E

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

COMMITTEE ON AGRICULTURE

Twenty-ninth Session

Rome, 30 September – 4 October 2024

Scaling up One Health through an integrated approach for food chain crisis management, agrifood systems and ecosystem health

Executive Summary

This proposal presents an integrated, all hazards framework for transforming agrifood systems using a comprehensive One Health approach to reduce the risks of biological threats to food production systems and ecosystem health, build resilience, address vulnerabilities and promote practices for environmental sustainability, with broad stakeholder participation. It outlines the progress in applying integrated approaches to manage threats to agrifood systems under the FAO Programme Priority Area on One Health (OH PPA) and proposes actions and ways forward for applying a *One Health Approach in Agrifood Systems for Global Health and Food Security*. In this regard, upstream prevention, early warning systems and surveillance, risk assessment, management and communication, multisectoral coordination for preparedness and rapid response, and community engagement are FAO's major responsibilities.

This paper also highlights the progress made and the importance of continuing to work with the other Quadripartite Organizations (UNEP, WHO and WOAH) to strengthen the implementation of the multisectoral approach to address health threats at the human-animal-plant-environment interface as part of the Quadripartite One Health Joint Plan of Action.

This document seeks guidance from the Committee on how FAO can strengthen and scale up its technical and investment support to Members to manage biological risks across the agrifood sectors, and to protect and transform agrifood systems through a comprehensive One Health approach.

Suggested action by the Committee

The Committee is invited to:

a) *take note of* the progress made towards a holistic application of the One Health approach across production sectors in FAO's 'One Health' Priority Programme Area;

b) *recommend* FAO to accelerate its support to Members through the development and implementation of a *Policy Framework on One Health in Agrifood Systems for Global Health and Food Security*;

c) *recommend* FAO to strengthen and scale up the implementation of the One Health approach in a coordinated manner among its Technical Units, Decentralized Offices (DOs) network and relevant partners to reduce productivity losses and promote global health;

d) *recommend* FAO to strengthen Members' capacities, including on investment leverage, through a more integrated 'One Biosecurity' approach, that coordinates and transcends sector-specific approaches and interventions on the upstream prevention and the sound management of biological and non-biological drivers of agrifood systems risks;

e) *recommend* FAO to promote multi-hazard early warning systems (MHEWS)[1] and support Members in integrating hazards to agrifood systems in their national early warning systems;

f) *note* the launch of the 'Quadripartite One Health Joint Plan of Action' and *encourage* FAO, in cooperation with its partners, to support Members in the development of their national policies on One Health adapted to their context, and advocate for investment in strengthening national One Health capabilities.

Queries on the substantive content of the document may be addressed to:

Mr Thanawat Tiensin
Director
Animal Production and Health Division (NSA)
Tel.: +39 0657054095
Email: NSA-Director@fao.org

[1] United Nations Office for Disaster Risks Reduction. n.d. *Early Warning System*. In: UN. New York, USA. [Cited 8 July 2024]. https://www.undrr.org/terminology/early-warning-system

I. Introduction

1. The productivity of food production systems is massively impacted by biological threats (including transboundary pests and diseases, zoonoses, antimicrobial resistant organisms, food safety hazards and invasive alien species), the invasion or resurgence of which gives rise to national or regional food security emergencies. The consequences of these threats are growing, constituting a major part of the losses, estimated at USD 124 billion annually, due to emergencies affecting agrifood systems[2] with huge consequences on global health. While FAO's portfolio of actions to support One Health and biosecurity[3] in agrifood sectors is significant, these hazards have been addressed mainly through sector-specific approaches by FAO's different Technical Divisions and Units, and require improved integration for policy development, surveillance, planning interventions and resource use, through a whole-of-society and systems approach.

2. In the current globalized context, an all-hazards approach, integrating national efforts for more effective biosecurity to reduce risks of important biological, chemical, and physical threats is needed. Efficiency gains in FAO's technical services to Members, taking a more integrated and strategic multi-hazard approach, would enable them to better understand the transmission, spread and pathogenesis of these hazards to better prevent, prepare and respond to the scale and breadth of these devastating threats. This is considered important especially to improve long-term investment planning considering the interrelated nature of threats to, and from, agrifood systems related to climate change, environmental pollution, biodiversity loss, land degradation and other drivers.

3. The proposal presents an integrated, all-hazards policy framework to apply *One Health in Agrifood Systems for Global Health and Food Security* to reduce the risks of biological threats that affect agrifood systems and ecosystem health. The focus will be to strengthen Members' national capacity, ranging from backyard and farm level interventions to measures at policy level and at national borders, to better prevent, prepare and improve control of health hazards to agrifood systems. FAO`s current services in these domains are built under its Programme Priority Area on *One Health for Better Production* (PPA BP3) of the FAO Strategic Framework 2022-31.

II. The challenges faced by food production systems

4. The increased and rapid movement of people, animals, plants and their products in a globalized world, coupled with degrading biodiversity and changing agro-ecological conditions, as well as inappropriate management practices and deterioration of rangelands, all contribute to the escalation of biological threats to agrifood systems and ecosystem health. As a result, these threats spread farther and faster than ever before, affecting particularly countries with weak sanitary and phytosanitary regulations and infrastructure. In addition, climate change, extreme weather events and seasonal variability drive the emergence, spread and severity of biological threats, all of which significantly affect the agrifood systems, the environment and global health.

5. Transboundary high-impact animal diseases, such as avian influenza, African swine fever, *peste des petits ruminants*, and Foot-and-Mouth Disease, affect the availability and quality of crucial livestock-derived foods, which contribute 33 percent of protein and 17 percent of calorie intake of diets.[4] These epidemics and many other animal diseases directly affect livelihoods, food security and nutrition of farming households, wildlife conservation and biodiversity, have negative effects along national and international livestock value chains, such as through trade restrictions.

6. The high risk of emerging and reemerging disease spillover and burden has been increased by extensive interactions among animals, humans, and ecosystems. Zoonotic diseases are becoming growing health threats worldwide with limited capacity of national veterinary services and, in the past

[2] FAO. 2023. *The Impact of Disasters on Agriculture and Food Security 2023 – Avoiding and reducing losses through investment in resilience.* Rome. https://doi.org/10.4060/cc7900en
[3] COAG/2003/9; https://www.fao.org/4/Y8453e/Y8453e.htm
[4] FAO. 2018. *World Livestock: Transforming the livestock sector through the Sustainable Development Goals*. Rome. 220 pp. https://openknowledge.fao.org/handle/20.500.14283/ca1201en

20 years, have been reported to cause morbidity and death in humans, and economic damage in the range of billions of USD in many local and global multi-sectoral economies, with significant long-term impacts on human health and global health security.

7. Plant health, soil health and ecosystem health are fundamental components of agrifood systems and are, therefore, critical for food production, environmental sustainability, and ecosystem stability. Crop pests and diseases, such as Fall Army Worm and Desert Locust, among others, are affecting regional and international trade, as well as food security and livelihoods of the poorest farmers globally. Each year, plant diseases cost the global economy around USD 220 billion, while invasive insects cost around USD 70 billion.[5] Over 3 500 invasive alien species are recognized which include the most significant agents affecting food production systems and biodiversity.

8. The increasing use of pesticides to prevent, combat or control pests is also an issue. FAO estimates that over the past two decades, globally, the agriculture sector has been applying around four million tonnes of pesticides each year.[6] If not used responsibly, these chemicals can adversely impact the health of animals and humans, as well as soil, water, air, biodiversity, pollinators and sustainability of agriculture in general.

9. In the aquaculture sector serious diseases can appear, spread rapidly and cause major losses. Estimates of economic losses from decreased production, export earnings and jobs caused by Acute hepatopancreatic necrosis disease (AHPND) and other shrimp diseases are estimated at USD 12 billion in the Kingdom of Thailand (2010–2017), and exceed USD 26 million in the Socialist Republic of Viet Nam (2015).[7] In 2017, the economic losses due to several pathogens in the People's Republic of China's tilapia aquaculture industry were estimated at USD 450 million.[8]

10. In forestry, insect pests damage about 35 million hectares of forests annually. These threats include chestnut blight and chestnut gall wasps, pine seed bug, and pine wood nematodes among others.

11. Food safety from production to consumption is essential to healthy agrifood systems and critical to human health. Food safety hazards, including zoonotic and non-zoonotic pathogens and chemical contaminants, can enter the food chain at any point, from prior to harvest to the time of consumption.

12. Each year, about USD 110 billion[9] in productivity and medical expenses is lost in low and middle-income countries (LMICs) due to unsafe food.

13. Increasing antimicrobial use (AMU), antimicrobial resistance (AMR) and emerging contaminants, such as antibiotics, pesticides and nitrates released into the soil environment due to agricultural and livestock practices is a critical global health problem affecting humans, animals and the environment. In a high-impact scenario, AMR would reduce 3.8 percent of global annual Gross Domestic Product (GDP) by 2050.[10]

14. The food and agriculture sectors are typically regulated in a siloed approach, which hampers opportunities for multistakeholder and interministerial collaboration. Strengthened governance, policy

[5] FAO. 2019. *New standards to curb the global spread of plant pests and diseases.* In: FAO. Rome. [Cited 8 July 2024]. https://www.fao.org/newsroom/detail/New-standards-to-curb-the-global-spread-of-plant-pests-and-diseases/en
[6] FAO. 2023. *Pesticides use and trade, 1990–2021. FAOSTAT Analytical Briefs Series No. 70*. Rome. https://openknowledge.fao.org/handle/20.500.14283/cc6958en
[7] Asian Fisheries Science 31S (2018): 29–58 *Asian Shrimp Production and the Economic Costs of Disease* https://doi.org/10.33997/j.afs.2018.31.S1.003
[8] FAO. 2020. Food Chain Crisis. Prevention saves lives https://openknowledge.fao.org/server/api/core/bitstreams/01a5ac08-2ef5-4163-ac7e-4a25b5151bb9/content
[9] Jaffee, Steven; Henson, Spencer; Unnevehr, Laurian; Grace, Delia; Cassou, Emilie. 2019. *The Safe Food Imperative: Accelerating Progress in Low- and Middle-Income Countries. Agriculture and Food Series;* Washington, DC: http://documents.worldbank.org/curated/en/484371545400065950/The-Safe-Food-Imperative-Accelerating-Progress-in-Low-and-Middle-Income-Countries
[10] World Bank. 2017. *"Drug-Resistant Infections: A Threat to Our Economic Future."* Washington, DC: World Bank. https://documents1.worldbank.org/curated/en/323311493396993758/pdf/final-report.pdf

and regulatory frameworks would be instrumental to facilitate coordination and collaboration, promote information sharing and secure stakeholders' engagement.

15. The complexity and interconnectedness of all these threats requires holistic, integrated solutions with a systemic approach that incorporates upstream and multisectoral prevention and preparedness measures integrating the health of humans, animals, plants and the environment. The adoption of a One Health approach is key to mitigating the risks of biological threats to agrifood systems. In addition, countries must adopt a multi-hazard and multi-sectoral systemic risk management approach to anticipate, prevent, prepare for and respond to agrifood system threats.

III. Enhancing availability, access and utilization of data to inform actions in countries

16. Within the FAO Strategic Framework 2022-31, One Health and biosecurity in the agriculture sectors are mainstreamed under the Priority Programme Area (OH-PPA) for *Better Production*. Great strides have been made over the past years towards the application of One Health for promoting sanitary and phytosanitary improvements and biosecurity along the entire agrifood systems domain to build sustainable agrifood systems that safeguard food supplies, and prevent health risks, disease spread, and losses in biodiversity. The major activities implemented across the sectors under the OH-PPA are summarised in the following sections:

*Promoting One Health networking across the sect*ors

17. The FAO One Health Technical Working Group was established in 2021 with the contribution of all Technical Divisions and Units to serve as a knowledge exchange platform on One Health initiatives and to strengthen the collaboration across sectors to move towards One Health in agrifood systems transformation.

Developing coordinated early warning systems and surveillance for hazards to agrifood systems and health security

18. Recognizing that many of the hazards to agrifood systems can cause productivity losses and lead to health risks, strengthened monitoring of these hazards and their specific drivers is needed to facilitate and guide timely risk communication for coordinated early action across sectors at the global, regional and country levels. Following the COVID-19 pandemic, the Quadripartite Organizations, custodians of several early warning systems, concluded the *One Health Intelligence Scoping Study*, assessed gaps in integration of health intelligence across sectors for effective early detection of emerging health risks- and proposed an operational framework for a Quadripartite-led One Health Intelligence System (OHIS).[11] The OHIS was designed for more efficient use of data across sectors for monitoring, early warning and forecasting of health risks, including risks of outbreaks of zoonotic potential, food security, environmental and public health risks. Several countries have expressed interest in implementing the system at national level.

19. FAO, as a leading Agency for disaster risk reduction in the agriculture sectors, is improving the integration of biological hazards into the Sendai Framework for Disaster Risk Reduction (SFDRR), including the development of Hazard Information Profile (HIP) Phase II for biological hazards to agrifood systems.

20. Furthermore, through its cooperation with the International Atomic Energy Agency (IAEA), FAO has in place the response capacities to protect food, agricultural water, feed and soil during nuclear or radiological emergencies, including monitoring and countermeasures and remediation actions.

[11] FAO, UNEP, WHO, and WOAH. 2023. Quadripartite One Health Intelligence Scoping Study - Final report. Rome. https://openknowledge.fao.org/handle/20.500.14283/cc4480en

Scaling up of FAO's technical and investment leverage to enhance Members capacities to manage biosecurity risks

21. Strengthening biosecurity using a comprehensive One Health approach is one of the key thematic components of FAO's OH-PPA to reduce losses of productivity, biodiversity, safe and secure food availability and prevention of health risks. The *Progressive Management Pathway for Terrestrial Animal Biosecurity*[12] and the *Progressive Management Pathway for Aquaculture biosecurity*[13] apply progressive, collaborative approaches to biosecurity management in value chains to reduce diseases and improve productivity.

22. The progressive management approach for biosecurity promotes attention to primary producer biosecurity for resilience and sustainable control of diseases, to enhance productivity, support livelihoods and reduce the need for antimicrobials and pesticide use, thus also strongly supporting FAO's Action Plan on AMR.[14] The approach requires national, regional and global cooperation and action.

23. FAO has developed a draft integrated biosecurity index (IBI) integrating indicators on biosecurity management from animal and plant health, forest and aquaculture health, and food safety. IBI does not replace existing tools related to biosecurity assessment and management of each individual sector but adds value through the assessment of intersectoral capabilities and gaps. The IBI is piloted in four selected countries in the Middle East, East Africa and Asia.

24. FAO is developing *Global Forest Biosecurity guidelines* to protect the health of forest ecosystems against invasive species and native pest outbreaks. This will protect healthy forest ecosystems and contribute to preserving biodiversity and reduce risks of infectious disease emergence and spillover. FAO's work on management of invasive alien species to agrifood systems productivity and biodiversity and ecosystem health contributes to achieving the Sustainable Development Goal (SDG) 15. FAO has also contributed to the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES) assessment report on Invasive Alien Species.[15]

25. FAO is developing a *Legal Assessment Tool on Biosecurity* to support countries in revising and updating their national biosecurity-related legislation. This tool incorporates international reference standards and good practices, paving the way for stakeholders' involvement in law development, compliance and enforcement.

Strengthening national capacities to manage plant and pest disease emergencies

26. Plant pests can have cascading effect on human and animal health. To address the challenges of transboundary plant pests and disease emergencies FAO has been implementing global and regional programmes, focusing particularly on prevention, by promoting international collaborations and capacity development for better preparedness, response and integrated pest management. Among these, the FAO Desert Locust Information Service has been crucial in addressing the locust outbreaks in Africa, the Middle East and Asia. Similarly, the Global Action for Fall Armyworm has been instrumental in combatting the pest throughout Africa and Asia.

27. The International Plant Protection Convention (IPPC) Secretariat, through the implementation of Phytosanitary Capacity Evaluations (PCE), the global *Pest Outbreak Alert and Response Systems* (POARS) and the IPPC Fusarium TR4 Global Coordination, has supported Members to develop and strengthen national capacities to prevent the introduction and spread of plant pests. IPPC is also

[12] COAG:LI/2024/6. https://openknowledge.fao.org/handle/20.500.14283/np161en
[13] FAO. 2023. *The Progressive Management Pathway for Aquaculture Biosecurity – Guidelines for application. FAO Fisheries and Aquaculture* - Technical Paper, No. 689. Rome. https://openknowledge.fao.org/server/api/core/bitstreams/548f754b-8cfd-4094-90b5-fc8f3a08749a/content
[14] More information provided in COAG/2024/INF/7 https://www.fao.org/governing-bodies/technical-committees/committee-on-agriculture/coag-2024/en
[15] IPBES (2023). *Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES secretariat, Bonn, Germany. https://www.ipbes.net/ias

gathering information on products used and scope of risks associated with AMR in the phytosanitary context.

Strengthening national capacities to curb the risk of AMU and AMR in the food and agriculture

28. FAO is leading the fight against AMU and AMR in the agriculture sectors through the FAO Action Plan on Antimicrobial Resistance and flagship initiatives, such as the International FAO Antimicrobial Resistance Monitoring (InFARM) system, and the Reduce the Need for Antimicrobials in Agrifood Systems (RENOFARM).[16]

Fostering integrated approach to preventing and managing zoonotic diseases and contributing to FAO's actions supporting food safety and pandemic prevention.

29. FAO provides support to Members in prevention and management of zoonotic diseases in food value chains through strengthening the capacity of animal health systems at regional and national levels to prevent, detect, prepare for and respond to endemic and emerging zoonotic diseases at the animal source. The support includes improvement of capacities related to key technical areas, such as surveillance, laboratory diagnostics, biosafety and overall biosecurity, workforce development and others. This work is being scaled up with support from the Pandemic Fund.

30. The FAO Agrifood Systems and Food Safety Division (ESF) addresses foodborne zoonotic diseases through improving the capacity of Members in food safety risk assessment and management, including enforcement of CODEX standards.

31. Furthermore, through the Sustainable Wildlife Management programme, FAO supports Members to prevent and mitigate the risk of zoonoses spillover from wildlife through various interventions, such as addressing upstream drivers for emergence and spillover of zoonoses through improved wildlife management, habitat conservation, risk reduction measures along the bushmeat value-chain.

32. The FAO Development Law Service (LEGN) supports Members in reviewing and revising their national legislation to facilitate coordinated responses to interconnected threats in the human-animals-plants and ecosystems nexus, with a focus on the compliance and enforcement of the legislation.

Scaling up knowledge exchange and transfer through innovative digital engagements with national experts in Member Nations

33. The One Health Knowledge Nexus was launched in November 2023,[17] embedded in FAO's Virtual Learning Centres (VLCs). This knowledge network offers an online platform and builds different Communities of Practice (CoPs) where people can collate, exchange and generate knowledge and evidence on different One Health topics. To date, three CoPs have been opened engaging over 1000 Members on: (i) Acaricide Resistance Management on Livestock Ticks, (ii) Terrestrial Animal Biosecurity; and (iii) the Quadripartite Return on Investment for One Health.

Fostering collaboration with the Quadripartite on One Health

34. FAO continues working with the Quadripartite (FAO, UNEP, WHO and WOAH) to strengthen the implementation of the multi-sectoral approach to biological risk management as part of the Quadripartite One Health Joint Plan of Action (OH-JPA).[18] FAO has developed a One Health Monitoring tool (OHMT)[19] to support countries in One Health situation analysis and implementation. The tool has been so far launched in four countries in Africa.

35. FAO and WHO have been running a joint programme on pesticide management to develop pesticide specifications and residue standards in food to minimize risks and adverse consequences to

[16] More information provided in COAG/2024/INF/7
[17] FAO. One Health Knowledge Nexus virtual-learning-center.fao.org/local/vlcs/view.php?id=12
[18] FAO, UNEP, WHO and WOAH. 2022. *One Health Joint Plan of Action (2022–2026). Working together for the health of humans, animals, plants and the environment.* Rome. https://doi.org/10.4060/cc2289en
[19] FAO. One Health Assessment Tool https://www.fao.org/one-health/resources/one-health-assessment-tool/en

plant, human and environmental health. Similarly, FAO and UNEP have been jointly serving the Secretariat of the Rotterdam Convention facilitating Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. The Secretariat has been promoting shared responsibility and cooperative efforts among parties in order to protect human and environmental health, cooperating actively with relevant international Organizations supporting also the holistic implementation of the One Health strategy.

IV. The way forward and follow-up actions

36. The need for an effective framework to manage biological threats to agrifood systems is crucial and FAO has recognised this as a key area for interdisciplinary collaboration. FAO is well positioned to lead the governance, oversight, communication and coordination of preventing and managing risks to agrifood systems through a One Health approach.

37. FAO will develop a *Policy Framework on One Health in Agrifood Systems for Global Health and Food Security*, which aims to accelerate its actions to manage animal and plant pests and diseases, zoonotic diseases, AMR and other threats to agrifood systems. As part of the framework, activities will be developed or reinforced in the following three main areas:

A. Scaling up of FAO's technical and investment leverage to Members through an integrated 'One Biosecurity' service offer, that coordinates and transcends sector-specific approaches and interventions.

38. This includes mainstreaming FAO's work on the prevention and the sound management of biological and non-biological drivers of agrifood systems risks. This work will build and improve upon the lessons of implementing the FAO Emergency Prevention System for Transboundary Animal and Plant pests and diseases (EMPRES), and the FAO Food Chain Crisis Management Framework,[20] through a broader One Health approach and will expand the scope to include the following activities:

a) Create a multi-hazard early warning system (MHEW) for integrated risk communication to Members through the development of a multi-hazard risk/AgriRisk dashboard for hazards to productivity, with regional risk forecasting and support to Members' national early warning systems. The dashboard will be initially developed at global level, with the review and inputs of countries and regional networks, and of Economic Commissions, to ultimately catalyse multidisciplinary efforts from "agrifood risk management Task Forces" to support risk management, including decision support, scenario analysis and risk response. The unification of hazard information related to agrifood systems will also strengthen FAO's contribution to Disaster Risk Reduction strategies at the UN and at country levels.

b) A *One Health Knowledge and Intelligence Hub* (OHKI Hub) will be established to bring together the integrated intelligence and best practices on managing pests, diseases and other threats to agrifood systems. An essential component of this OHIK Hub will be the AgriRisk dashboard and the One Health Knowledge Nexus to scale up knowledge sharing and transfer through innovative digital engagements with national biosecurity and risk management experts in Member Nations to build capacity and promote investments. This approach will enhance attention to primary producer biosecurity for resilience and sustainable control of pests and diseases, to increase productivity, support livelihoods and reduce the need for antimicrobials and pesticide use.

c) FAO will continue its work on the development and deployment of IBI. This tool will test cross sectoral capacities to manage risks to agrifood systems and will add value through strengthening the collaborative areas of work on prevention, preparedness and response across sectors. It will also integrate actions to reduce the risks of invasive alien species to agrifood systems productivity and biodiversity and ecosystem health.

[20] FAO Food Chain Crisis Management Framework. https://openknowledge.fao.org/server/api/core/bitstreams/313cf954-bf55-41d3-a304-5912fab942a5/content

d) Further efforts will be made to mainstream consideration of hazards to agriculture sectors into national emergency preparedness and disaster risk reduction planning, considering their importance to Disaster Risk Reduction and securing primary producer productivity. This will support Members in improving technical and operational coordination and capacities to implement anticipatory actions and undertake emergency response to build resilience at all levels.

B. Support the implementation of the FAO Action Plan on AMR.

39. FAO will implement the recently launched ten-year initiative to *Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation* (RENOFARM). This will enable the implementation of the FAO Action Plan on AMR and provide support to Members in addressing AMR sustainably and with a One Health approach.

C. Accelerating actions for implementation of One Health approach to global health.

40. FAO will continue to collaborate with the Quadripartite and other key partners at regional and national levels to strengthen its actions for the implementation of the multi-sectoral approach to biological risk management with a focus on strengthening health systems for the management of zoonotic diseases, AMR, food safety threats and environmental health as part of the Quadripartite One Health Joint Plan of Action and provide technical guidance on appropriate tools and methodologies.