February 2022 APRC/22/3

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联合国粮食及农业组织 Food and Agriculture Organization of the United Nations Organisation des Nations Unies pour l'alimentation et l'agriculture Продовольственная и сельскохозяйственная организация Объединенных Наций Organización de las Naciones Unidas para la Alimentación y la Agricultura منظمة الأغذية والزراعة للأمم المتحدة

FAO REGIONAL CONFERENCE FOR ASIA AND THE PACIFIC

Thirty-sixth Session
Dhaka, Bangladesh, 8-11 March 2022
Actions to promote climate resilient agrifood systems in Asia and the Pacific region

Executive Summary

Climate change is one of the most important challenges to enhancing food security and nutrition in the region and globally. Resilience to climate change is a crucial feature of sustainable agrifood systems. Strengthening the climate resilience of agrifood systems requires action to anticipate, absorb and accommodate shocks or to manage the impacts or recover from shocks resulting from climate variability and change over time. The impacts of past and ongoing climate change are likely more significant than previously thought. In addition, there are substantial time lags between the development and adoption of new technologies and practices needed to strengthen resilience. Thus, the window available for action to invest in resilience and ensure that the agrifood system is adapted to future potential climate risks is narrow. Action now to anticipate and adapt, but also to address the drivers of future risks from climate change – such as agro-ecosystem degradation, reduced resilience and adaptive capacities, and excess greenhouse gas emissions – will have lasting benefits. This paper provides an overview of climate resilient agrifood systems and the specific challenges in moving towards resilience. The paper also provides guiding approaches and examples to facilitate urgently needed action and responds to requests from Members to highlight practical examples of actions being rolled out by national counterparts, FAO and other partners to promote or support the transition toward climate resilient agrifood systems and requirements for scaling up. The paper and examples provided are also aligned with the proposed vision for the new FAO corporate Strategy on Climate Change.

Delegates are invited to share experiences with national approaches and specific policies, programmes and measures to transition toward climate resilient agrifood systems. Where relevant, delegates are asked to highlight key institutional and technical challenges for the attention of FAO and other partners to accelerate needed actions, capacities and investment to foster climate resilient agrifood systems in the region, as well as specific guidance that should be reflected in the FAO Strategy on Climate Change.

Suggested action by the Regional Conference

a. Take note of FAO's initiatives to support Members to adopt policies, programmes and measures to foster climate resilient agrifood systems in the region;
b. Share additional country-level experiences with promoting climate resilient agrifood systems;
c. Provide guidance on key institutional and technical challenges for the attention of FAO and other partners to accelerate needed action and investment to foster climate resilient agrifood systems in the region;
d. Advise on priority areas of activity related to scaling up climate resilient agrifood systems in the region that should be integrated into the new FAO Strategy on Climate Change.

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Introduction: Climate resilient agrifood systems

Systems analysis has come to provide an important framework for assessing and addressing ongoing and future challenges for food security.[1] The agrifood systems provides food, energy and nutrition while drawing upon and feeding back into a range of other biophysical and socio-economic systems such as climate, natural ecosystems, health and trade. It is subject to multiple interconnected dependencies, feedbacks, impacts and risks that can result from changes in components of the agrifood systems itself and related systems such as the health of ecosystems and socio-economic development trends.[2] At APRC35, Members acknowledged the need for a transformation to sustainable and resilient food systems[3] in Asia and the Pacific to ensure food security and nutrition for all in a way that will not compromise the economic, social and environmental bases to generate food security and nutrition for future generations.[4]

Climate change is one of the most important ongoing and future challenges to enhancing food security and nutrition in the region and globally.[5] [6] Climate variability and change can result in a range of shocks impacts and feedback effects that influence food security through changes in food availability, access, utilization and stability (**Error! Reference source not found.**).[7] These impacts can often occur simultaneously at multiple points over different geographical scales and time horizons.[8] Agrifood systems also influence the climate system through greenhouse gas emissions resulting from the production, processing, distribution and consumption of food and the degradation of terrestrial and marine systems that play a role in climate regulation. Climate change in turn, exacerbates the degradation of the ecosystems and natural resources base, which undermines the productive capacities of agrifood systems.

[1] Von Braun, J., Afsana, K., Fresco, L. O., Hassan, M., & Torero, M. 2021. *Food systems: Definition, concept and application for the UN Food Systems Summit*.
[2] Simpson, N. P. et al. 2021. A framework for complex climate change risk assessment. One Earth. Vol 4. (also available at DOI: https://doi.org/10.1016/j.oneear.2021.03.005)
[3] A sustainable food system delivers food security and nutrition for all in a way that will not compromise the economic, social and environmental bases to generate food security and nutrition for future generations.
[4] FAO APRC 35. 2020. *Building sustainable and resilient food systems in Asia and the Pacific*. APRC/20/5.
[5] FAO. 2018. Asia and the Pacific Regional Overview of Food Security and Nutrition 2018 – Accelerating progress towards the SDGs. Bangkok.
[6] FAO, IFAD, UNICEF, WFP and WHO. 2020. The State of Food Security and Nutrition in the World 2020.Transforming food systems for affordable healthy diets. Rome, FAO. (also available at https://doi.org/10.4060/ca9692en)
[7] Mbow, C. et al. 2019. Food Security. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes interrestrial ecosystems*. Intergovernmental Panel on Climate Change (IPCC).
[8] Schipanski, M. E., MacDonald, G. K., Rosenzweig, S., Chappell, M. J., Bennett, E. M., Kerr, R. B., et al. 2016. Realizing resilient food systems. BioScience 66, 600–610. doi: 10.1093/biosci/biw052

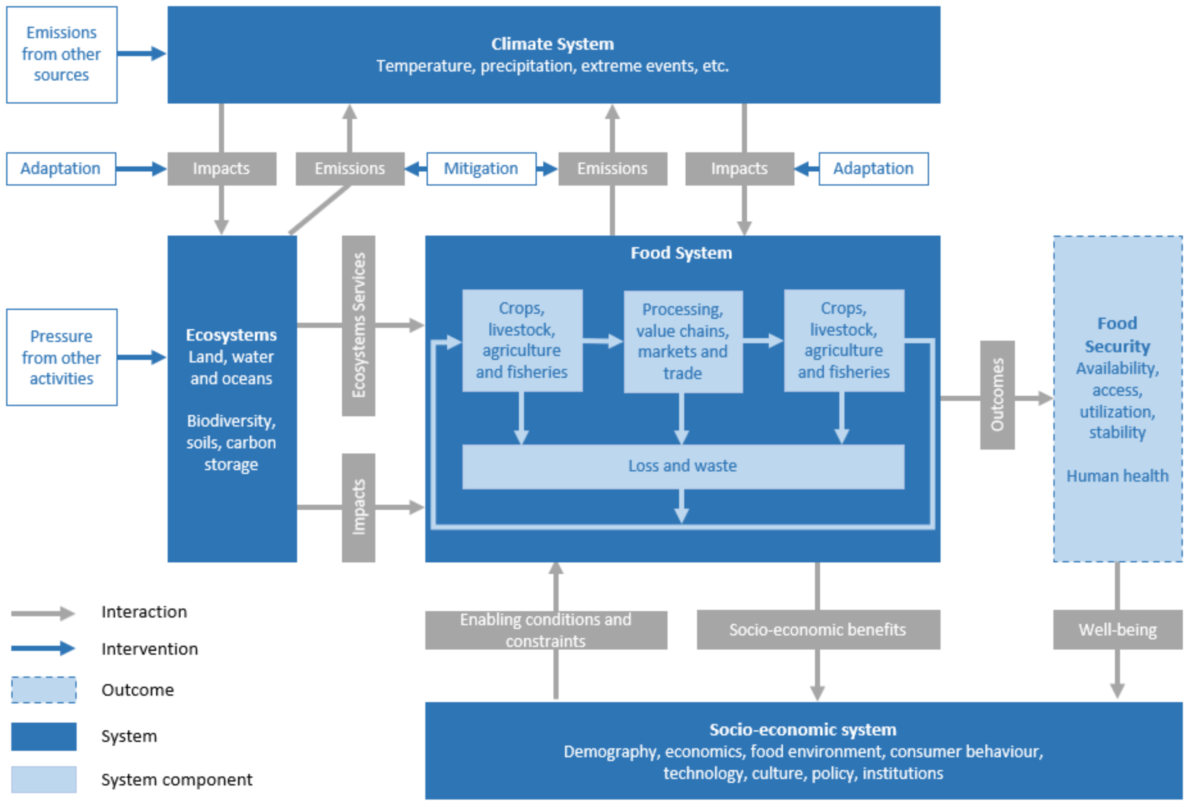

Figure 1. Interlinkages between the climate system, food system, ecosystems and socio-economic system. Source: Adapted from IPCC. 2019. [also available at https://www.ipcc.ch/site/assets/uploads/sites/4/2019/11/Figure-5.1.jpg]

1. Resilience to climate change is a crucial complementary and integrated feature of sustainable agrifood systems.[9] Green and climate resilient agrifood systems, through a mix of autonomous responses to climate hazards and the adoption of deliberate measures and policies, are able to anticipate, absorb and accommodate shocks and to manage the impacts or recover from shocks resulting from climate variability and change[10]. Because of the potentially catastrophic risks of climate change to agrifood systems, particularly over the longer-term, action to foster green and climate resilient agrifood systems also requires early, precautionary steps to minimize future risks through measures that can deliver adaptation and mitigation co-benefits.[11 12 13] Action to build resilience to climate change can be deployed at multiple levels and requires integrated measures covering a range of sectors and agrifood systems components. It is common that specific measures to respond to the impacts of climate change on agrifood systems will have synergies across a range of actions including disaster risk management, adaptation and mitigation (**Error! Reference source not found.**) as well contribute to efforts to meet Sustainable Development Goal (SDG) targets.

[9] Ibid.

[10] FAO. 2021. Climate resilient agriculture. Rome.

[11] Wollenberg, E. et al. 2016. Reducing emissions from agriculture to meet the 2 C target. Global change biology, 22(12), 3859-3864.

[12] Challinor, A. J. et al.2014. A meta-analysis of crop yield under climate change and adaptation. Nature Climate Change. 4, 287–291.

[13] United Nations Environment Programme (UNEP). 2017. The Emissions Gap Report 2017: A UN Environment Synthesis Report. (also available at https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf)

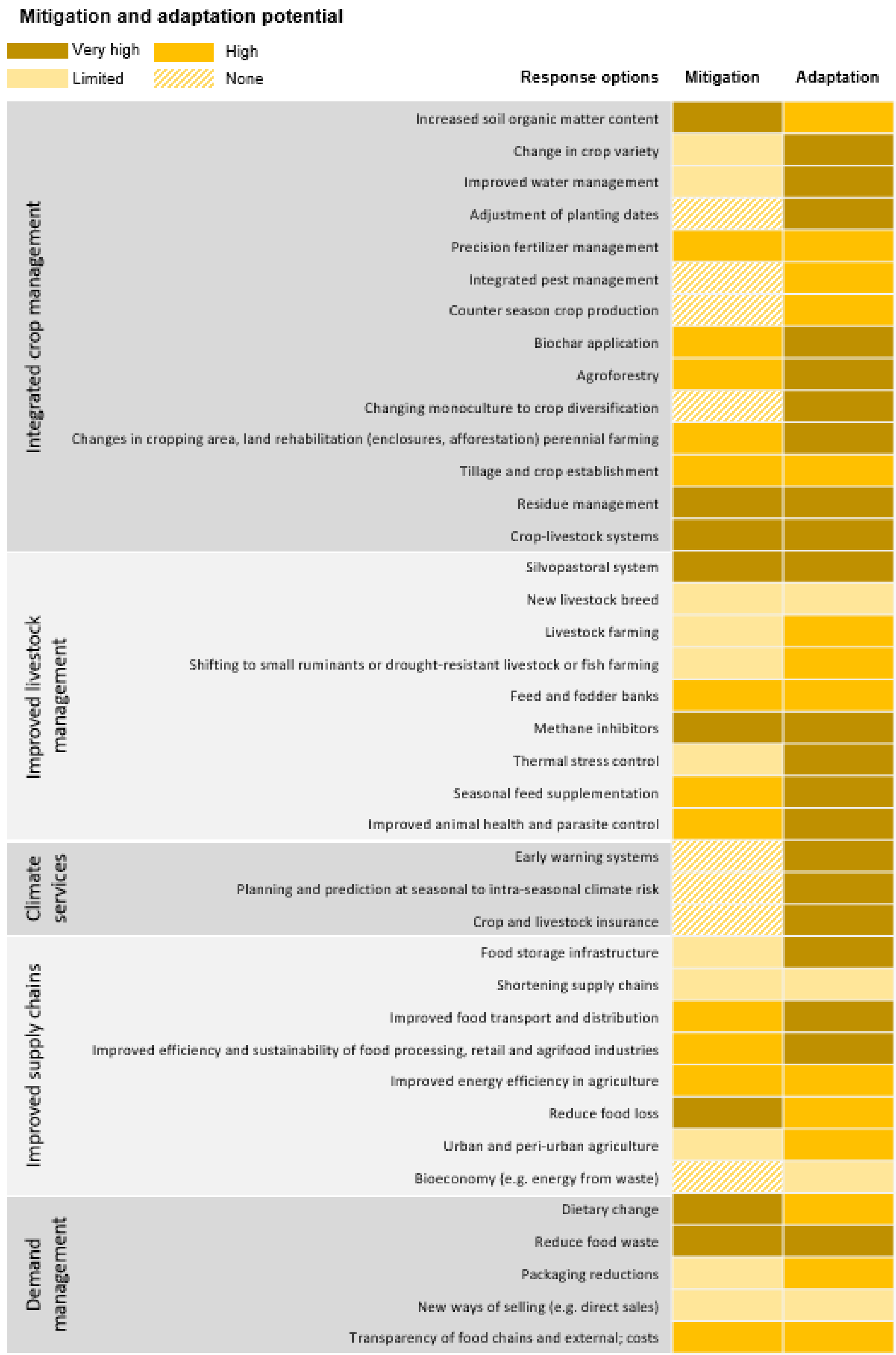

Figure 2. Response options related to food systems and their potential impacts on mitigation and adaptation. Source: Adapted from Mbow, C. et al. 2019. Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes interrestrial ecosystems. IPCC.

2. Because of the interdependencies and feedbacks within and among agrifood systems, the climate system and other supporting systems, the state and quality of these systems can be important determinants of resilience. Healthy natural ecosystems, including land, forests, water and oceans and

associated biodiversity and ecosystem services, are critical for the sustainability and resilience of agrifood systems. For example, measures to enhance biodiversity by promoting neglected and underutilized species can play an important role in strengthening climate resilience and tackling climate change.[14] [15] Efforts to improve stewardship of the environment and ecosystems supporting agriculture through green measures are fundamental to tackle climate change, nature and biodiversity loss, pollution and waste in an integrated manner. Sustainable agricultural and forestry practices can also engage local communities to improve adaptive capacity, enhance biodiversity, increase carbon storage in farmland and forest soils and vegetation, and reduce greenhouse gas emissions. Similarly, inclusive social protection systems can be an important measure to strengthen the resilience of agrifood systems and their capacity to deliver food security and nutrition outcomes for at-risk and vulnerable groups under normal circumstances and also during crises such as climate-induced disasters.[16]

Challenges to fostering climate resilient agrifood systems

3. Practical action to invest in specific measures and options to strengthen the climate resilience of agrifood systems varies because of the place-specific nature of these systems and the challenges associated with anticipating the scale and timing of the impacts of climate change. The expected impact from climate change on one or many elements of the agrifood system is primarily a function of the trends in hydrometeorological hazards, the exposure of each element to these hazards, and the vulnerability or susceptibility of the element to harm.[17] The probability and expected size of impact will influence the timing and scale of action to enhance resilience. Small, expected impacts will favour relatively uncostly, incremental measures such as changes in agronomic practices. Such impacts are normally associated with near-term time scales. Large impacts may lead to producers finding alternative livelihood options within and outside of the agrifood systems (**Error! Reference source not found.**). Large impacts are often associated with near-term extreme climate events or future catastrophic events resulting from continuing climate change processes. However, detailed information on specific impacts at the required scale is often either not available or incomplete.[18]

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[14] IPBES-IPCC. 2021. Co-Sponsored Workshop Report on Biodiversity and Climate Change. [available at https://www.ipbes.net/events/launch-ipbes-ipcc-co-sponsored-workshop-report-biodiversity-and-climate-change]
[15] FAO. 2021. Climate change, biodiversity and nutrition nexus – In brief. Rome.
[16] FAO APRC 35. 2020. Op. Cit.
[17] Van Oldenborgh, G., Van Der Wiel, S. K., & Phillip, S., et al. 2021. Pathways and Pitfalls in extreme event attribution. World Weather Attribution. [available at https://www.worldweatherattribution.org/pathways-and-pitfalls-in-extreme-event-attribution/]
[18] Nissan, H. et. al. 2018. On the use and misuse of climate change projections in international development. WIREs Clim Change. DOI : https://doi.org/10.1002/wcc.579

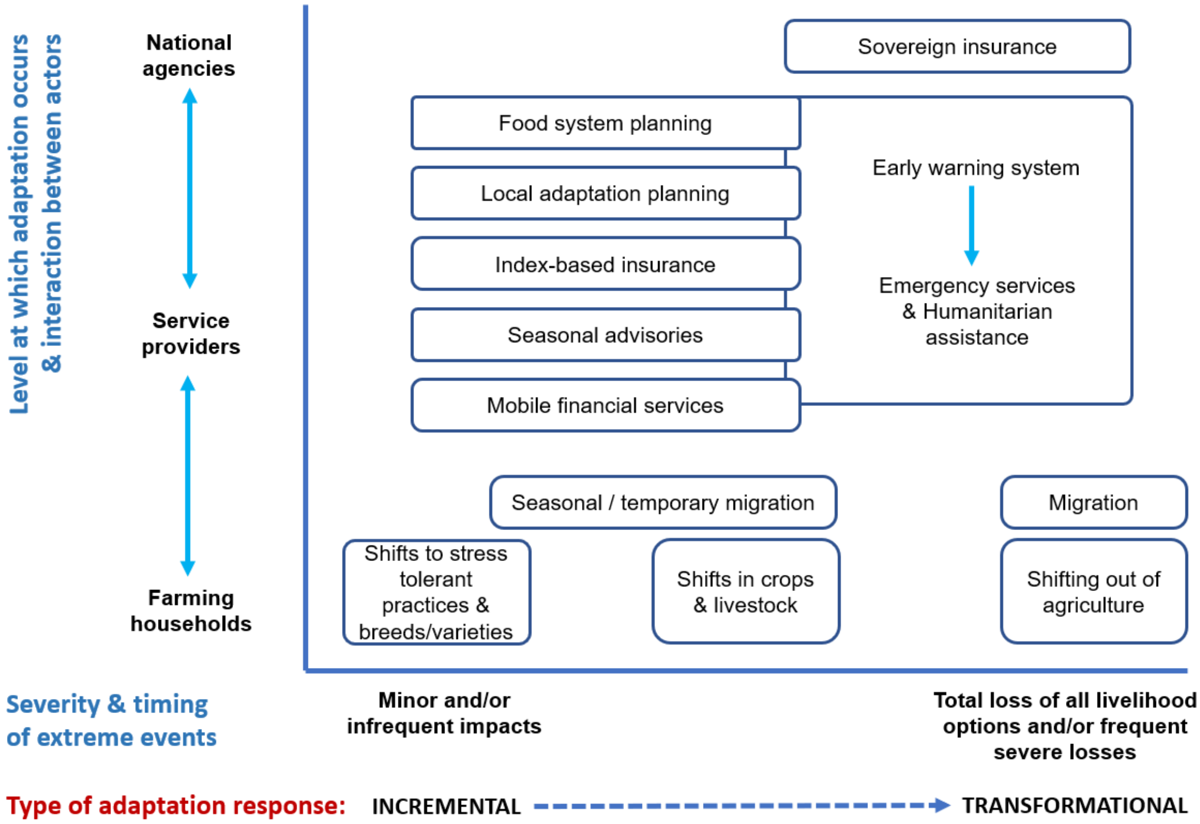

Figure 3. Options to adapt to climate change based on severity of impact. Source: Adapted from Loboguerrero et al. 2018. Feeding the world in a changing climate: An adaptation roadmap for agriculture. Global Commission on Adaptation.

4. A further challenge is the possibility of compound and complex effects resulting from small changes in hazard, exposure and/or vulnerability across different elements of agrifood systems, interconnected systems and feedbacks from response measures over space and time (**Error! Reference source not found.**). For example, variability in climate modes such as the El Niño Southern Oscillation and the Indian Ocean Dipole have been found to be a significant factor in crop yield anomalies and a possible source of synchronous crop failure across multiple production systems.[19] [20] The steadily increasing accumulation of anthropogenic greenhouse gases in the atmosphere that is driving climate change could also be considered a compound risk that will result in significant but unknown potential impacts on agrifood systems. Such effects will not always be negative.[21] For example, regular incremental changes in growing season conditions might change the agro-ecological suitability of a food production system in ways that make prevailing activities unsuitable but open up opportunities for new activities. Given the multiple interactions that such impacts pose across multiple systems, the associated risks can go unappreciated, unrecognized and/or undetected until corrective action is urgent and unavoidable. Response measures that are poorly considered or implemented might also result in unintended, negative impacts that are not recognized until after a policy or measure has been adopted.[22] As a result, climate resilient agrifood systems, in addition to the capacity to anticipate, absorb and respond to shocks, should also be able to adapt,

[19] Anderson, W. B., et al. 2019. Synchronous crop failures and climate-forced production variability. Science Advances. Vol. 5, No. 7. DOI: 10.1126/sciadv.aaw1976
[20] Simpson. N. P., et al. 2021. Op. Cit.
[21] Shi, Q., Lin, Y., Zhang, E., Yan, H. & Zhan, J. 2013: Impacts of Cultivated Land Reclamation on the Climate and Grain Production in Northeast China in the Future 30 Years. Adv. In Meteorology, 2013, 1–8. DOI: 10.1155/2013/853098.
[22] Atteridge, A. & Remling, E. 2017. Is adaptation reducing vulnerability or redistributing it? WIREs Climate Change. Vol 9. Issue 1. DOI: https://doi.org/10.1002/wcc.500

adjust and transform in response to new information, changing development priorities, and ongoing climate change.[23]

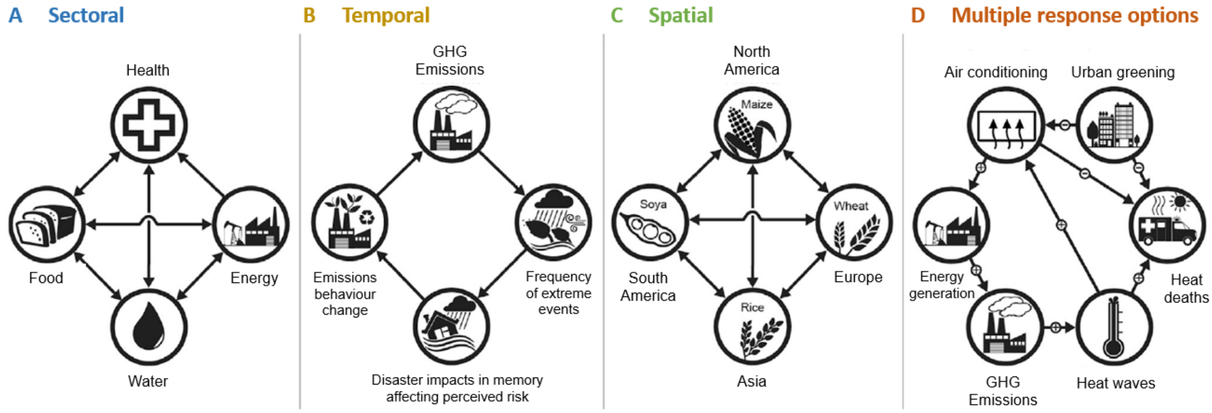

Figure 4. Illustrative overview of multiple material and conceptual boundaries and interaction effects involved in action to enhance climate resilience. Source: Adapted from Simpson, N. P. et al. 2021. A framework for complex climate change risk assessment. One Earth. Vol 4. Note: Examples include (A) cross-sectoral interactions such as between water, energy, food, and health; (B) temporal lags such as between climate extremes and behaviour change; (C) spatial telecoupling such as for food trade networks and breadbasket failures; and (D) interactions of multiple mitigation and adaptation response options such as urban greening and fossil-fueled air conditioning as responses to extreme heat.

Climate resilient agrifood systems in Asia and the Pacific: A narrow window for action

5. Evidence to support rapid investment in resilient agrifood systems in Asia and the Pacific is plentiful but often insufficient to address the complex needs of decision-makers. Climate change is normally considered a risk to agrifood systems over longer-term time horizons (over and beyond 20-30 years). This is reflected in the state of research on climate change impacts on food security, which has tended to focus on long-term projections, with less attention directed towards ongoing or observed impacts of climate change.[24] The uncertainty associated with modelling projections over long time scales and the lack of evidence beyond just a small fraction of the agrifood systems' components and supporting systems have provided inconclusive and uncompelling evidence for prompt and significant action.[25]

6. However, progress to address these knowledge gaps is being made. Recently published work by Working Group One of the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report highlights a number of climate impact drivers (CID) and their implications for a range of key sectors and sector assets across the world's climate regions. In the case of agrifood systems, a wide range of CIDs have been identified as relevant across crops, livestock and pasture, forestry, fisheries and aquaculture (**Error! Reference source not found.**). Some CIDs, such as temperature and temperature extremes and floods, are relevant across all sectors, while others such as precipitation, and agricultural and ecological drought, are highly relevant to crops, livestock, pasture and forestry systems but not necessarily fisheries and aquaculture systems.

7. In Asia and the Pacific, a number of these CIDs of importance for agrifood systems are already considered to have changed or are soon to change compared to the climate of the recent past with high to medium levels of confidence (**Error! Reference source not found.**). In Asia and the Pacific, significant warming trends have been observed. In Asia, growth has been observed in the

[23] Gitz, V. & Meybeck, A. 2012. Risks, vulnerabilities and resilience in a context of climate change. In A. Meybeck, J. Lankoski, S. Redfern, N. Azzu & V. Gitz, eds. Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a joint FAO/OECD Workshop, pp. 19-36. Rome, FAO and Paris, OECD.
[24] Nissan, H. et. al. 2018. Op. Cit.
[25] Hertel, T. W. & de Lima, C. Z. 2020. Viewpoint: Climate impacts on agriculture: Searching for keys under the streetlight. Food Policy 95, 101954.

incidence of flood and drought as well as moderate climate extremes, such as increases in the numbers of warm days and nights, heatwaves and the incidence of intense rainfall at seasonal and daily time scales.[26] [27] [28] Meanwhile, cold extremes have decreased. In some areas of the Pacific, precipitation has declined and the frequency and intensity of marine heatwaves increased. Sea-level rise in Asia has advanced more quickly relative to the global average. These trends are projected to grow.[29] Evidence to link these changes directly to negative impacts on agrifood systems is strengthening. Studies have shown links between climate change patterns and shifts in the extent, location and yields of cropping systems in the region and led to changes in management practices.[30] [31] [32] [33] In fisheries, climate change has been found to be affecting the spatial distribution of fish populations and the timing of fish spawning and migration.[34] Changes in temperature are also already having a negative impact on agricultural workers; particularly in the hotter and humid regions of South and Southeast Asia.[35,36] Agrifood systems are also an important driver of climate change. Dietary shifts in the region towards processed, packaged and convenience foods and increased consumption of oils and fats, caloric sweeteners and meat result in substantial levels of agrifood systems emissions and other externalities.[37]

8. Downstream processing activities have overtaken land-use change as the largest source of greenhouse gas emissions from agrifood systems in the region.[38]

[26] Alexander, L. V. 2016. Global observed long-term changes in temperature and precipitation extremes: A review of progress and limitations in IPCC assessments and beyond. Weather and Climate Extremes, 11, 4–16. doi:10.1016/j.wace.2015.10.007

[27] Lehmann, J., Coumou, D. & Frieler, K. 2015. Increased record-breaking precipitation events under global warming. *Climatic Change*, *132*(4), 501–515. doi:10.1007/s10584-015-1434-y

[28] Westra, S., Alexander, L. V. & Zwiers, F. W. 2013. Global increasing trends in annual maximum daily precipitation. Journal of Climate, 26(11), 3904–3918. doi:10.1175/JCLI-D-12-00502.1

[29] Ranasinghe, R., Ruane, A. C., Vautard, R., Arnell, N., Coppola, E., Cruz, F.A., Dessai, S., Islam, A.S., Rahimi, M., Ruiz Carrascal, D., Sillmann, J., Sylla, M.B., Tebaldi, C., Wang, W. & Zaaboul, R. 2021. Climate Change Information for Regional Impact and for Risk Assessment. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.

[30] Shi, Q., Lin, Y., Yan, H., Zhang, E. & Zhan, J. 2013. Impacts of Cultivated Land Reclamation on the Climate and Grain Production in Northeast China in the Future 30 Years. Adv. In Meteorology, 2013, 1–8, doi:10.1155/2013/853098

[31] Jha, B. & Tripathi, A. 2017: How susceptible is India's food basket to climate change? Soc. Change, 47, 11–27, doi:10.1177/0049085716681902

[32] Abbas, G. et al. 2017: Quantification the impacts of climate change and crop management on phenology of maize-based cropping system in Punjab, Pakistan. Agric. For. Meteorol., 247, 42–55, doi:10.1016/j.agrformet. 2017.07.012.

[33] FAO. 2018. Dynamic development, shifting demographics, changing diets. Bangkok. 172 p.

[34] Cramer, W., Yohe, G. W., Auffhammer, M., Huggel, C., Molau, U., Da Silva Dias, M. A. F., & Tibig, L. 2014. Detection and attribution of observed impacts. Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 979–1037. doi:10.5167/UZH-105700

[35] Dasgupta, S. et. al. 2021. Effects of climate change on combined labour productivity and supply: an empirical, multi-model study. Lancet Planet Health. Vol 5.

[36] Lima, C. et al. 2020. Heat Stress on Agricultural Workers Exacerbates Crop Impacts of Climate Change. Review. Environ. Res. Lett. 16. 044020.

[37] Kelly, M. 2016. The Nutrition Transition in Developing Asia: Dietary Change, Drivers and Health Impacts. In P. Jackson, W. E. L. Speiss, & F. Sultana (Eds.), *Eating, Drinking: Surviving*. Springer. doi:10.1007/978-3-319-42468-2

[38] Tubiello, F. et. al. 2021. Greenhouse gas emissions from food systems: building the evidence base. Environ. Res. Lett. 16. DOI: https://doi.org/10.1088/1748-9326/ac018e

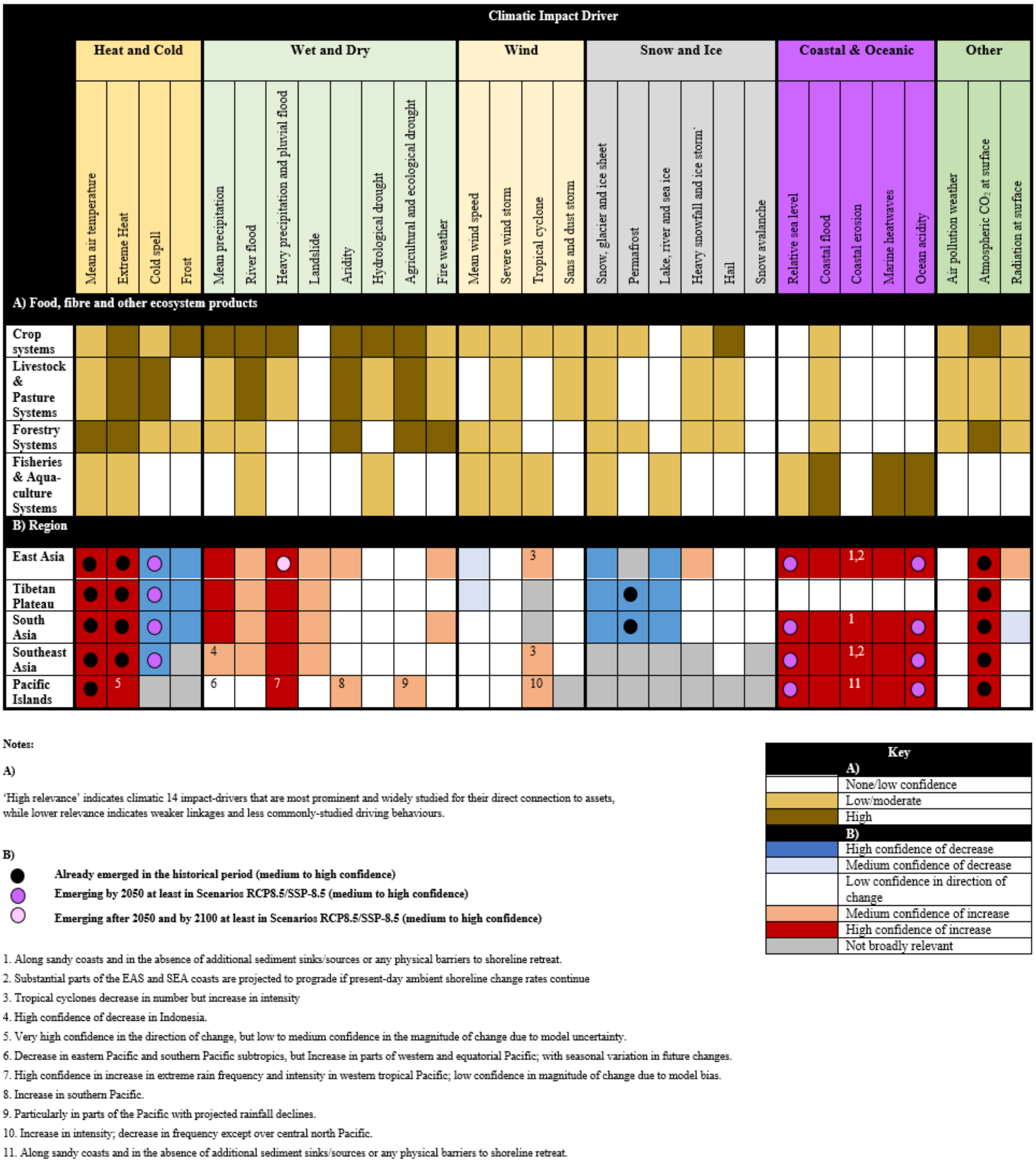

Figure 5. A) Relevance of key climatic impact drivers for the food, fibre and other ecosystems sector and sectoral assets; B) Summary of confidence in direction of projected change in climatic impact drivers in Asia and the Pacific, representing their aggregate. Adapted by the author from: Ranasinghe, R. A., et al 2021. Climate Change Information for Regional Impact and for Risk Assessment. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

9. However, the quality and completeness of information on system-wide and cumulative risks to food security from anthropogenic climate change remains weak.[39] [40] [41] The IPCC has noted that the

[39] Porter, J. R. et al. 2014. Food security and food production systems. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change, pp. 485–533.
[40] Campbell, B. M. et al. 2016. Reducing risks to food security from climate change. Global Food Security, 11, 34–43.
[41] FAO APRC 34. 2018. *Climate Action for Agriculture: Strengthening the Engagement of Agriculture Sectors to Implement the Climate Change Elements of the 2030 Agenda in Asia and the Pacific*. APRC/18/3.

direction of some CIDs cannot be determined due to lack of evidence.[42] Despite prevailing information gaps, FAO has found that climate change in the region is already having an impact on multiple elements of the agrifood system and undermining efforts to tackle remaining food insecurity.[43] Work to assess the multisectoral impacts of climate change under different warming scenarios using a range of indicators relevant to agrifood systems – including water stress, drought intensity, crop yields, and habitat degradation – indicate that the populations of Asia and the Pacific are the most exposed and vulnerable to negative impacts of continued global warming.[44] [45] New research that attempts to capture the aggregate impacts of such climate changes on agrifood systems using agriculture sector-wide total factor productivity as the measure of interest indicates that the extent of the negative impact from past climate change may have been significant. For example, it was found that the cumulative impact of anthropogenic climate change on agricultural total factor productivity in Asia and the Pacific between 1961 and 2020 compared to a scenario without climate change was -19.4 and -19.3 percent, respectively.[46] This finding suggests that agrifood systems output in the region should have been significantly greater when correcting for the observed impacts of climate change increasingly highlighted in the work of the IPCC.

10. The broader implication is that the fruits of past investments in agricultural research and development (R&D) have likely been crucial in helping to offset potential larger negative impacts of climate change on agrifood systems. Benefits gained from R&D accrue slowly – over decades – due to issues with technology diffusion and adoption. The stock of knowledge capital also declines over time without injections of new and additional innovation and knowledge.[47] As a result, early and anticipatory investment is required to ensure that agrifood systems will be able to withstand future shocks. Modelling suggests that investments in R&D over the next ten years in combination with targeted investments in irrigation capacity and water-use efficiency in Asia and the Pacific could deliver significant benefits in terms of food security over medium- and longer-term climate change scenarios and contribute to the achievement of SDG targets.[48] However, while the value of public expenditure on agricultural R&D in Asia and the Pacific grew dramatically in the 1980s and 1990s, the level has stabilized and is declining in some regions as a proportion of agricultural output. While new sources of climate finance comprising expenditures by private actors (e.g. households, corporations, commercial and institutional financial institutions) and investors and public actors (e.g. government, public-owned financial institutions and multilateral financial institutions including the Green Climate Fund (GCF)) are investing in climate action, it is estimated that only 3.6 percent of total climate finance is being directed to the agriculture and land-use sectors[49]

11. This analysis points to a relatively narrow window in the near and medium terms (10-15 years) to make the next generation of investments in climate resilient agrifood systems. The innovations required to ensure that our agrifood systems will be adequately prepared for the full range of potential future climate scenarios, while minimizing emissions and the future risks of significant climate change, will need to be developed in the coming few years, well before the potential impacts will be fully understood. Fortunately, the window for action corresponds with the 2030 Agenda and the commitment period of the Paris Agreement. But while countries in Asia and the Pacific have identified a range of policies and measures as priorities for agrifood systems under their nationally determined contributions (NDCs) and national adaptation plans (NAPs), many are still not well

[42] Ranasinghe, R. et al. 2021. Op. Cit.
[43] FAO. 2018. Op. Cit.
[44] Byers, E. et al. 2018. Environ. Res. Lett. 13 055012.
[45] FAO. 2021. Op. Cit.
[46] Ortiz-Bobea, A., et al. 2021. Op Cit.
[47] Fuglie, K. 2018. Op. Cit.
[48] Sulser, T. & Wiebe, K. 2021. IMPACT modelling to explore SDG trade-offs for food and water security in the context of climate change in the Asia-Pacific region. Report for FAO-RAP.
[49] Buchner, B. et al. 2019. Global Landscape of Climate Finance. Climate Policy Initiative. (also available at https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/)

targeted or costed.[50] [51] Prevailing distinctions between core concepts in building resilience such as disaster risk management and adaptation also encourage policies, measures and institutional arrangements that are disconnected and narrowly focused. Mitigation actions are often categorized as separate from resilience. This situation, which stems from the historical and political debates that have characterized the global governance system to manage climate change, acts as a barrier to thinking and acting in a systematic way to address the full range of risks that climate change presents to agrifood systems. Climate resilient agrifood systems aims to overcome these barriers by supporting the informed and holistic adoption of disaster risk management, adaptation and mitigation measures in a way that is consistent with and complements the aspiration of multi-generational food security and nutrition.

Approaches for promoting climate resilient agrifood systems

12. Given the complexity of working across food systems and the difficulties in resolving the need for near-term action under conditions of uncertainty, integrated approaches based on long-term goals for a resilience building process rather than specific practices are likely to provide better foundations for agrifood system-wide resilience.[52] Building policy and investment decisions around guiding principles or target outcomes can help to minimize issues associated with uncertainty and complexity by providing a consistent basis for action now and in the future. Agroecology, for example, provides a comprehensive set of principles that relate to agricultural and ecological management as well as broader social and political aspects of agrifood systems.[53] Similarly, FAO and World Health Organization guidance on sustainable and healthy diets provides an alternative but potentially complementary set of principles to guide policies and measures that: promote all dimensions of individuals' health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable.[54] Alternatively, climate-smart agriculture (CSA) is an outcome-based approach that aims to improve productivity, strengthen resilience and reduce emissions.[55] CSA and the tools developed to support this approach highlight synergies and trade-offs that might prevail between enhancing climate resilience and other food system outcomes.

13. Because these approaches are not prescriptive, they can be adapted to the specific needs of different actors across agrifood systems and incorporate a range of practices and measures drawing on different disciplines. They support a transition to climate resilient agriculture by bringing together the climate, resilience, environment and agriculture agendas, triggering action in agrifood systems to respond to the climate crisis. Importantly, these approaches provide rationale and guidance for immediate and informed action that is consistent with the overarching objective of sustainable and resilient agrifood systems. When combined with robust processes for monitoring, the evidence accumulated over time can be used to evaluate policies and measures and suggest changes in a manner consistent with iterative risk management. Inclusive and scenario-based planning exercises incorporating a range of possible future risks and policies and measures consistent with the principles and outcomes underlying these approaches are an important complementary tool to inform decision-making for resilience.[56]

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[50] Crumpler, K., Dasgupta, S., Federici, S., Meybeck, M., Bloise, M., Slivinska,V., Salvatore, M., Damen, B., Von Loeben, S., Wolf, J. & Bernoux, M. 2020. Regional analysis of the nationally determined contributions in Asia – Gaps and opportunities in the agriculture and land use sectors. Environment and Natural Resources Management Working Paper No. 78. Rome, FAO. https://doi.org/10.4060/ca7264en

[51] Crumpler, K., Dasgupta, S., Federici, S., Meybeck, A., Bloise, M., Slivinska, V., Von Loeben, S., Damen, B., Salvatore, M., Wolf, J. & Bernoux, M. 2020. Regional analysis of the nationally determined contributions in the Pacific – Gaps and opportunities in the agriculture and land use sectors. Environment and Natural Resources Management Working Papers No. 82. Rome, FAO. https://doi.org/10.4060/ca8681en

[52] Jones, R. N. et al. 2014. Foundations for decision making. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 195-228.

[53] FAO. 2019. The ten elements of agro-ecology. Rome. Italy.

[54] FAO and WHO. 2019. Sustainable healthy diets – Guiding principles. Rome.

[55] FAO. N. D. Climate-smart agriculture. (also available at http://www.fao.org/climate-smart-agriculture/overview/en/)

[56] Jones, R. N. et al. 2014. Op. Cit.

Practical examples for moving toward climate resilient agrifood systems

14. The concepts and analyses presented in this paper suggest that urgent action to move toward climate resilient agrifood systems is required to address impacts from observed and ongoing changes in climate and ensure that food system actors can anticipate and absorb future shocks as well as adapt and transform in response to a range of potentially complex future climate scenarios. While integrated approaches based on principles or target outcomes provide a supporting rationale and guidance for the direction this action should take, knowing what specific policies and measures to consider and adopt now is difficult without examples, means, evidence and capacity.

15. APRC35 requested FAO to support the use of innovative technologies, evidence-based analyses and partnerships to develop multisectoral solutions for pressing issues such as climate change. Specifically, Members requested further guidance on different types of agrifood system interventions that will foster sustainable and resilient food systems.[57] The following examples highlight practical actions that can be deployed in support of or in parallel with the priorities outlined by governments in the NDCs, NAPs, Disaster Risk Reduction plans and other relevant policies to strengthen coordination in implementation and overall impact. Deployment of similar actions as part of an overarching, sector-wide approach, whether based on agro-ecology, healthy diets, CSA or a combination of these approaches and others, can support immediate, incremental progress toward the realization of climate resilient agrifood systems at regional, national and farm levels while laying the foundation for broader system-wide transformation over time.

16. This paper and the following examples are also aligned with the proposed vision for the new FAO Strategy on Climate Change. The working vision statement for the strategy developed following initial consultations with Members is that agrifood systems are *climate-resilient and adaptive to the impacts of climate change and contribute to low-carbon economies while providing nutritious food for healthy diets, feed, fibre and fuel through innovative solutions, for present and future generations*. The Strategy is being developed through a consultative process at the request of the Council and will be presented for approval in 2022. The Regional Conference can reflect on these and other relevant examples in providing guidance on region-specific priorities and actions that should be reflected in the strategy and implementation arrangements.

Multistakeholder and multisector interventions and partnerships

17. Multistakeholder and multisector interventions and partnerships help to ensure coordination and engagement in the identification and promotion of measures for climate resilient agrifood systems. The ASEAN Climate Resilience Network (ASEAN CRN) is a region-specific example of multistakeholder partnership that is creating opportunities to identify and deploy resilience measures regionally and nationally. Since 2014, ASEAN CRN, with support from development partners including FAO and GIZ, has provided a platform for knowledge exchange and dialogue on experiences with building resilience in agrifood systems. The group has developed guidance on CSA practices,[58] [59] supported the deployment of pilot initiatives and organized exchanges on scaling up ambition in NDCs,[60] private sector engagement and innovation in food systems.[61] ASEAN CRN was also a driving force behind the establishment of the ASEAN Negotiating Group on Agriculture, which has worked to highlight region-specific priorities for climate resilient agrifood systems under the

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57 FAO. 2020. Report: Thirty-fifth Session of the FAO Regional Conference for Asia and the Pacific. Thimphu, Bhutan, 1-4 September 2020 (virtual).

58 ASEAN CRN. 2015. ASEAN Regional Guidelines for Promoting Climate Smart Agriculture (CSA) Practices. Endorsed by the 37th AMAF
10 September 2015, Makati City, Philippines.

59 ASEAN CRN. 2017. ASEAN Regional Guidelines for Promoting Climate Smart Agriculture (CSA) Practices Volume 2. Adopted at 39th AMAF Meeting, 28 September 2017.

60 FAO. 2017. Climate action for agriculture: Strengthening the role of scientific foresight and climate-smart agriculture in addressing NDC priorities. Workshop Report.

61 UN Food System Summit Dialogues. 2021. Innovation to Boost Climate-Smart Nature-Positive Food Production in the Association of Southeast Asian Nations (ASEAN) Region. (also available at https://summitdialogues.org/dialogue/12274/official-feedback-12274-en.pdf?t=1622636575).

United Nations Framework Convention on Climate Change processes – particularly the Koronivia Joint Work on Agriculture (KJWA). The success of ASEAN CRN in engaging in global processes provides a useful model for countries and groups looking to build capacity, mobilize finance and strengthen political will to move toward climate resilient agrifood systems.[62] With the support of FAO's technical cooperation programme, countries in the Pacific have started a similar process of awareness-raising, exchange and collaboration to advance regional priorities under KJWA. The first regional submission from the Pacific under KJWA was made in December 2020.

Innovative research, evidence-based analyses and technologies

18. Climate foresight and scenario analysis support governments and other agrifood system actors to anticipate and experiment with possible responses to future, hypothetical climate conditions, the impacts on different elements of the agrifood system, and feedbacks and interactions with other sectors and sources of uncertainty.[63] With support from the Global Environment Facility (GEF), FAO, CGIAR Research Program on Climate Change, Agriculture and Food Security and the University of Utrecht, the Government of Lao PDR is employing various approaches and integrated modelling analyses prepared by Lao Government staff using the FAO Agro-ecological Zoning approach to develop different narratives for the development of agriculture under different climate conditions and to test different response pathways and intervention measures.[64]

19. The Paris Agreement established an Enhanced Transparency Framework to build confidence that developed and developing countries alike are making progress towards the priorities outlined in their NDCs. A key source of support for transparency is the GEF Capacity Building Initiative for Transparency (CBIT). With help from FAO, a number of countries in Asia and the Pacific are working with CBIT to strengthen their capacities to measure, report and verify adaptation and mitigation actions in the agriculture, forestry and other land-use sectors.[65] Working with national universities and technical experts from FAO and other institutions, countries are developing new analyses to assess climate change risks and inform possible measures for mitigation and adaptation. Investment in building capacity with geospatial monitoring systems and developing management information systems will enable iterative processes for data generation, analysis and learning. Because transparency reporting under the Paris Agreement is economy-wide, the CBIT is promoting deeper collaboration with other sectors relevant for agrifood systems, such as energy, transport and waste. Work under the FAO CBIT programme and new initiatives such as the Scaling up Climate Ambition on Land Use and Agriculture[66] programme is now informing the development of tools and processes[67] to support the development of NDC implementation plans, NAPs, and the formulation of sector-specific inputs for long-term strategies for low-carbon and climate resilience.

20. To inform national and project-level consideration of the impacts of climate change on agriculture and the increasing requests for open production and sharing of climate risk information, FAO is also developing a set of tools designed specifically for climate risk information needs of the agriculture sector. Major climate funds, such as the GCF, require robust climate evidence to be presented as part of the funding proposal in order to justify investments in adaptation activities. While climate data and their analyses are becoming more accessible through general-purpose web platforms such as the new Climate Information Platform,[68] tools that cater to the specific needs of agriculture decision-makers are not readily available. The FAO Climate and Agriculture Risk Visualization and

[62] Siw, F., Bacudo, I., Damen, B. & Dinesh, D. 2021. Climate governance and agriculture in Southeast Asia: Learning from a polycentric approach. Frontiers in Political Science.
[63] Vervoort, J. M. et al. 2014. Challenges to scenario-guided adaptive action on food security under climate change. Global Environmental Change. Vol 28. DOI: https://doi.org/10.1016/j.gloenvcha.2014.03.001
[64] FAO. 2020. Training for using foresight to policy recommendations. (also available at http://www.fao.org/in-action/samis/resources/news/detail/ru/c/1370983/)
[65] FAO. 2021a. Climate-smart agriculture case studies 2021. Rome. Italy. DOI: https://doi.org/10.4060/cb5359en
[66] FAO. n. d. Scaling up Climate Ambition on Land Use and Agriculture through NDCs and National Adaptation Plans. (also available at http://www.fao.org/climate-change/programmes-and-projects/detail/en/c/1273079/).
[67] FAO. n. d. FAO and the Enhanced Transparency Framework. *Tools and Resources*. (also available at http://www.fao.org/climate-change/our-work/what-we-do/transparency/tools-resource).
[68] Climate Information Platform. n. d. About. (also available at https://climateinformation.org).

Assessment Platform allows users to compute CIDs and agriculture-related climate indices for the past and the future in any user-selected seasons and areas, using the latest data from the IPCC WG1 Interactive Atlas.[69] More complex climate trend analyses of extreme weather events and agrometeorological risks can be processed in the Climate Hub, a programming and plotting tool for more advanced users.

21. Consistent with providing an evidence base for adopting agro-ecological principles as a foundational framework for moving toward climate resilient agrifood systems, the Tool for Agro-ecology Performance Evaluation (TAPE) has been developed by FAO to build evidence and collect data about sustainable agriculture and the role of agro-ecological approaches. Resilience to climate change and greenhouse gas emissions are two of a number of advanced criteria that can be used to adapt TAPE to consider the contribution of agro-ecology to climate resilient agrifood systems.[70] TAPE is currently being deployed in a number of countries around the region.[71]

22. Specific innovations and technologies can strengthen multiple dimensions of climate resilience in agrifood systems. For example, the use of direct seeded rice has been found to maintain or increase yields, while reducing water inputs and reducing methane emissions by between 33 and 60 percent.[72] Further down the value chain, solar-powered milk-cooling centres introduced by FAO in Afghanistan have provided a product management solution for rural villages that are deprived of electricity.[73] FAO has also been supporting the installation of locally manufactured hermetic metallic silos for improved food and seed storage and market access. In Papua New Guinea, combination solar dryers for cocoa have been installed by FAO to reduce the need for firewood/charcoal as well as to reduce women's drudgery, workload and risks in firewood collection. FAO is supporting the integration of inland fisheries and aquaculture operations into broader environmental management plans and integrated water and land management institutions. For example, in Samoa, under the community-based ecosystem management programme FAO is working with fisheries administration officials and communities to deliver coral and mangrove restoration for climate change adaptation and fisheries enhancement training sessions.

Market-based measures and leveraging public investment including incentives for MSMEs and small holders

23. Market-based measures and incentives can help push a wide range of agrifood system actors towards sustainable and resilient practices and mitigate potential negative climate impacts. For example, public and private organizations involved in rice production, distribution and trade have been working to build an enabling environment for MSMEs and smallholders in order to provide access to markets for rice products that contribute to building climate resilience and sustainable development products through adoption of the Sustainable Rice Platform (SRP) Sustainable Rice Standard.[74] The SRP standard is consistent with a number of agro-ecological and CSA objectives, including improved labour conditions, enhanced on-farm and landscape-level resilience, and reduced greenhouse gas emissions from rice production.[75] The standard is attractive for private companies looking to improve the quality of their rice products and contribute to sustainable development. For example, in Viet Nam, Olam and Loc Troi Group have indicated they will change procurement practices to include smallholder farmers who work with a new GEF-supported FAO and Government of Viet Nam project to adopt the SRP standard. Moves by retailers such as the LIDL supermarket chain in Europe to stock

[69] IPCC. n.d. IPCC WGI Interactive Atlas. (also available at https://interactive-atlas.ipcc.ch/).
[70] Mottet, A. et al. 2020. Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agro-ecology Performance Evaluation (TAPE). Frontiers in Sustainable Food Systems. Volume 4. DOI: 10.3389/fsufs.2020.579154
[71] FAO. 2021b. Op. Cit.
[72] Debashis, C. et al. 2017. A global analysis of alternative tillage and crop establishment practices for economically and environmentally efficient rice production. Scientific Reports (2017) 7: 9342.
[73] FAO. 2021. A solar-powered milk cooling centre created a sustainable market for the people of Karukh. (also available at http://www.fao.org/afghanistan/news/detail-events/en/c/1372077/).
[74] FAO. 2021a. Op. Cit.
[75] Ibid.

SRP-verified rice products[76] will open up new opportunities for rice producers to access markets that reward sustainable and resilient practices.

24. Payments for ecosystem services, including Reducing emissions from deforestation and forest degradation (REDD+) results-based payments and jurisdictional approaches, are market-based mechanisms that are finding ways to reward communities for stewardship of resources that can strengthen resilience to climate and other stressors over time. The active promotion of sustainable forest management and development of sustainable forest product value chains that are linked to climate resilient commodities through programmes and projects (e.g. Forest Certification, Forest Legislation, Enforcement, Governance and Trade; REDD+ Results-based Payments) are emerging as important adaptation and mitigation strategies for country governments and communities across the region. For example, Indonesia has recently been successful in accessing US$103 million from the GCF and was also offered US$56 million through REDD+ Results-based Payment from Norway for reducing deforestation rates. A related approach being developed by the Solomon Islands with support from GEF and FAO is the establishment of a Protected Area trust fund to provide financial resources for the Government and partners to promote restoration, the enhancement of carbon stocks, and biodiversity conservation. This mechanism aims to support sustainable forest management programmes that deliver significant benefits in terms of resilience, while also ensuring that they are socially viable and economically feasible over the long term.

Experiences with COVID-19 response and green recovery

25. In response to the slowdown in economic activity that has resulted from COVID-19 lockdowns across the region and around the world, there has been sustained interest in the role that recovery measures could play in stimulating economic activity and job growth, while also contributing to improved environmental outcomes, including resilience. Agricultural nature-based solutions (NBS) is an evolving approach that could be a useful way to identify fast-track investments in such measures. NBS aims to use natural processes or elements over various temporal and spatial scales to improve the ecosystem function of landscapes affected by agricultural practices, and enhance livelihoods and other social and cultural functions.[77] FAO is using NBS to support the identification of measures with local and global environmental and resilience benefits under its portfolio of GEF-7 Trust Fund and Least Developed Countries Fund projects.

26. More targeted measures to address post-harvest losses resulting from COVID-19 disruptions point to additional options to strengthen resilience to a range of possible shocks, including climate change. For example, in Wewak, Papua New Guinea, the provision of cooler boxes for increased fresh fish shelf life helped market vendors to preserve their livelihoods in response to the local market closures following the COVID-19 outbreak. In Herat, Afghanistan, support for the local manufacture of food and seed metallic storage silos helped wheat producers in a similar fashion. Evidence suggests that the impacts of climate change on the conditions for storage of agricultural output and food stuffs could increase the incidence of loss and spoilage in the future.[78] Provision of similar climate-proofed storage measures will be an important element of future strategies to build agrifood systems resilience. To address disruptions to value chains connecting producers and consumers, the Open Food Network used digital innovations including open-source and community-controlled platforms to connect consumers and farmers.

[76] LIDL. 2021. LIDL is the first German retailer to join the Sustainable Rice Platform (In German). (also available at https://unternehmen.lidl.de/pressreleases/2020/201104_beitritt-sustainable-rice-platform).
[77] Simelton, E., et. al. 2021. NBS Framework for agricultural landscapes. Frontiers in Environmental Science.
[78] Mbow, C. et al. 2019. Op. Cit.