Adaptation Research Alliance

Transitions Research

Digitisation and Food Systems

A need for collective adaptation approach

TLS Learning Journey Series

About Transitions Research

Transitions Research is a social science research collective. We examine radical transformations shaping our future, including both urbanisation and the emergence of a climate-resilient society. Our research on urban resilience foregrounds social vulnerability, the differential impact on marginal social groups and communities. Our expertise is focused on driving climate action that's inclusive and participatory by engaging with diverse stakeholders to co-create and test resilience solutions that address challenges of the most vulnerable.

About the Adaptation Research Alliance

The Adaptation Research Alliance (ARA) is a global coalition responding to the urgent challenges faced by vulnerable communities from climate change. Their membership is made up of researchers, funders, policymakers, development bodies and community-based organizations committed to action-oriented research for adaptation that supports climate resilient futures.

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This report has been shaped by insights, reflections, and experiences shared by members of the Adaptation Research Alliance through their Tracking, Learning, and Sharing (TLS) program. Their perspectives have been integral to framing the findings and recommendations presented here.

October 2025

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Overview

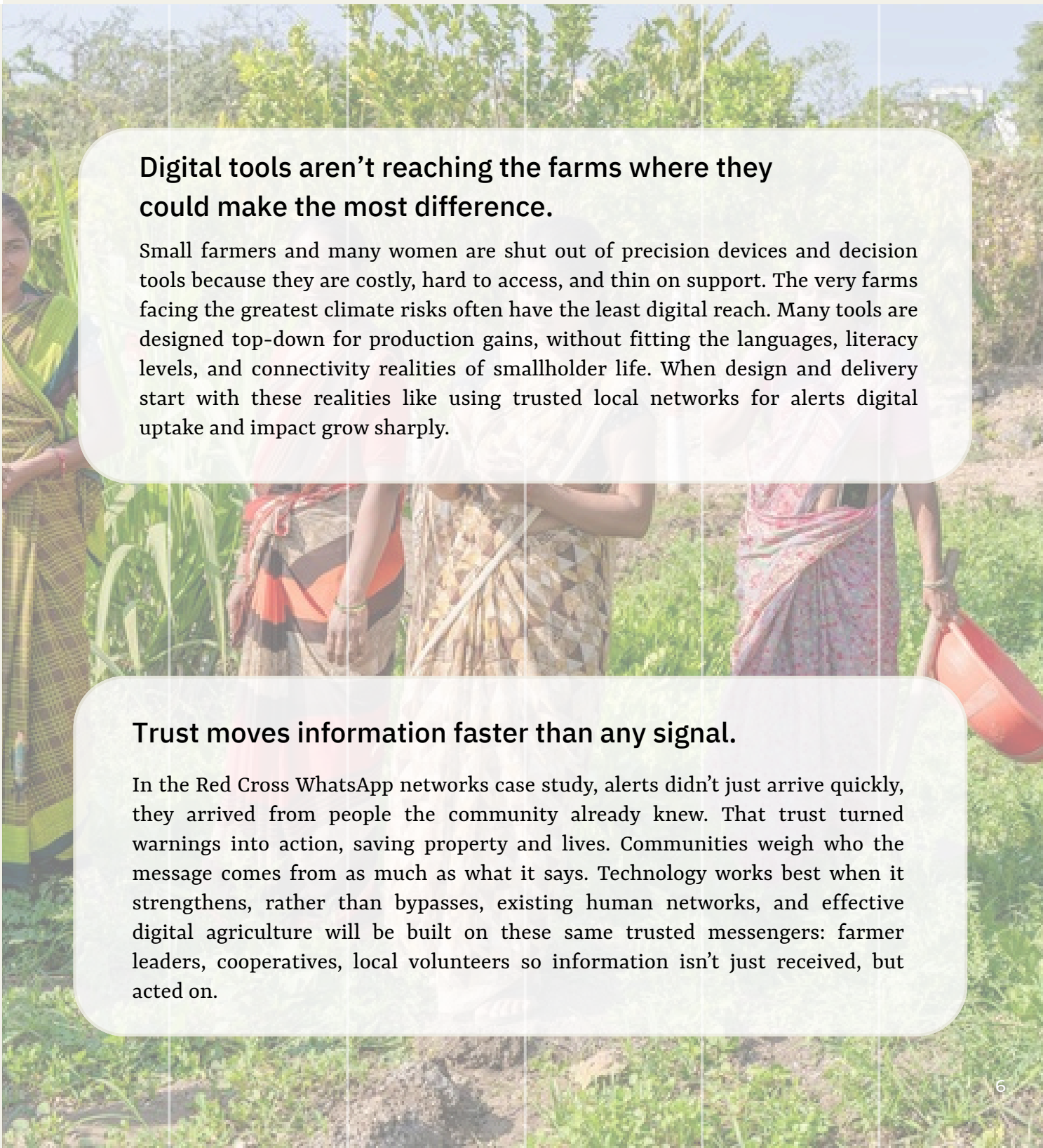
Climate change is reshaping how food systems function across Asia and the Pacific, and smallholder farmers are feeling the brunt of it. Crops, incomes, and food security are increasingly at risk, with yields of key staples like rice, wheat, and maize projected to decline by 20–30%[1] in the coming years. Economic losses are mounting, South-East Asia faces potential agriculture losses of up to 6% of GDP, while East and North-East Asia could lose over $250 million[2] in output under various scenarios.

Digital tools are often highlighted as a smart solution to strengthen resilience enabling better forecasting, smarter resource use, and faster responses to climate risks. However, the potential of digital adaptation remains unevenly realised. Gaps in infrastructure, access, policy, and capacity continue to limit smallholders' ability to benefit from these technologies, especially in rural and marginalized communities.

To understand how digital solutions can better serve as adaptation pathways for food security, Transitions Research convened regional dialogues with members of the Adaptation Research Alliance (ARA) across Asia Pacific. These sessions, held February, 2025, brought together 21 participants representing researchers, practitioners, and community-based organisations from countries such as Iraq, Nepal, Indonesia, Myanmar, Bangladesh, Pakistan and India. This report shares those collective reflections and co-created ideas for moving forward. The sections that follow first unpack the problem, then present regional examples of adaptation in action, before turning to shared insights and recommendations for future collaboration.

1. Ellen Gray, "Global Climate Change Impact on Crops Expected Within 10 Years, NASA Study Finds", NASA (1 November 2021), https://www.nasa.gov/earth-and-climate/global-climate-change-impact-on-crops-expected-within-10-years-nasa-study-finds/
2. Sanjay Srivastava, Convergence of Food Systems Transformation and Climate Action (United Nations Economic and Social Commission for Asia and the Pacific, (2024), https://www.unfoodsystemshub.org/docs/unfoodsystemslibraries/regional-progress-reviews/asia-pacific/convergence-of-food-systems-transformation-and-climate-action_unescap.pdf

Key Insights

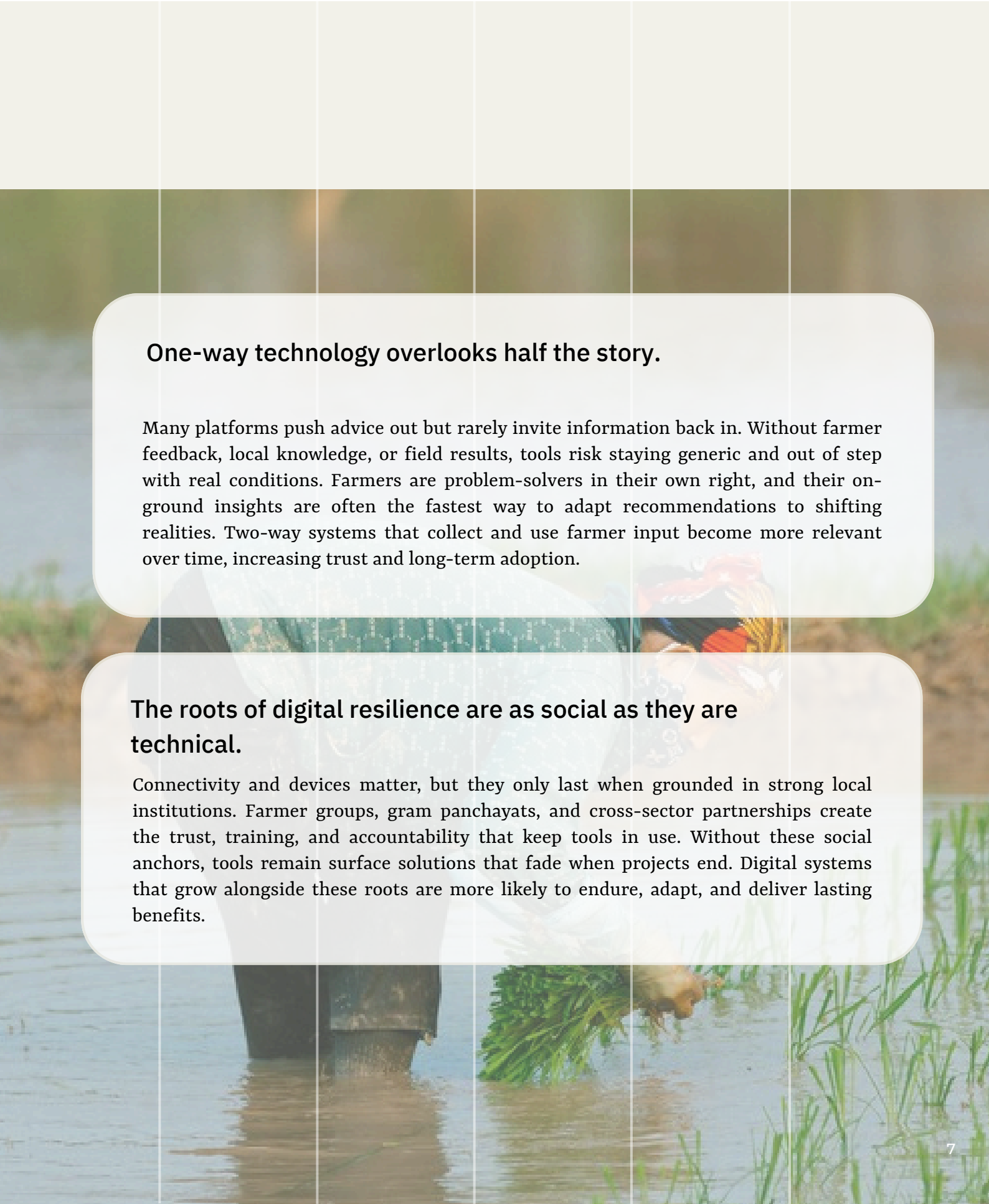


Digital tools aren't reaching the farms where they could make the most difference.

Small farmers and many women are shut out of precision devices and decision tools because they are costly, hard to access, and thin on support. The very farms facing the greatest climate risks often have the least digital reach. Many tools are designed top-down for production gains, without fitting the languages, literacy levels, and connectivity realities of smallholder life. When design and delivery start with these realities like using trusted local networks for alerts digital uptake and impact grow sharply.

Trust moves information faster than any signal.

In the Red Cross WhatsApp networks case study, alerts didn't just arrive quickly, they arrived from people the community already knew. That trust turned warnings into action, saving property and lives. Communities weigh who the message comes from as much as what it says. Technology works best when it strengthens, rather than bypasses, existing human networks, and effective digital agriculture will be built on these same trusted messengers: farmer leaders, cooperatives, local volunteers so information isn't just received, but acted on.



One-way technology overlooks half the story.

Many platforms push advice out but rarely invite information back in. Without farmer feedback, local knowledge, or field results, tools risk staying generic and out of step with real conditions. Farmers are problem-solvers in their own right, and their on-ground insights are often the fastest way to adapt recommendations to shifting realities. Two-way systems that collect and use farmer input become more relevant over time, increasing trust and long-term adoption.

The roots of digital resilience are as social as they are technical.

Connectivity and devices matter, but they only last when grounded in strong local institutions. Farmer groups, gram panchayats, and cross-sector partnerships create the trust, training, and accountability that keep tools in use. Without these social anchors, tools remain surface solutions that fade when projects end. Digital systems that grow alongside these roots are more likely to endure, adapt, and deliver lasting benefits.

Food Systems Facing Layered Vulnerabilities

The focus on food systems emerged directly from the Adaptation Research Alliance's (ARA) regional dialogue process. As part of the Tracking, Learning and Sharing (TLS) initiative, members from across Asia Pacific were invited to identify themes most relevant to their contexts and learning priorities. Through this process, participants highlighted food security and the role of digital technologies, including AI, as pressing adaptation challenges and opportunities. This shared prioritisation provided the starting point for deeper exploration in the regional session, where members exchanged evidence and experiences of how climate risks are reshaping food systems, and what digital pathways could offer in response.

Food systems across Asia and the Pacific are under growing pressure from compounding environmental, social, and economic risks. Climate shocks, rising temperatures, extreme weather [3], and oceanic disruptions are already eroding yields and threatening livelihoods, while unsustainable farming practices [4] continue to degrade land and reduce resilience. These risks are not experienced equally. Smallholders, women, and marginalized communities face the sharpest impacts, with limited access to resources, protection, or infrastructure. The promise of digital solutions remains unevenly realised: most tools are designed for large, export-oriented farms, leaving smaller producers excluded [5] due to barriers in finance, literacy, and connectivity. Without urgent action to close these gaps through inclusive policies, better infrastructure, and targeted support the region risks deepening existing inequalities and missing the opportunity for digital adaptation to strengthen resilience where it is needed most.

3. Robert Mendelsohn, Ariel Dinar, and Apurva Sanghi, 'Coping with Climate Change: An Evaluation of Agricultural Impacts and Adaptation in Japan', World Bank Policy Research Working Paper no. 1393 (Washington, DC: World Bank, 2025).
4. P. Sundram, 'Food Security in ASEAN: Progress, Challenges and Future', Frontiers in Sustainable Food Systems 7 (2023): https://doi.org/10.3389/fsufs.2023.1260619
5. S. Hackfort, 'Patterns of Inequalities in Digital Agriculture: A Systematic Literature Review', Sustainability 13, no. 22 (2021):, https://doi.org/10.3390/su132212345
6. Shruti Samadder, Sanjay P. Pandya, and Sudhanand Prasad Lal, 'Bridging the Digital Divide in Agriculture: An Investigation to ICT Adoption for Sustainable Farming Practices in Banaskantha District of Gujarat, India', International Journal of Environment and Climate Change 13, no. 9 (2023): 1376–1384, https://doi.org/10.9734/ijecc/2023/v13i92367

Regional Priorities and Strategic Focus

Asia-Pacific's food security faces serious threats from climate shocks, land degradation, inequality, and a widening digital divide. Yet, across the region, promising digital innovations are being harnessed to strengthen food system resilience. From high-tech platforms to simple phone-based networks, actors are addressing different facets of the challenge.

In South Asia, India's mKisan platform[7] delivers weather-based farming advice to over 5 million farmers, leveraging satellite data for timely agronomic guidance. In Southeast Asia, apps like Green Way and Golden Paddy[8] in Myanmar connect thousands of smallholders with pest alerts, localized forecasts, and fair market prices. In coastal regions, tools like Peskas[9] first piloted in Timor-Leste and now scaled through a regional "Digital Hub" in Malaysia help fishers and policymakers access real-time data on catches and ocean conditions, aiding adaptation to shifting stocks. In flood-prone areas of Bhutan and India, WhatsApp-based[10] warning systems allow communities to share alerts within minutes, providing critical lead time to prepare.

These examples show how digital tools are addressing distinct vulnerabilities across agriculture and fisheries, offering smart solutions aligned with local needs. These examples show how digital tools are addressing distinct vulnerabilities across agriculture and fisheries, offering smart solutions aligned with local needs. At the same time, participants cautioned that such benefits remain uneven, with persistent gaps in access and equity limiting who can take advantage of these innovations.

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7. Jim Stephenson, Tom Chellew, Luja von Köckritz, Alison Rose, and Dhanush Dinesh, 'Digital Agriculture to Enable Adaptation: A Supplement to the UNFCCC NAP Technical Guidelines', CCAFS Working Paper no. 372 (Wageningen: CGIAR Research Program on Climate Change, Agriculture and Food Security, 2021), https://unfccc.int/sites/default/files/resource/CCAFS_NAP_Agriculture_Supplement.pdf
8. Stephenson et al., 'Digital Agriculture to Enable Adaptation', [20].
9. Lee Kwai Han, "A New Data Hub Helps Small-Scale Fishers Adapt to Climate Change", Mongabay (9 July 2025), https://news.mongabay.com/short-article/2025/07/a-new-data-hub-helps-small-scale-fishers-adapt-to-climate-change/
10. Shailendra Yashwant, "WhatsApp Messages from Bhutan Save Lives in Assam", Dialogue Earth (4 July 2019), https://dialogue.earth/en/water/community-communications-save-lives-in-assam/

The Hidden Costs of Going Digital

While digital tools show promise, persistent gaps in access and equity remain. Participants highlighted that smallholders, especially women and marginalised groups are often excluded from these benefits. Broader evidence supports this: For example, just 24%–37%[11] of farms under 1 hectare have access to 3G or 4G services, compared to 74%–80% of large farms over 200 hectares. Current agri-tech benefits tend to favor farmers with better connectivity and resources, risking further exclusion[12] of smallholders, especially women and marginalized groups. If only wealthier farmers access these tools, digital adaptation could unintentionally deepen rural inequalities.

Concerns also persist over data ownership[13] and privacy where farmers question who controls their data and how it might be used. Experts warn against over-reliance on proprietary technologies that may fail or ignore local knowledge systems.
Ultimately, digitisation alone cannot solve food system resilience challenges. Success depends on inclusive, user-centered approaches, strong governance, and supportive policies. Bridging gaps in infrastructure, affordability, and digital literacy must become a regional priority to ensure no farmer or fisher is left behind.

11. Edward B. Barbier, 'Overcoming Digital Poverty Traps in Rural Asia', Review of Development Economics 27, no. 3 (2023), https://doi.org/10.1111/rode.12962
12. Sustainability Directory, 'Digital Agriculture for Climate Resilience in Asia', Sustainability Directory (18 May 2025), https://prism.sustainability-directory.com/scenario/digital-agriculture-for-climate-resilience-in-asia/
13. Edward B. Barbier, 'Overcoming Digital Poverty Traps in Rural Asia', Review of Development Economics 27, no. 3 (2023), https://doi.org/10.1111/rode.12962

Stories from the Region

Across the Asia-Pacific, organisations are already responding to the challenges of digital adaptation in diverse and creative ways. The following stories highlight real-world efforts to bridge gaps, empower farmers, and embed resilience through digital tools each shaped by context, and each revealing both promise and complexity.

Case Study 1: Who Benefits from Digital Farming Tools?

Aditi - Alternative Futures

In many parts of Asia, new digital tools in farming such as sensors for plant health and laser machines for land levelling promise better yields and reduced manual labour. However, these innovations often fail to reach small farmers and women, who face barriers like high costs, limited digital access, and inadequate training or support. Much of this technology remains designed from the top down, with an emphasis on boosting production rather than addressing real, on-ground challenges. To bridge these gaps, the CGIAR–Climate Change, Agriculture and Food Security (CCAFS) programme, in collaboration with Alternative Futures, has introduced a range of targeted digital solutions. These include handheld sensors to assess plant health and optimise fertiliser use, Laser-Assisted Precision Land Levelling (LLL) systems to enhance water, seed, and fertiliser efficiency while reducing labour, and the Nutrient Expert tool that provides site-specific fertiliser management guidance. While these tools help cut input use and improve efficiency, their success ultimately depends on how accessible, affordable, and responsive they are to the actual needs of farming communities.

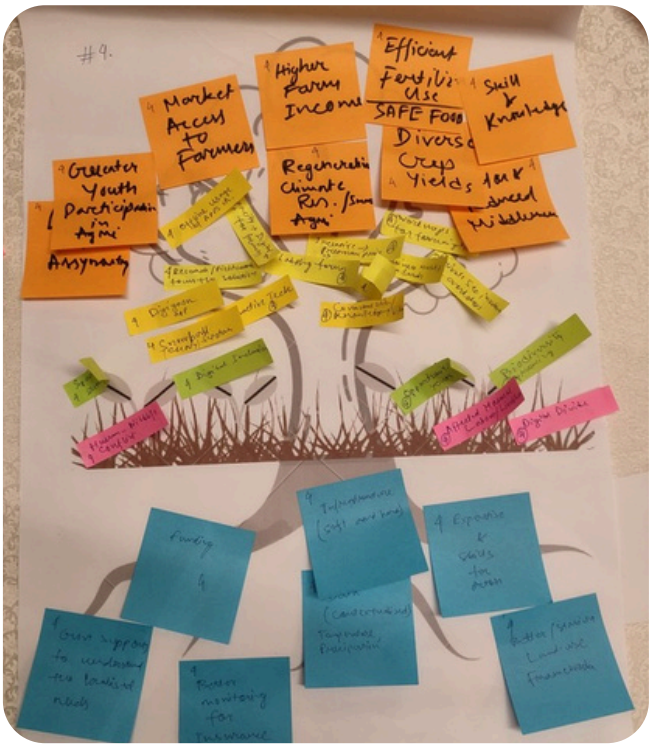
Case Study 2: Early Warnings, Safer Communities – Red Cross Volunteer Networks

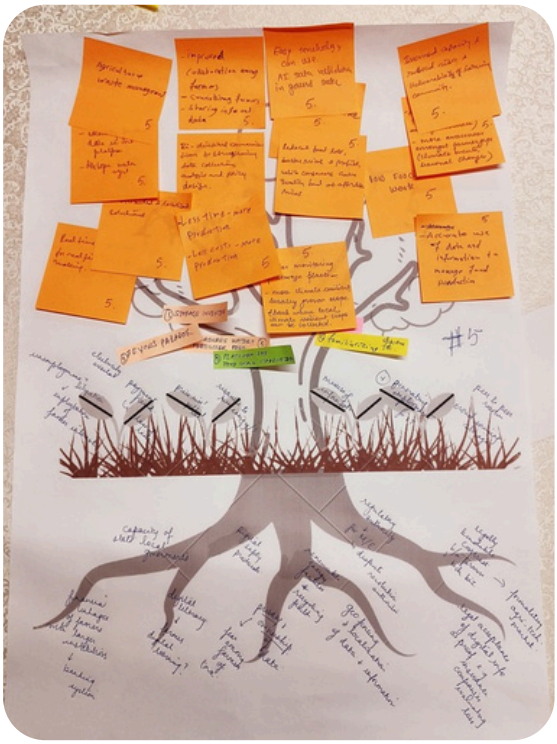
Aditi - Alternative Futures

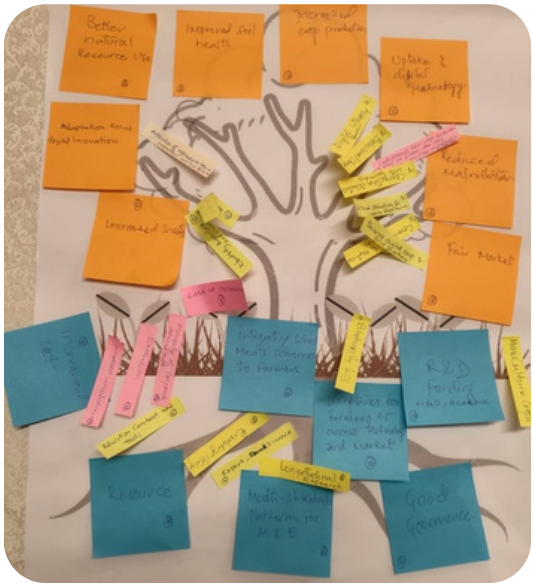
In Assam, Gujarat, Himachal Pradesh, and Uttarakhand, Red Cross volunteers partnered with local communities to build village-level early warning systems through a Community-led Early Warning Early Action (EWEA) approach using WhatsApp networks. These networks relayed weather alerts from state-level meteorological offices to the last mile, enabling timely forecasts and mobilization of pre-positioned supplies. The initiative covered more than 20 districts in Assam including Majuli, Darrang, Jorhat, and Dhemaji as well as coastal and flood-prone districts in Gujarat such as Bharuch, Kutch, and Jamnagar, and high-risk flood zones in Himachal Pradesh and Uttarakhand like Kangra, Dehradun, and Rudraprayag. The results were striking: in Jina Borbhatta, Assam, no household suffered property loss during the 2019 floods for the first time; in Vadodara, Gujarat, over 500 volunteers were activated ahead of Cyclone Vayu, enabling timely evacuations; and in Bharuch and Kachchh, four-hour flood warnings helped communities move livestock and safeguard belongings. This experience shows that simple digital tools, when combined with trusted local networks, can significantly reduce flood losses and strengthen early preparedness in vulnerable regions.

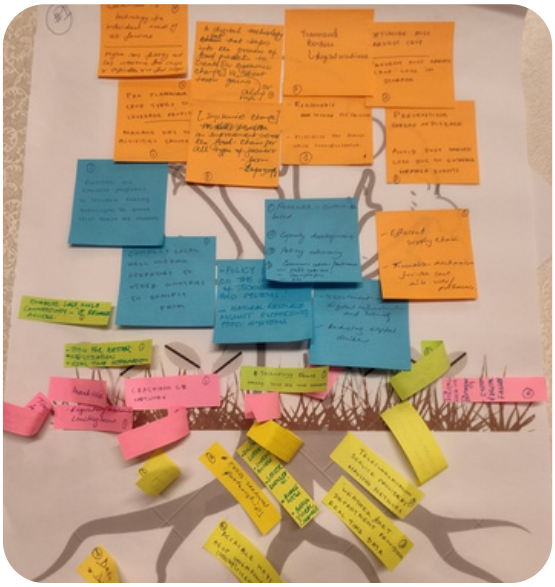
Collaborative Groundwork: Collective Visioning Through the Solution Tree

As part of the regional dialogue, we engaged in a structured visioning exercise titled **"Building the Future of Digital Tech in Food System Resilience."** The session used a Solution Tree approach, a participatory tool often used in workshops to map challenges and pathways for change, to unpack a central question: How can digital technology serve as a smart adaptation solution for food security? Further details on the activity are available in the Annex









The exercise generated a set of cross-sectoral insights, organised here under four themes: aspirations, actions, foundations, and risks. Together, these themes capture the common priorities and concerns that surfaced across groups.

Aspirations Anchored in Equity and Efficiency

Across the tables, there was a shared vision: digital solutions should do more than make farms "more productive." Participants did want technology that reduced post-harvest loss, stabilised farmer incomes, and strengthened supply chains, but they also spoke equally about fairness. The aim was equitable market access, not just faster market transactions.

They imagined a future where young people saw agriculture not as a fallback but as a career of choice, supported by modern skills and tools. Where climate-smart practices were the norm, and not a special project. Where children had better nutrition because their households could plan, store, and diversify food with the help of timely information.

Importantly, these aspirations didn't stop at efficiency, they reached into justice, sustainability, and dignity. Technology was seen as a means to transform rural livelihoods, slow down migration driven by distress, and ensure that those producing food could do so with security and pride.

Driving Change Through Localised and Inclusive Action

In the exercise, the "branches" represented the concrete actions required to move towards the shared vision. Participants consistently emphasised localisation as central to these actions. Capacity-building should not be a generic training programme but rooted in the languages, formats, and rhythms of rural life. Digital literacy needs to be practical, not theoretical, so that a farmer can troubleshoot an app in the middle of a busy market day or use a weather alert to decide whether to harvest early.

Women farmers, often excluded from extension services, were placed front and centre: participants called for digital advisory systems designed around their schedules and needs, from voice-based messages to women-only farmer networks. Youth-focused agri-tech education whether in schools, through community learning hubs, or via apps like Digigaon was seen as essential for preparing "future-ready farmers."

A recurring theme was that technology must flow both ways. It should not only send instructions from a central source but also collect and value farmer feedback, local knowledge, and on-ground results. This shift from technology as a one-way delivery mechanism to a collaborative tool was seen as critical to making it relevant and trusted.

Laying the Groundwork: What Must Be in Place

Beneath these aspirations lay the roots: conditions without which the branches cannot grow. At the most basic level: reliable, affordable digital infrastructure. For many rural and remote areas, this still means the difference between being able to receive a pest warning in time or losing an entire produce.

But infrastructure was only one layer. Participants also stressed the need for cross-sector partnerships that link governments, startups, researchers, and farmer groups in long-term collaboration. They called for policy frameworks to safeguard farmer data, ensure fair minimum support prices in digital marketplaces, and make inclusion a non-negotiable standard.

Public investment, they argued, must go into both “hard” systems like telecom towers and monitoring networks, and “soft” systems like digital literacy training, farmer help desks, and participatory governance. Integration of climate and digital priorities into local panchayat plans and national agriculture strategies was seen as a way to make sure digital adaptation isn’t treated as a side project, but as part of core agricultural development.

Risks and Blind Spots: What Might Hold Us Back

In mapping the “weeds,” represented risks and blind spots that could hold back progress. Participants were candid about the pitfalls they’ve seen elsewhere. Technology failures whether due to poor connectivity, weak maintenance, or tools that simply don’t match local farming practices can waste time and erode trust. Over-reliance on proprietary platforms can push farmers into dependency while sidelining traditional knowledge systems.

The participants warned of corporate concentration in agri-tech, where a handful of players control data, platforms, and even seed and input markets. Biodiversity loss from promoting monocropping through certain digital advisories was flagged as a real danger. And while digital divides are well-known, participants highlighted their persistence: women, older farmers, and marginalised communities remain systematically excluded if extra measures are not built in.

Corruption both in the flow of funds and in the design process when solutions are driven by vendor interests rather than farmer needs was also seen as a barrier that can derail even well-intentioned programs.

Surprising Possibilities and Seeds of Change

Yet the conversation did not end with caution. In the “sprouts,” participants pointed to unanticipated opportunities already taking root. Digital platforms for fair pricing can shift bargaining power towards smallholders. Youth are beginning to engage with agriculture through innovation challenges, start-ups, and local maker spaces.

Cross-cultural exchanges between farmers from different regions, climates, and crops were seen as a rich source of innovation, particularly when supported by open data platforms that anyone can contribute to and learn from. Policy momentum is also building in parts of the region around stricter digital regulation, climate-smart agriculture incentives, and integrated rural development windows that, if used well, could align digital transformation with the needs of farmers rather than the demands of markets alone.



Why This Matters Now

The Asia-Pacific region's recent climate shocks from catastrophic floods to record heatwaves have devastated farms and fisheries, ruining lives and livelihoods. Digital tools[15] offer an effective sustainable solution. Innovations as simple as communication through social media and as complex as climate-smart advisories, remote sensing, and AI-driven early warning systems can help anticipate hazards and make effective decisions. Countries need to keep up with digital progress in order to act fast and act right.

For funders and policymakers, this is a window of opportunity. Supporting digital adaptation now can help avoid far greater losses in the future and many of these tools can reach large numbers of farmers and fishers quickly, if the right investments are made. As the FAO's Chief Economist has mentioned, we need to act on the best data we have and focus resources where they're needed most especially for those already facing the sharpest climate risks.

14. "Climate Change Impacts Increase in Asia – 2023", United Nations in India (27 July 2023), https://india.un.org/en/240359-climate-change-impacts-increase-asia-2023

15.FAO, "AI and Digital Tools for Climate Resilient Agrifood Systems on the Spotlight at the Science and Innovation Forum 2023", FAO (22 September 2023), https://www.fao.org/agroinformatics/news/news-detail/fao--ai-and-digital-tools-for-climate-resilient-agri-food-systems--on-the-spotlight-at-the-science-and-innovation-forum-2023/en

16. FAO, "AI and Digital Tools for Climate Resilient Agrifood Systems 2023"

Way Forward

The access and equity gaps described here are not confined to the Asia-Pacific they mirror challenges in smallholder and coastal communities worldwide. From African drylands to Latin American highlands, the same patterns emerge: tools are being developed faster than they are being adapted to local contexts, and those most at risk often remain last in line to benefit.

The immediate task is not to chase the newest technology, but to close the distance between what exists and who it reaches. This means focusing on connectivity where it is weakest, ensuring affordability for small and marginal producers, and embedding farmer and fisher feedback into every stage of design and delivery. If these conditions are met, digital adaptation can evolve from isolated pilots into reliable, everyday tools for those facing the sharpest climate risks whether in Asia-Pacific or any other region where food systems are under pressure.

Appendix

Learning Journey Methodology

The Learning Journey on digitisation and food systems was designed as a participatory and co-creative process, grounded in the real-world knowledge needs of Adaptation Research Alliance (ARA) members. Members from the Asia–Pacific region identified this theme as a priority, seeking a deeper understanding of how digital technologies can serve as adaptation solutions to strengthen food system resilience.

To enrich this exploration, a member-led presentation showcased on-ground experiences of implementing digital solutions, complementing insights gathered through previous engagements. This exchange provided a strong foundation for collective learning. An interactive group activity further deepened discussions on key stakeholders, collaboration challenges, and inclusive strategies for advancing knowledge at the intersection of climate and food systems.

Focus Group Discussions

The focus group discussion was conducted using a flowchart-like model to visually map out, analyze, and evaluate complex decisions, especially under conditions of uncertainty.

In the Solution Tree activity, each part of the tree represented a layer of collective reflection. The trunk captured the current realities and challenges in digitalisation and food systems, grounding discussions in lived experience. The fruits illustrated the desired outcomes, what success would look like if digital tools truly strengthened resilience. The branches highlighted key actions and pathways to achieve these goals, while the roots reflected the foundational enablers such as policy support, funding, and inclusive participation. Finally, weeds and sprouts symbolised the risks that could hinder progress and the emerging opportunities that could accelerate change.

Analyzing the Data

The data collected during the focus group discussion formed the primary basis for deriving key insights. A complementary literature review of secondary sources from the Asia–Pacific region helped situate these findings within the broader landscape of existing challenges and ongoing interventions. Designed as a learning-focused workshop, each qualitative input shared and discussed contributed to building a holistic and contextually grounded understanding of the digital adaptation–food systems nexus.

Participating Organisations in the TLS Symposiums

The learning journey engaged ARA's Asia Pacific members, with deeper insights gathered from those who participated in the regional knowledge symposiums.

1. Alternative Futures
2. Aran for the Development of Civic Culture
3. Biozid Climate Institute
4. CarbonCare Innolab (CCIL)
5. Center for People and Environment (CPE)
6. Center for Study of Science, Technology and Policy (CSTEP)
7. Doh Eain
8. Earthlanka Youth Network
9. Gorakhpur Environmental Action Group (GEAG)
10. Institute for Global Environmental Strategies (IGES)
11. Integrated Design
12. International Academy (PRIA) – Participatory Research in Asia
13. International Centre for Integrated Mountain Development (ICIMOD)
14. IRO Organization for Community Development
15. Kota Kita
16. Mahila Housing Sewa Trust
17. Nepal Water Conservation Foundation for Academic Research (NWCF)
18. RV University
19. Sevanatha – Urban Resource Center
20. SERAC-Bangladesh
21. Sindh Community Foundation
22. Transitions Research

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