that alleviate CPD pressures. Similarly, a reduction in crop diversity at landscape level (vs farm level crop diversity) and increased uniformity of cultivars will lead to greater vulnerability to CPD. **IS11:** There will be an increase in the use of CPD-resistant varieties arising from plant breeding technology. However, CPDs may evolve to overcome the genetic resistance of the CPD-resistant crop varieties, or there is a limit to the resistance traits that can bred into plant stocks, with the result that there may be severe crop failure and immediate detrimental effects on food availability and nutrition. **IS12:** Increased dependence on pesticides and resistant varieties to control CPD damages leading to increased costs of production and lower profit margins.

		IS13: CPDs may become resistant to pesticides, resulting in increased crop damage and CPD outbreaks. **<u>High climate risk (RCP8.5) / High technology (HT)</u>** **IS14:** Homogenised agriculture focussing on fewer agricultural commodities reduce the inherent resilience and natural biocontrol of agricultural systems causing increased vulnerability to CPDs and associated crop damages and failures under climate risks. **IS15:** Climate change and increase in trade and market connectivity under homogenised agriculture facilitate the introduction and establishment of novel transboundary pests and diseases. *Assuming that high technology adoption involves increase in globalised trade and market connectivity and causes expansion and intensification agriculture. Introduction and spread of novel transboundary pest and diseases depends on the crop protection measures employed by governments, as well as phytosanitary/biosecurity measures in place at points of entry for international imported commodities. Species-level information about pest responses are not clearly understood.* **IS16:** Acute invasive species – such as fall army warm – could have a devastating impact on production leading to 60-100% of yield losses. **IS17:** Climate change and technological adoption will also reduce pressure from some pests, especially in lowland areas. *Species-level information about pest responses are not clearly understood.* **IS18:** Under high technology and climate risks, the focus will be on producing more food under challenging conditions while compromising environmental sustainability i.e., by using chemical fertilizers and pesticides and impacting biodiversity, or conceding system resilience i.e., reduced local-scale crop diversity and increased dependence on international markets.
South Africa	If the present conditions of low climate risk and low land reform continue, crop diversity is expected to	**<u>Low climate risk (RCP 2.6) / Low land reform (LR)</u>**

	increase with beans and potatoes expanding by 10% at the expense of maize. Due to recurring droughts, there is a possibility that pasture lands will increase at least in the land reform and small-scale farms owned by emerging farmers. Emerging farmers and some small-scale farmers, with limited access to capital, are likely to either delay or not cultivate in the drought years. Also, most small-scale, and large-scale commercial farmers are likely to adopt Climate-Smart Agriculture practices such as cover cropping, low tillage, and crop residues to reduce the impacts of climate shocks. Under present circumstances, CPD induced crop damage is one of the major constraints for crop as well as livestock production. Under high climate risk, CPD will have compounding and interacting negative effects on agricultural production. Farmers have reported an increase in the incidence of crop pests and livestock diseases during droughts. Under high climate risk, mean losses in yield due to CPD may increase by 10 to 25% per degree of global mean surface warming. Mean estimates of CPD induced yield losses are estimated at ~32% (20-57% range) of annual crop yields, when average global surface temperatures increase by 2°C. In South Africa, access to water is an important constraint to food production with many small scale and emerging farmers having limited or no access to irrigation. With land reform, climate adaptation plans, and technological advancement, irrigation	**IS1:** CPD induced yield losses represent a significant yield gap (~40% of annual yields) which can be reduced by adopting management practices such as cover cropping, low tillage, and crop diversification. **IS2:** Recurring droughts (in dryland areas) and flash floods (in the highland farms) interact with the effects of CPD, increasing production costs and yield losses. **IS3:** Recurring droughts affect livestock production as livestock die and get sick due to livestock diseases, requiring frequent veterinary intervention, increasing production costs. **IS4:** Stark differences will worsen among production models in terms of agricultural production and CPD management; small scale farms depend on biological control of crop pests from natural enemies and traditional biocontrol through practices such as using plant extracts to manage CPD impacts, while emerging and large-scale farmers increasingly use on pesticides. **IS5:** Reduction in the arable area as increased intensity of climate shocks in combination with greater CPDs and related crop losses will limit the uptake of new farmland for small scale farmers and/or lead to increased rates of abandonment. **IS6:** Increasing inequality due to unequal distribution of land and water access will create conflicts between commercial and small/emerging farmers may cause some commercial farmers to abandon the land and migrate. This will increase the land under pasture, reduce crop production, and possibly increase the proportion of semi-natural and grassland land covers. **IS7:** Increase in natural and semi-natural landcovers may benefit local biodiversity, associated ecosystem services and small-scale farming; however, reduced proportion of agricultural land cover might result in reduction in overall food production – therefore, there may be higher trade-off between biodiversity and food production. **<u>Low climate risk (RCP 2.6 / high land reform (HR)</u>**

	infrastructure can improve in the future, which may have some impact on CPD prevalence. In South Africa, diverse and contrasting production systems and uncertainties associated with land reform make projections about agriculture change highly complicated and context-dependent. Presently, three kinds of production models are prevalent in South Africa: (i) smallscale farms (1-50 ha) – growing a mix of food and vegetables for subsistence and local informal markets, (ii) land reform emerging farms (50-200ha) – growing food crops for local markets and livestock, (iii) large-scale commercial farms (>200 ha) – engaging in national and international markets and highly mechanised. Emerging farms have over the years increased area under pastureland due to the inability to farm under recurring droughts. Smallscale farmers and commercial farmers have adapted to climate risks by practising conservation agriculture, developing infrastructure like rainwater harvesting, or using capital or loans to buy additional inputs – fertilizers, water, pesticides, improved variety seeds. Pastureland area under emerging farmers have increased, and area under arable land has declined in the past 10 years. Government policies target towards capacity building of the emerging farmers to enable them to engage with markets and function as commercial farmers. If the same approach continues in the future, land reform will increase commercial agriculture mainly owned by emerging farmers. In	**IS8:** Land reform alongside commercialisation will most likely lead to an increase in crop land area, mechanisation, and homogenisation (loss of crop diversity at landscape-scale) as farmers may focus on selected market commodities. Landscape homogenisation will reduce natural biocontrol and increase the dependence on pesticides and chemical fertilizers, which will increase the costs of production and reduce profits. **IS9:** Land reform <u>**without**</u> significant technological transformation (through government support) by emerging and small farmers may lead to an increase in pastureland and crop diversity, which may reduce the effects of CPD on crops as the diversified landcover around the farms will provide biocontrol. *In the above, assumption is that small and emerging farmers may not be able to upscale to large scale commercial farms without the support from the government. The support includes training for and access to mechanisation, irrigation and storage infrastructure, and market access.* **IS10:** Commercialisation of emerging farmers following successful land reform and technological adoption will result in the increased use of CPD-resistant varieties and chemical pesticides for managing CPD damages which may have negative outcomes for environmental sustainability as increased use of CPD-resistant varieties will lead to reduction in crop diversity and chemical pesticides will impact biodiversity. **IS11:** Greater dependence on chemical inputs and resistant varieties may result in CPDs gaining resistance to crop varieties and pesticides and causing severe damages in future. **LS12:** Use of chemical inputs promoted through technological adoption as part of government supported land reform would increase agricultural sector's contribution to GHG emissions, negatively impact biodiversity and ecosystem services, and affect water quality. **IS13:** Agricultural intensification with irrigation as a central feature can be beneficial for certain pests and potentially reduce the impact of natural biocontrol mechanisms on pest populations.

	contrast, if a land reform programme happens without government-supported technological adoption and market engagement, land reform would increase in the area under emerging farms comprising a mix of crop and pasture lands.	<u>**High climate risk (RCP 8.5) / low land reform (LR)**</u> **IS14:** Effects of changing climate and more variable weather suggest that CPD outbreaks are likely to be more unpredictable with increasing severities. Also, CPD induced yield losses will vary greatly among major crops and agroecosystems. **IS15:** Increase in the incidence of crop pests and livestock diseases under high climate risks will affect quality and quantity of agricultural production, increase the cost of production as farmers invest in external inputs to manage pests and diseases, and create uncertainties about yields and profits, which will affect long-term enterprise sustainability. **IS16:** Increase in temperatures and weather extremes will also increase the range and prevalence of livestock pathogens and disease vectors and may increase exposure of livestock to new pathogens and disease vectors. Costs of production will increase as more inputs, such as pesticides, will be needed. **IS17:** Climate stress (heat, inadequate food, and water) will reduce the body condition and lower immunity of livestock, causing increased mortality and morbidity under high climate risk. Costs of production will increase as more inputs, such as veterinary care, will be needed. **IS18:** High climate risk and low land reform will aggravate the conflict between the existing large-scale commercial farmers and rural small-scale and emerging farmers. Aggravated CPD-induced yield losses will accentuate the conflict as rural farmers sustain higher yield losses in comparison to commercial farmers who can use capital to access agricultural inputs, information and adapt quickly. **IS19:** Smallscale farmers are pushed out of business under recurring climate shocks and CPD outbreaks. As a result of climate-driven increase in crop damages and failure, small-scale farmers especially commercial famers with smaller enterprise size and low capital access will face severe reduction in profit margins and income which will threaten enterprise sustainability.

		LS20: Increase in use of chemical pesticides to combat the aggravated CPD attacks will increase the contribution of agriculture sector to greenhouse gas emissions, negatively impact non-target biodiversity, and affect water quality through the leaching of pesticides and nutrients. **<u>High climate risk (RCP 8.5 / High land reform (HR)</u>** **IS21:** Climate and increased trade and subsequent homogenisation of agricultural systems because of land reform and technological adoption will facilitate introduction and establishment transboundary CPDs and livestock diseases which will exacerbate losses in crop and livestock production. **IS22:** Conversion of emerging land reform farms to intensive commercial farming would reduce land cover diversity and associated biodiversity underpinning natural biocontrol services making the agricultural landscape much more prone to CPD outbreaks and CPD-induced yield losses. **IS23:** High dependence on CPD resistant crop varieties, disease-resistant livestock, and chemical pesticides would increase the cost of production and reduce profits margins. **IS24:** CPDs and livestock diseases under climate change may become resilient to resistant varieties resulting in increased vulnerability and agricultural yield losses. **IS25:** High-input agriculture involving agricultural expansion and intensification under climate risks will involve greater negative impacts on biodiversity and environment affecting food system sustainability and resilience. **LS26:** Increase in use of chemical pesticides to combat the aggravated CPD attacks and promoted by land reform **<u>(+technological adoption and government support)</u>** will increase the contribution of agriculture sector to greenhouse gas emissions, negatively impact non-target biodiversity, and affect water quality through the leaching of pesticides and nutrients. In absence of **technological adoption and government support**, land reform will lead to increase in the proportion of agricultural area under emerging farmers who may not have resources to buy pesticides for the whole farm. Under this condition, emerging farmer may

		use pesticides for a limited proportion of the farm area (cultivated land). Increased are of pastureland under non-supported land reform will provide some support for natural biocontrol services underpinned by biodiversity (natural enemies).
Malawi	Under present conditions, pests and diseases inflict substantial annual crop losses. Like in the rest of the countries described here, pest pressures are projected to increase with rising temperatures. The number of generations, population size, activity, and distribution of pests is known to increase when temperatures rise by 2˚C to 9˚C. An increase in the dry season duration (beyond four months) causes a resurgence and the establishment of many minor pests (cassava mealybug, cassava green mite and grasshopper). Insect pests sensitive to temperatures migrate and colonise high altitudes, which are more optimal for their growth and survival. Malawi is primarily small-scale production with farmers mainly cultivating maize, soybean, potato, and groundnut. Under effective policy implementation, food imports and exports, and irrigable land is expected to increase. Also, effective policy implementation stresses on increasing crop diversification. Under climate risks CPD prevalence and impacts are projected to increase. Bring more area under irrigation will result in landcover homogenization. Impetus on crop diversification may help improve resilience of food systems to climate shocks and CPD outbreaks.	**Low climate risk (RCP 2.6) / ineffective agricultural policies (LT=Low Technological adaptation)** **IS1:** About 40% of annual crop yields are lost to CPD. CPD induced yield losses represent a significant yield gap which can be reduced by adopting integrated pest management (promoted by agricultural policies in Malawi) by combining the use of resistant crop varieties, cultural control, biocontrol through maintenance of biodiversity and natural enemies, and chemical pesticides. **IS2:** Biodiversity and cultural practices play an important role in managing CPD pressures, especially for smallholder farmers who primarily practice low-input small-scale and subsistence agriculture. **IS3:** CPD pressures in lowland systems are higher compared to the highland and more heterogenous and diversified agricultural systems where biodiversity and ecosystem services contribute to food production. **IS4:** Loss of livestock due to diseases directly impact food security in the small-scale mixed farm systems with high dependence on livestock. **High climate risk (RCP 8.5) / ineffective agricultural policies (LT)** **IS5:** Reduced mean annual yields and an increased yield instability due to climate shocks will be aggravated by interactions with the increased intensity and frequency of CPD outbreaks. **IS6:** Diverse farm and crop systems are likely to experience lower mean yield losses from CPDs than more homogenous production systems. **IS7:** Under low input agriculture, where farmers do not have access to external inputs, the CPD-driven crop damage will result in higher yield losses in homogenous farm systems where crop and landcover diversity is lower.

		IS8: Loss of ecosystem services, such as biocontrol and pollination, due to climate-driven mismatches between the life cycles of crop pests and their natural enemies, and crop-pollinator interactions affecting the quantity and quality of agricultural produce. **IS9:** Decrease in the number of pest species in certain areas – e.g., lowland areas, as the climate becomes suboptimal, assuming current crop cultivation remains the same and maybe too extreme for the survival of some CPD species. **IS10:** Increase in investments for pest management using chemical pesticides by local and regional stakeholders, including farmers, organizations, and governments, causing an increase in costs of agricultural production, reduced profit margins, increase in food prices, and reduction in available income to allocate other household needs. **Low climate risk (RCP 2.6) / effective agricultural policies (HT)** **IS11:** If the agricultural policy includes intensive cultivation of susceptible cultivars, pest and disease incidence and severity are likely to be exacerbated. **IS12:** Increased trade because of agricultural policies promoting market integrity will lead to homogenisation of agricultural systems, which will facilitate introduction and establishment of novel transboundary pest and diseases and invasive species. **IS13:** Acute invasive species – such as fall army warm – could have a devastating impact on production leading to 60-100% of yield losses. **IS14:** Agricultural intensification with irrigation as a central feature can be beneficial for certain pests (such as cutworms), increase the abundance of chewing insects, and reduce the impact of biocontrol mechanisms on pest populations. This will lead to greater use of chemical inputs and increased costs of food production. **IS15:** If agricultural policies focus on shifts towards more continuous cultivation patterns without breaks between seasons - crop-free periods, it will lead to an increase in survival and population size of CPDs.

		High climate risk (RCP 8.5) / effective agricultural policies (HT) **IS16:** Climate change will facilitate increase in CPD distribution and prevalence (especially in the highland areas in Malawi) leading to increase susceptibility CPD-induced crop damages and yield losses. **IS17:** Increase in crop diversity will provide greater resilience to CPD induced crop damages and yield losses and offset the effects of CPD impacts under high climate risks. **IS18:** Increase in use of CPD-resistant varieties will reduce crop losses in the short- to medium-term, but CPDs may evolve (3 to 8 years) to overcome the resistance of the CPD-resistant crop varieties. The result can be a severe crop failure with immediate detrimental effects on food availability and nutrition. **IS19:** Increased dependence on pesticides and resistant varieties to control CPD damages leading to increased costs of production and lower profit margins. **IS20:** Climate and increased trade will facilitate introduction and spread of novel transboundary pest and diseases, and which will exacerbate CPD induced losses. High crop diversification will offset some of these losses. **IS21:** Introduction and spread of novel transboundary pest and diseases and invasive species depends on the country- and regional-level crop protection measures employed by governments. **IS22:** Climate change and technological adoption will also reduce pressure from some pests, especially in lowland areas.
Zambia	Zambian agriculture primarily consists of maize and cassava grown by small-scale farmers (~85% of farmers with ~1.5 ha land). Most of these farmers lose about 20–40% of crop yield at pre-harvest due to crop pests and diseases and attribute about 10-20% of yield loss to poor quality soil and climatic	**Low climate risk (RCP 2.6/ low market efficacy (LT)** **IS1:** Most farmers lose about 20–40% of crop yield at pre-harvest due to CPD. **IS2:** Biodiversity plays an essential role in managing CPD pressures through biocontrol by natural enemies in more diverse and heterogenous agriculture systems.

	conditions. Farmers generally do not use control measures for very common and less devastating pests, such as beetles, aphids, caterpillars, and grasshoppers. Under severe disease infections or infestations by large numbers of armyworms or grasshoppers they often handpick and destroy insects, spray ash or chilli powder, or destroy the infected plants. Farmers usually practice farm diversification through agroforestry, regular rotations, and intercropping to reduce crop vulnerability to pest damage. Under high climate risk and high market connectivity, it is expected that agricultural land will increase to meet the food demands of growing population. The increase in agricultural land will primarily be due to expansion and intensification of arable land area with focus on market-determined crops leading to monoculture. Agricultural trade and irrigation is also expected to increase. Such a scenario will likely involve increase in CPD impacts due to climate effects and monoculture, loss of agrobiodiversity and associated ecosystem services.	**IS3:** Small-scale farmers manage CPD impacts by cultural practices - handpick and destroy insects, spray plant extract, wood ash, or chilly powders, and destroy the infected plants. **IS4:** Under low market efficacy, farmers would not afford to use chemical pesticides and CPD-resistant crop varieties. **High climate risk (RCP 8.5) / low market efficacy (LT)** **IS5:** Climate and variable weather conditions are likely to make pest and pathogen attacks more unpredictable and severe which will reduce crop yields by 40-60% and affect food system resilience and food security. **IS6:** Loss of ecosystem services, such as biocontrol and pollination, due to climate-driven mismatches between the life cycles of crop pests and their natural enemies, and crop-pollinator interactions affecting the quantity and quality of agricultural produce. **IS7:** Under low input agriculture, where farmers do not have access to external inputs, the CPD-driven crop damage will result in higher yield losses in homogenous farm systems where crop and landcover diversity is lower. **IS8:** Diverse farm and crop systems are likely to experience lower mean yield losses from CPDs than more homogenous production systems. **IS8:** Decrease in the number of pest species in certain areas – e.g., lowland areas, as the climate becomes suboptimal, assuming current crop cultivation remains the same and maybe too extreme for the survival of some CPD species. **IS10:** Increase in investments for pest management using chemical pesticides by local and regional stakeholders, including farmers, organizations, and governments, causing an increase in costs of agricultural production, reduced profit margins, increase in food prices, and reduction in available income to allocate other household needs. **Low climate risk (RCP 2.6) / High market efficacy (HT)**

		IS11: An increase in globalised trade of economically important plants and animals will reduce farm-level diversity, lead to landscape-level homogenisation, and negatively affect long-term resilience of food systems to crop pests and diseases. *Homogenised production characterised by reduced crop diversity, due to the reliance on a few dominant crops, could occur with agricultural expansion and intensification, and transformation of heterogeneous small-scale agriculture to large-scale corporate agriculture.* **IS12:** Due to market integration, farmers will have better access to resistant and improved varieties of crops, mechanisation, and chemical fertilizers and pesticides. However, pests and pathogens may evolve to overcome the genetic resistance of crops and chemical pesticides resulting in severe crop failures with detrimental effects of food availability and nutrition. **IS13:** Market integration will allow better access to chemical fertilizers which will increase plant growth and vigour and enhance the nutritional qualities of crops – e.g., increase in size and number of leaves, which may lead to increase in pest attacks. **LS14:** Increase in investments for pest management using chemical pesticides by local and regional stakeholders, including farmers, organizations, and governments, causing an increase in costs of agricultural production, reduced profit margins, increase in food prices, and reduction in available income to allocate other household needs. **LS15:** Increase in monocultures will lead to farm-scale homogenisation which will reduce biodiversity and associated ecosystem services such as biocontrol, pollination and nutrient recycling consequently causing decreases resilience food system and increased vulnerability to CPD attacks. **LS16:** Increased trade (import and export) due to higher market connectivity will lead to homogenisation of agricultural systems, which will facilitate introduction and establishment of novel transboundary pest and diseases and invasive species. **LS17:** Agricultural intensification with irrigation as a central feature can be beneficial for certain pests (such as cutworms), increase the abundance of chewing insects, and reduce

		the impact of biocontrol mechanisms on pest populations. This will lead to greater use of chemical inputs and increased costs of food production. **High climate risk (RCP 8.5) / high market efficacy (HT)** **IS16:** Loss of farm diversity and heterogeneity will negatively impact the biocontrol services that alleviate CPD pressures. Reduction in crop diversity and increased uniformity of cultivars will lead to greater vulnerability to CPD under climate risks. **IS17:** Loss of ecosystem services, such as biocontrol and pollination, due to climate-driven mismatches between the life cycles of crop pests and their natural enemies, and crop-pollinator interactions affecting the quantity and quality of agricultural produce. **IS18:** Reduced farm-diversity due to increase in monoculture of market-driven crop species will cause reduced resilience of agroecosystems to combined and interactive shocks of climate and CPD attacks. **LS20:** Climate and increased trade will facilitate introduction and spread of novel transboundary pest and diseases, and which will exacerbate CPD induced losses. High crop diversification will offset some of these losses.