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Resilient livelihoods and food security in coastal aquatic agricultural systems: Investing in transformational change

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Key Messages

- Coastal aquatic agricultural systems are generally highly productive, but multiple constraints limit the ability of poor families to harness this productivity to improve food security, nutrition, and income.
- Securing improvements in fisheries and aquaculture for poverty reduction requires addressing these constraints in a multi-sectoral context, recognizing that families dependent upon aquatic agricultural systems pursue a diversity of livelihood options.
- Transformational change depends on locally driven solutions, rooted in multi-stakeholder dialogue and participatory analysis of the constraints and opportunities in each location, linking solutions across scales.
- Many of the drivers of change—including international trade and investment, climate change, and ecosystem degradation—are shared among coastal regions in Asia, the Pacific, and Africa, providing important opportunities for exchange of lessons and experience.
- Technological and market innovation to improve productivity and income of poor coastal fishers and farmers must be complemented by investments that enhance their resilience to natural disasters and economic or institutional shocks and that strengthen their social, political, and economic rights.
- The CGIAR is pursuing these goals through an integrated program of action research aimed at improving food security for 50 million households by 2022, in collaboration with national and local institutions and international development partners.

Introduction

Rising food prices, climate stress, and increased competition over the natural resource systems that underpin global food production have sharpened focus on the challenge of feeding an estimated 9 billion people by mid-century. The majority of the world's poor today depend on the health of productive agroecosystems for their livelihoods and nutritional security. Strengthening the resilience, productivity, and livelihood benefits of aquatic agricultural systems presents a major opportunity to address the twin challenges of food security and poverty reduction.

Aquatic agricultural systems (AAS) are diverse production and livelihood systems where families cultivate a range of crops, raise livestock, farm or catch fish, gather fruits and other tree crops, and harness natural resources such as timber, reeds, and wildlife. Aquatic agricultural systems occur along freshwater floodplains, coastal deltas, and inshore marine waters, and are characterized by dependence on seasonal changes in productivity, driven by seasonal variation in rainfall, river flow, and/or coastal and marine processes.[1]

Despite this natural productivity, the farming, fishing, and herding communities who live in these systems are among the poorest and most vulnerable in their countries and regions. More than 500 million people depend on aquatic agricultural systems for their livelihoods, but the constraints they face mean that a third or more live on less than US$1.25 a day. In these communities, women constitute a disproportionate share of the poor due to unequal gender relations and differential access to and control of resources.

This report provides an overview of the scale and scope of development challenges in coastal aquatic agricultural systems, their significance for poor and vulnerable communities, and the opportunities for partnership and investment that support efforts of these communities to secure resilient livelihoods in the face of multiple risks.

1. Coastal systems in crisis

Coastal regions provide an exceptionally high concentration of beneficial ecosystem services, making them among the most productive ecosystem types globally. For this reason, coasts have universally and disproportionately attracted human settlement, with 40% of the world's population inhabiting the coastal zone.[2] The productivity of these systems comes from fisheries, aquaculture, agriculture, and livestock production, coupled with critical supporting services, such as transport and trade. Within coastal systems, 'hotspots' of concentrated productivity, including embayments, river deltas, mangrove forests, and coral reef areas, have attracted the highest concentrations of settlement. An estimated 275 million people, for example, live within 30 km of coral reefs and draw extensively on them for livelihood and food security.[3] Beyond the immediate coast, continental shelves provide a wealth of services, including an estimated 25% of global primary productivity—the ecosystem processes that underlie food production.[4]

Given the high productivity of aquatic systems (both marine and inland), it is paradoxical that so many who rely on them remain in poverty. A growing body of evidence highlights a consistent failure of classical approaches to resource science, governance, and development intervention to recognize and integrate the complexity of rural/coastal production systems and the diversity of scales at which system drivers operate. Classical marine resource science and management approaches, for example, have developed largely in the context of single-species, large-scale, commercially valuable fisheries in industrialized countries. Yet less than 0.5% of fishers globally operate in this context.[5] Conventional approaches in the 'fishery manager's toolbox' focused narrowly on managing fish stocks are not transferable to the context in which the vast majority of fishers operate—that of small-scale fisheries in the developing world.[6]

Policies governing the operation of fisheries and aquaculture are often based on the joint premises of maximizing yield and protecting resources, and rely on centralized management and enforcement. In most cases, developing countries do not have the human, infrastructure, or financial capacity to enforce fisheries regulations or generate the data necessary to centrally manage resource extraction. In most poor regions, this has led to 'de facto open-access' fisheries, where increasing market pressure, population growth, ecosystem degradation, and fishing efficiency have overrun management systems.

[1] We define aquatic agricultural systems as systems in which the annual production dynamics of freshwater and/or saline or brackish coastal systems contribute significantly to total household income.

[2] Agardy, T., G.N. Sciara, and P. Christie (2011). Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. Marine Policy 35: 226–232.

[3] WRI (2011). Reefs at Risk Revisited. Washington, D.C.: World Resources Institute.

[4] UNEP (1992). The World Environment 1972–1992: Two Decades of Challenge. New York: Chapman and Hall.

[5] Mills, D.J., L. Westlund, G. de Graaf, R. Willmann, Y. Kura, and K. Kelleher (2011). Underreported and undervalued: Small-scale fisheries in the developing world. In R.S. Pomeroy and N.L. Andrew, eds., Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World. Oxfordshire, UK: CABI.

[6] Andrew, N.L., and L. Evans (2011). Approaches and frameworks for management and research in small-scale fisheries. In R.S. Pomeroy and N.L. Andrew, eds., Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World. Oxfordshire, UK: CABI.

Coastal habitats have degraded at an alarming rate in recent decades, with systems attracting the highest population densities suffering the most. Some 20% of all mangroves have been lost since 1980, and some 40% of coral reef systems are considered severely or highly degraded.[7] Concurrently, coastal systems have increasingly failed to reach their potential to support coastal populations (see Box 1). While there are signs of recovery in some well-studied, large-scale fisheries responding to conservation and management efforts in recent decades, most small-scale fisheries, particularly those in developing countries, are data-poor or have 'unassessed' fish stocks that are declining quickly.[8]

Management institutions focused primarily on natural resource exploitation or conservation are not primed to cope with the rapidly changing face of the coasts. Population growth, urban expansion, increased demand for resources from diverse users, globalized markets, and climate change are among common challenges that combine with profound issues of economic, social, and institutional marginalization to drive poverty and vulnerability. In this respect, poor rural communities in coastal aquatic agricultural systems share characteristics with communities in other agroecosystems, including drylands, semi-arid tropics, and forest margins, 'left behind' by the Green Revolution in agriculture and requiring a different kind of response.[9]

Coastal systems comprise multiple production systems, people and livelihoods, governance institutions, and external drivers. Attempts to address the crisis in global fisheries must necessarily confront the challenge of securing livelihoods for poor AAS communities, recognizing the inseparable links between the large-scale and small-scale subsectors, inland and marine production, and wild capture fisheries and aquaculture (see Box 2). Also vital is an appreciation for the roles that farming, livestock production, and agricultural processing and trade play in the livelihood opportunities and decision making of coastal communities. A narrow preoccupation with either economic productivity or ecosystem status must give way to interventions and management conceived around drivers of change and a 'whole-system' approach to managing coastal resources and building resilient livelihoods.

Box 1. Ghana's coastal fisheries on the edge.

National fish consumption in Ghana is among the highest in Africa (approaching 30 kg/capita/year) and represents on average about 60% of animal protein supply.[1] For coastal communities, fish is even more important as a source of nutrition, as well as a base of the coastal economy.

The fisheries for small pelagic fish are the most critical for food security, and represent around 80% of the total fish catch by the artisanal fleet. As much as 20% of the national workforce may rely directly or indirectly on the fisheries sector.[2]

Alarmingly, both national statistics and fisher opinions point to a dramatic decline in the resource over the last decade, resulting in increased imports of fish and severely straining livelihood systems and food security in coastal villages throughout the country. Unconstrained growth in all major fleets alone could account for heavy overexploitation. However, this is massively compounded by heavily subsidized fuel and increasing fishing power of individual vessels.

The only conceivable pathway to improved fishery yield, well-being, and resilience among coastal communities in Ghana is radical reform in the way fisheries systems are governed. Top-down, command-control systems must be replaced by inclusive decision making that engages communities directly in formulating management plans and rules, complemented by sustainable livelihood initiatives rooted in understanding the constraints and opportunities facing rural households. Data from past peak catches supported by bioeconomic modeling suggest that yields of at least three times the current catch of small pelagic species could be achieved through improved management.[3] A groundswell of support for reform among stakeholders and donors has created a window for transformation that may represent a 'last shot' at avoiding catastrophic collapse of these systems.


Small-scale fishing vessels in Ghana

WorldFish, in partnership with the University of Rhode Island, local NGO Friends of the Nation, and others, is working to address this need for governance reform. Rather than a simple macro-level analysis of resource rents and opportunities for gains in economic efficiency through a reallocation of use rights, sound decision making for policy and institutional reform requires locally driven analysis to determine the types of innovations that will jointly support resource conservation, livelihood improvement, and social equity.[4]

[1] WorldFish Center, CRC, and USAID (2010). Livelihood diversification and fishing communities in Ghana's Western Region; Finegold, C., A. Gordon, D. Mills, L. Curtis, and A. Pulis (2010). Western Region Fisheries Sector Review, WorldFish Center.
[2] Atta-Mills, J., J. Alder, and U.R. Sumaila (2004). The decline of a regional fishing nation: The case of Ghana and West Africa. Natural Resources Forum 28: 13–21.
[3] Finegold, C., A. Gordon, D. Mills, L. Curtis, and A. Pulis (2010). Western Region Fisheries Sector Review, WorldFish Center; Bailey, M., U.R. Sumaila, and M. Lindroos (2010). Application of game theory to fisheries over three decades. Fisheries Research 102(1–2): 1–8.
[4] Ratner, B.D., and E.H. Allison (2012). Wealth, rights, and resilience: An agenda for governance reform in small-scale fisheries. Development Policy Review (30)4: 371–398.

[7] Spalding, M., M. Kainuma, and L. Collins (2010). World Atlas of Mangroves. Washington, D.C.: Earthscan.
[8] Costello, C., D. Ovando, R. Hilborn, S.D. Gaines, O. Deschenes, and S.E. Lester (2012). Status and solutions for the world's unassessed fisheries. Science 27 September 2012 [Online] DOI:10.1126/science.1223389.
[9] DFID (2012). Promoting innovation and evidence-based approaches to building resilience and responding to humanitarian crises: A DFID strategy paper. London: Department for International Development. [Online] http://www.dfid.gov.uk/Documents/publications1/prom-innov-evi-bas-appr-build-res-resp-hum-cris.pdf.

Box 2. Fisheries, aquaculture, and food security.

Marine fisheries alone produce up to 90 million metric tons of high-quality protein, annually contributing to food security for 1 billion people globally. They provide full- and part-time livelihoods for an estimated 60 million people, 97% of whom are in developing countries. Of these, 84% are in the small-scale sector.[1] Millions more operate in the subsistence sector, often on a seasonal basis, or have livelihoods indirectly supported by fisheries. While fisheries may only be important to some for a few months of the year, it is often during a critical period when crop production is low and there are few alternatives for food production or when other alternatives fail (such as in times of drought).

In addition to capture fishery production, the rapidly developing marine and brackish-water aquaculture sectors produce 23 million tons annually, including shrimp, fish, and mollusks, contributing a combined 38% of total global aquaculture production.[2] About half of the demand for food fish is now met by aquaculture. It is the fastest-growing food production sector in the world, growing at an average annual rate of nearly 10% since 1970. World demand for aquatic products will continue to rise,[3] driven by stagnating production from wild fisheries and an increasingly wealthy, urbanized, and populous world. Aquaculture production may need to double by 2030 to meet future demand. Ninety-two percent of production is expected to come from developing countries.[4]

From the perspective of poverty reduction, a focus on the small-scale sector in developing countries is essential, as the small-scale sector accounts for the vast majority of employment in fisheries and aquaculture, and over half of production.

There are important differences between marine systems, where fishing itself is the primary cause of declining stocks globally, and freshwater systems, where external environmental pressures are the greatest threat to sustainability. Yet it is equally important to understand the ways that freshwater and marine systems are interlinked in terms of economics and trade, ecological functions, and livelihoods. Flows of both nutrients and pollutants from river systems, for example, affect the productivity of coastal habitats, and harvesting wild fish to supply feed for the aquaculture industry is often profitable yet typically a net loss for nutritional security.

Current research and policy discourse on sustainability of fisheries, aquaculture, and food security often fail to probe the specific impacts on livelihoods and nutritional well-being for poor households. Examining livelihood and nutritional impacts requires identifying and openly deliberating on trade-offs among goals for food security, conservation, and macro-economic growth, as well as synergies.[5]

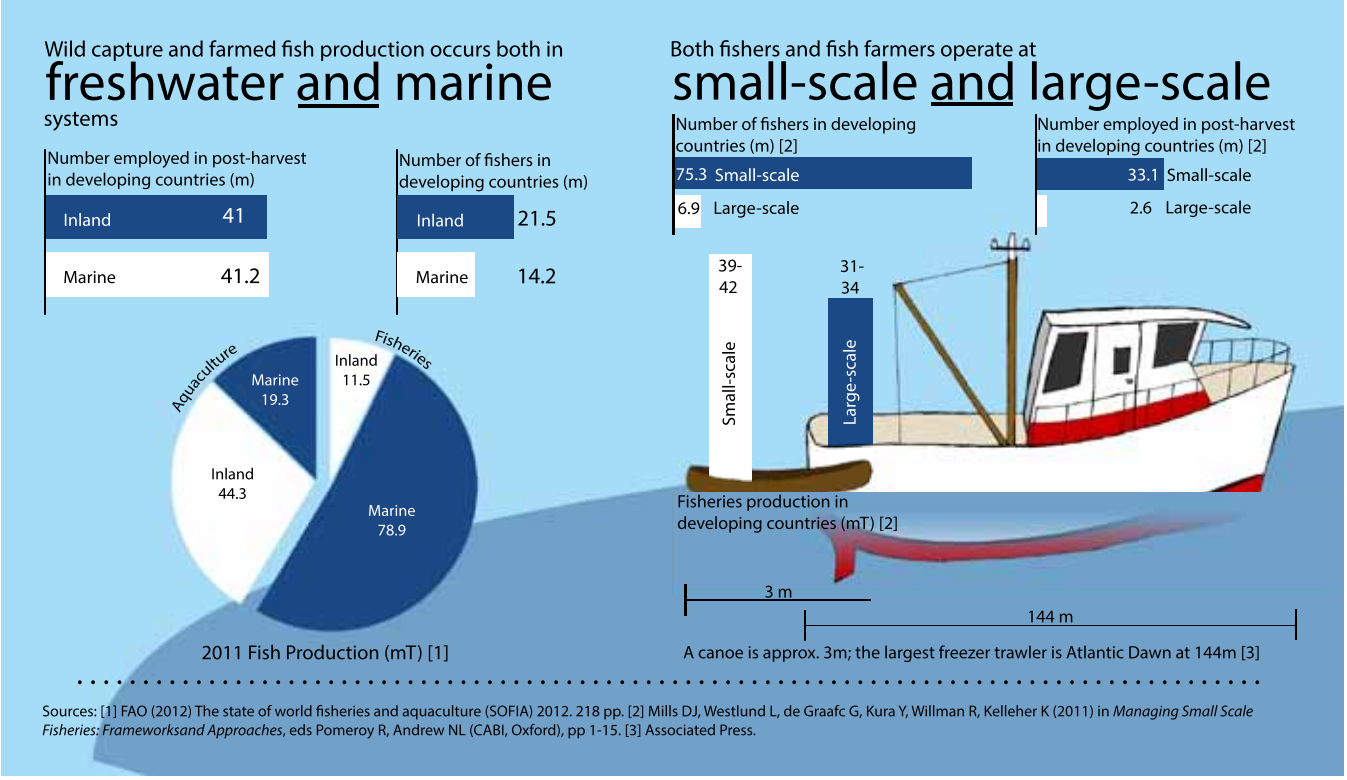


Figure 1. Production and employment in fisheries and aquaculture.

[1] World Bank, FAO, and WorldFish Center (2010). The Hidden Harvests: The Global Contribution of Capture Fisheries. Washington, D.C.: World Bank; UNEP (2011). Towards a Green Economy.
[2] FAO (2012). State of World Fisheries and Aquaculture 2012. Rome: United Nations Food and Agriculture Organization.
[3] Hall, S., A. Delaporte, M.J. Phillips, M. Beveridge, and M. O'Keefe (2011). Blue Frontiers: Managing the Environmental Costs of Aquaculture. Penang, Malaysia: WorldFish and Conservation International. [Online] www.worldfishcenter.org/resource_centre/media/pdfs/blue_frontiers/report.pdf.
[4] FAO (2011). The State of Food Insecurity in the World. Rome: United Nations Food and Agriculture Organization.
[5] Hall, S.J., R. Hilborn, N. Andrew, and E.H. Allison. Innovations in capture fisheries: An imperative for nutrition security in the developing world. Under review, Proceedings of the National Academy of Sciences.

2. What's at stake?

The complexity of aquatic agricultural systems and the multiple drivers of change affecting them have made these profoundly challenging development arenas.[10] Yet the role these systems play in the lives of so many of the world's poor rural households also makes them profoundly important.

The character of this livelihood dependence varies greatly by region. Asia's mega deltas, for example, are densely populated and support a mix of predominantly family-based farming and fishing. The Ganges-Brahmaputra-Megna system alone supports the livelihoods of 160 million people. In Bangladesh, 20 million rural farm households, 40% of whom live below the poverty line of US$1.25 per day, depend on the aquatic agricultural systems within the river system's floodplains. The islands of the Pacific and East Asia support much smaller populations, but a large portion of them are poor and depend on coastal resources for their primary sources of income. In the Solomon Islands, for example, 75% of the population relies on subsistence farming and fishing, while at the macro level fishery products account for 19% of the total export revenues of the country. The Philippines has a more diverse economy and lower rates of poverty than the above-mentioned regions, but agriculture and fisheries are central to the economies of many poorer coastal provinces.

The nutritional importance of food derived from aquatic agricultural systems extends well beyond the populations engaged in production, processing, and trade. Aquatic foods, including fish, crustaceans, and mollusks, are the primary source of animal protein for 2.6 billion people.[11] A growing body of research is showing that fish are important not only for supply of protein but especially for essential fatty acids and micronutrients.[12] Low-cost, small species that are typically eaten whole or ground into pastes tend to be especially rich in micronutrients. Sustaining and improving the availability of affordable fish products is a highly efficient route to fighting childhood malnutrition and reducing child mortality.

Where aquatic agricultural systems predominate, their development is also central to political and social stability. In many places, access to land, seasonal floodplains, fishing zones, and other productive resources along the coasts is the focus of intense competition, often with the poor and vulnerable at significant disadvantage.[13] Likewise, gender inequities in these systems are at once a source of conflict, an obstacle to development progress, and an essential key to transformation (see Box 3).

Eating fish and rice, Bangladesh

[10] Welcomme, R.L., I.G. Cowx, D. Coates, C. Béné, S. Funge-Smith, A. Halls, and K. Lorenzen (2010). Inland capture fisheries. Philosophical Transactions of the Royal Society B 365, 2881–2896; Small, C., and R.J. Nicholls (2003). A global analysis of human settlement in coastal zones. Journal of Coastal Research 19(3): 584–599.

[11] Allison, E.H. (2011). Aquaculture, Fisheries, Poverty and Food Security. Penang, Malaysia: WorldFish Center. [Online] www.worldfishcenter.org/resource_centre/WF_2971.pdf.

[12] Beveridge, M.C.M., S.H. Thilsted, M.J. Phillips, M. Metian, M. Troell, and S.J. Hall (2012). Meeting the food and nutrition needs of the poor: The role of fish and the opportunities and challenges emerging from the rise of aquaculture. Journal of Fish Biology (in review); Thilsted, S.H. (2012). The potential of nutrient-rich small fish species in aquaculture to improve human nutrition and health. In R.P. Subasinghe, J.R. Arthur, D.M. Bartley, S.S. De Silva, M. Halwart, N. Hishamunda, C.V. Mohan, and P. Sorgeloos, eds., Farming the Waters for People and Food, 57– 73. Proceedings of the Global Conference on Aquaculture 2010, Phuket, Thailand. 22–25 September 2010. Rome: FAO and Bangkok: NACA.

[13] Allison, E.H., B.D. Ratner, B. Åsgård, R. Willmann, R. Pomeroy, and J. Kurien (2012). Rights-based fisheries governance: From fishing rights to human rights. Fish and Fisheries 13(1): 14–29.

Box 3. Gender equity and transformative change.

The globalized market processes, population growth, migration, and urbanization that rapidly change aquatic agricultural systems are all gendered. In Bangladesh and Cambodia, rural-urban migration, a predominantly male phenomenon, has feminized agriculture. In the Philippines, women predominate among rural-urban migrants, while men remain in agricultural livelihoods, and women equal men in pursuing overseas migration.[1] In all of these countries, women's engagement in the agriculture sector is generally higher than men's but often invisible or under-estimated in official statistics.

These differences in the gender division of labor have implications for the nature of poverty, marginalization, and vulnerability. Women's disproportionate suffering of asset poverty arises from socio-cultural norms that restrict access to, ownership of, and control over natural, physical, and financial resources. This is pronounced in Bangladesh, where rural women own only 8% of all productive assets.[2] Equally significant, women's involvement in community-based aquatic resource management is often minimal because of customary power relations and time and mobility constraints related to domestic tasks and maintaining a reputation for decency. However, where poor women are granted conditions enabling them to claim long-term rights over public water bodies, as the formation of fish-farming groups in Bangladesh has shown, the engagement of and benefits to women can be sustained.[3]

Gender-based marginalization and vulnerability translate into highly gendered well-being outcomes as well. Women are more vulnerable to gender-based violence than men, both in private and in public. In Bangladesh and the Solomon Islands, over 50% of women experience physical or sexual violence at the hands of an intimate partner.[4]

Gender inequities also block progress in fighting malnutrition. In Bangladesh, where productivity and income increases from fish ponds occurred at the household level, this did not necessarily translate into nutrition gains for women and girls.[5]

Small-scale fisheries, Tonle Sap, Cambodia

Pro-poor improvements in the productivity, profitability, and adaptive capacities of coastal communities can only be achieved to their full potential and sustained if they occur jointly with changes in the social norms and attitudes that underlie inequalities. AAS users and their development partners need to design and test the effectiveness of innovative integrated strategies to address both technical AAS challenges and the social constraints impeding marginalized AAS users, and particularly poor women, from exerting their capacities to act individually and with others to make full use of available resources to improve their own and their families' well-being.

[1] PCW (2010). Fact Sheet: Filipino Women and Men. Manila: Philippine Commission on Women.
[2] Quisumbing, A.R., and J.A. Maluccio (2000). Intrahousehold allocation and gender relations. FCND Discussion Paper 84. Washington, D.C.: IFPRI.
[3] Nathan, D., and N.A. Apu (1998). Women's independent access to productive resources: Fish ponds in the Oxbow Lakes Project, Bangladesh. Gender Technology and Development 2(3): 397–413.
[4] NIPORT (2009). Bangladesh Demographic and Health Survey, 2007. Dhaka, Bangladesh: National Institute of Population Research and Training; MWYCA & NSO [Ministry of Women, Youth and Children Affairs & National Statistics Office] (2009). Solomon Islands Family Health and Safety Study. Noumea: Secretariat of the Pacific Community; World Bank (2004). Zambia: Strategic Country Gender Assessment. Lusaka: World Bank.
[5] Kumar, N., and A.R. Quisumbing (2010). Access, Adoption and Diffusion: Understanding the Long-Term Impacts of Improved Vegetable and Fish Technologies in Bangladesh. Washington, D.C.: IFPRI.

Excerpted from: CGIAR Research Program on Aquatic Agricultural Systems (2012). Gender Strategy Brief: A gender transformative approach to research in development in aquatic agricultural systems. [Online] http://www.worldfishcenter.org/publications/gender-strategy-brief-gender-transformative-approach-research-development-aquatic-agricultural-systems.

3. An integrated approach

Enhancing the contribution of aquatic agricultural systems to rural development and food security requires carefully designed investments that address the multidimensional and strongly gendered nature of poverty and vulnerability. In the case of many aquatic agricultural systems, poor and disenfranchised people living in highly productive environments produce (and often trade) goods of high value in global markets but are unable to climb out of poverty. They find themselves trapped in an unfavorable dynamic equilibrium by processes that exist simultaneously at multiple scales and are self-reinforcing.[14] A schematic diagram of the multiple dimensions of poverty (see Box 4) provides a simplified view of such traps, seen from a household perspective. Governments, markets, and community institutions are simultaneously weak in places characterized by poverty traps. In such circumstances, small adjustments at any one level—such as building some aspect of household assets (e.g., by improving access to education or health care), introducing new technologies, or investing in incremental improvements in democratic decentralization—are unlikely to move the system away from its dominant, stable dynamic equilibrium.

That is why it is critical to address the broad context at multiple scales, following a diagnosis of which parts of the trap are most difficult to escape, and which can best respond to intervention. Achieving these transformations at scale requires partnership with agencies and change agents that are able to implement innovations that influence governance at all levels and that improve collaboration across jurisdictions (see Box 5).

Box 4. Measuring and addressing poverty.

To identify the poor in aquatic agricultural systems and support them with the right types of development interventions, we must understand and take into account the complex multiple dimensions of poverty and their interrelationships. The figure below highlights three key dimensions of poverty.

Figure 1. Three key overlapping and reinforcing dimensions of poverty.

Income and asset poverty is when individuals and households do not have sufficient means to sustain a decent standard of living. Standardized measures are used in economic planning and targeting in social protection schemes, but local development activities may use more qualitative techniques, such as wealth ranking, to identify the poor.

Vulnerability is the result of people's exposure to ecological, economic, and institutional shocks and stresses, the sensitivity of their livelihood systems to these risks, and their capacity to cope and adapt. Two common applications are mapping of vulnerability to famine by the World Food Program[1] and mapping of vulnerability to climate change risks by the Intergovernmental Panel on Climate Change.

Marginalization sees certain groups systematically disadvantaged because they are discriminated against on the basis of their ethnicity, race, religion, sexual orientation, caste, gender, age, education, class, disability, HIV status, migrant status, or where they live.[2]

These conditions and processes, which are often strongly gendered, overlap and may reinforce one another, so that people who are socially excluded or marginalized may become income and asset poor, and asset poverty reduces capacity to adapt, making its victims more vulnerable to external shocks and adverse trends.[3]

[1] World Food Program (2007). Vulnerability Analysis and Mapping. [Online] http://www.wfp.org/operations/vam/.
[2] Atkinson, A.B. (1998). Social exclusion, poverty and unemployment in exclusion, employment and opportunity. A.B. Atkinson and J. Hills, eds. CASE paper. Center for Analysis of Social Exclusion, London School of Economics, London; DFID (2005). Reducing Poverty by Tackling Social Exclusion. London: Department for International Development. [Online] http://www.dfid.gov.uk/pubs/files/social-exclusion.pdf.
[3] Allison, E.H., C. Béné, and N.L. Andrew (2011). Poverty reduction as a means to enhance resilience in small-scale fisheries. In R. Pomeroy and N.L. Andrew, eds., Managing Small Scale Fisheries: Frameworks and Approaches, 216–237. CABI.

The mandate of the CGIAR Research Program on Aquatic Agricultural Systems is to confront the paradox of high ecological productivity mingled with high prevalence of poverty, vulnerability, and inequity among social groups. Its goal is to transform aquatic agricultural systems to realize their full development potential while remaining resilient as societies and environments change. The program, launched in 2011, is harnessing the strengths of the CGIAR in agricultural research and combining them with the skills and capacities of community groups, national agricultural research systems, nongovernmental organizations, the private sector, advanced research institutes, and other partners, to pursue an innovative, integrated program of action research.

As in other integrated agricultural systems, effective engagement with poverty and vulnerability in aquatic agricultural systems means putting the poor and vulnerable at the core of our work. This requires research to be rooted firmly in the development agenda and responsive to context-specific differences in threats and opportunities. The AAS approach recognizes the importance of aquatic resources, and fisheries in particular, but asserts that sustainable management of these resources to confront rural poverty and malnutrition requires a much more integrated approach to research and development than has generally been the case. While calls to emphasize poverty reduction are not new to the international conservation community, implementation has been dogged by lack of resources and capacity to accomplish

[14] Barrett, C.B., and B.M. Swallow (2006). Fractal poverty traps. World Development 34(1): 1–15.

Box 5. Governing the coastal seascape in the Philippines.

In the Philippines, small-scale fisheries annually supply the fish-food needs of over 100 million Filipinos and provide direct employment to 1.4 million fishers.[1] Yet, the productivity of these systems and food security in rural coastal areas of the country are put at risk by degraded fishery habitats, intensified resource-use competition and conflict, and post-harvest losses. Limited capacity of state institutions, inconsistent fishery policies, and weak institutional partnerships have stymied efforts to restore the health of coastal fisheries.

In an effort to better understand the opportunities for improving cross-scale coastal governance, WorldFish recently partnered with the Department of Agriculture's Bureau of Agricultural Research to conduct assessments in eight coastal regions. At each site, the research team conducted participatory systems analyses to help local stakeholders identify driving factors as the focus for future interventions. Assessing the need for reforms through such 'bottom-up' analysis helps develop a constituency for effective implementation.[2]

For such reforms to achieve their intended outcomes for food security and livelihoods, however, institutional strengthening is needed to improve collaboration in rule setting, monitoring, and enforcement across jurisdictions. No one model of cross-scale governance is appropriate for all socio-cultural and ecological settings.[3] Indeed, the study identified examples of four distinct fisheries governance arrangements along the Philippine coasts,[4] ranging from integrated fisheries and aquatic resource management councils, as found in San Miguel Bay, to more loosely structured clusters and alliances of municipalities, as found in the Visayan Sea; each approach has its particular advantages and challenges. This kind of experimentation represents a 'second generation' in small-scale fisheries co-management efforts, recognizing the centrality of navigating power dynamics and cross-sectoral and cross-scale relationships in the broader governance context.[5]

Harvesting cage culture fish

1 Pido, M.D., M.L. Perez, L.R. Garces, and N.D. Salayo. (in prep). Re-thinking Sustainable Development of Small-Scale Fisheries in the Philippines: Past Initiatives, Lessons Learned and Strategic Directions.
2 Perez, M.L., M.D. Pido, L.R. Garces, and N.D. Salayo (2012). Towards Sustainable Development of Small-Scale Fisheries in the Philippines: Experiences and Lessons Learned from Eight Regional Sites. Penang, Malaysia: WorldFish Center.
3 Ratner, B.D., B. Barman, P. Cohen, K. Mam, J. Nagoli, and E.H. Allison (2012). Strengthening governance across scales in aquatic agricultural systems. Working Paper. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural Systems. [Online] http://www.worldfishcenter.org/resource_centre/WF_3121.pdf.
4 Pomeroy, R., L. Garces, M. Pido, and G. Silvestre (2010). Ecosystem-based fisheries management in small-scale tropical marine fisheries: Emerging models of governance arrangements in the Philippines. Marine Policy 34: 298–308.
5 Ratner, B.D., E.J.V. Oh, and R.S. Pomeroy (2012). Navigating change: Second generation challenges of small-scale fisheries management in the Philippines and Vietnam. Journal of Environmental Management 107: 131–139.

this emphasis in much more than a token manner.[15] At the same time, the rural/agricultural development community has not been very successful either in shifting from technology-focused to poverty-focused approaches.

Working with rural communities, we aim to harness their existing strengths as we work together with partners to address challenges identified through an extensive participatory process involving stakeholders at multiple levels. This process builds on earlier participatory approaches to rural development and extends them by a focus on community empowerment, a transformative approach to gender, a recognition of the importance of nutrition as a key lever for change, and a commitment to long-term engagement, all supported by an innovative approach to monitoring and evaluation as the basis for learning and scaling.

The complexity and diversity of these systems mean there can be no single technical fix or blueprint solution to the challenges they face.[16] Our research must operate across sectors and be informed by diagnoses of constraints and opportunities at multiple scales. This includes the household level, where socio-cultural norms, beliefs, and attitudes underlie the persistence of gender inequity. Only by this multi-scale, multi-sectoral approach will we effectively contribute to the transformational change the poor deserve.

Pursuing this path challenges the CGIAR to move beyond traditional circles and change the way we do much of our research. By emphasizing approaches that call for research *in* development—rather than research *and* development or research *for* development—we are pursuing a conscious change in emphasis and mindset.

15 Sayer, J.A., and B.M. Campbell (2004). The Science of Sustainable Development: Local Livelihoods and the Global Environment. Cambridge, UK: Cambridge University Press.
16 Chambers, R. (2010). Paradigms, poverty, and adaptive pluralism. IDS Working Paper 344. Sussex, UK: Institute of Development Studies.

4. A theory of change

The central hypothesis driving the program is that the CGIAR can have greater impact on aquatic agricultural systems by moving beyond the linear production model that has dominated much of agricultural research to embracing a more integrated, innovative view of how to achieve development in agricultural systems. We are pursuing this through an action research and partnership-driven approach that moves far beyond the persistent views of development as either a purely technical process or as charity. We embrace development as a human right, whose goal is to achieve improved well-being for those currently living in poverty and with hunger.

By focusing on the needs of farmers, fishers, local government officials, NGO workers, marginalized ethnic groups, and women, we work to provide them with greater opportunities to innovate, thereby improving their means and incentives to increase agricultural productivity, sustain natural resources, access markets for goods and labor, and realize their rights and freedoms. Building the relationships, structure, capital, capabilities, and freedoms to allow this innovation system to flourish are the key development activities of the program.

To focus our approach on pathways of action that are likely to have impact, the program builds on our analysis of key constraints driving poverty and vulnerability in aquatic agricultural systems, and identifies a set of six corresponding hypotheses of change to frame our research agenda (Figure 1). These hypotheses comprise our preliminary theory of change. This theory argues that releasing the productive potential of aquatic agricultural systems to benefit the poor will require resource users and their partners in development to generate innovations in farming, natural resource management, marketing, livelihood strategies, and social institutions. The capacity and confidence to innovate will be greater if people are less poor and vulnerable, better fed, and better integrated into economic, social, and political processes.

Our hypotheses suggest that productivity gains, improved natural resource management, improved access to markets, transformed gender relations, improved policies, impact at scale, and flourishing knowledge exchange and innovation systems will collectively effect significant poverty reductions in aquatic agricultural systems. By pursuing actions that address these hypotheses and achieve the corresponding program objectives, we will realize outcomes and impacts on the three dimensions of poverty through income and asset building; social, political, and economic rights; and resilience and adaptive capacity.

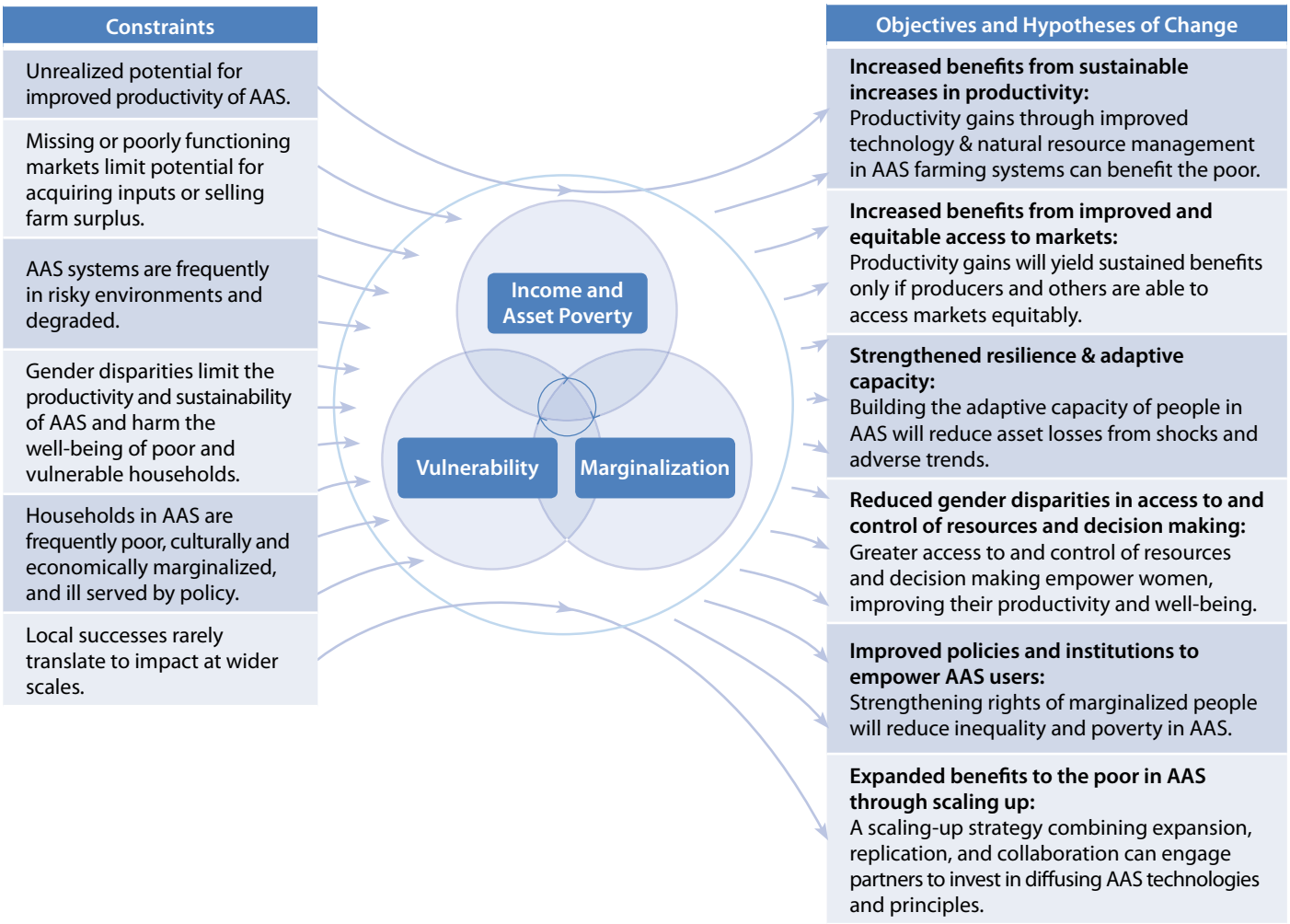


Figure 1. Theory of change for the program.

However, the relative importance of these processes in any given context can be determined only through careful diagnosis, and some contexts may not require addressing all of them. Diagnosis and sequenced interventions are therefore critical underlying principles of this program, as they are in much contemporary development practice at both micro and macro scales.[17] We will focus in each location on the appropriate combination of research activities that best addresses the key constraints and opportunities faced by local households. In some, the primary focus will be on developing new technologies and attracting private investment to better harness the productive potential of the aquatic agricultural systems (see Box 6), while in others the focus may be on strengthened community participation in decision making as a means to assert rights and reduce exposure to risk (see Box 7).

Box 6. Leveraging private investment in small aquaculture enterprises.

Large-scale commercial aquaculture already attracts substantial investment, but there is a need to catalyze investments in strategies that address environmental impacts and enable equitable access to markets by small producers in order to enhance local livelihoods and build food security. WorldFish, with various partners, has been exploring new investment models and partnerships for small and medium enterprises (SMEs),[1] which make up the majority of aquaculture producers in developing countries but are often marginalized in accessing the technology, financing, and markets needed to improve and grow.

WorldFish research has shown that investments in small aquaculture enterprises can be commercially rewarding for investors and at the same time generate positive environmental outcomes and social benefits. SMEs create income, employment, and significant social and economic multiplier effects in developing countries; investments in aquaculture SMEs therefore offer scope for delivering sustainable sources of fish, while positively impacting communities.[2]

Lack of access to finance and funding mechanisms remains a key inhibitor for many aquaculture SMEs to grow and improve practices, so partnerships with private investors remain key to achieving impact at scale. While a sound business case should be at the core of any investment, WorldFish research identifies a potential role for patient, socially responsible (impact) investors during startup and growth phases.

Often, for example, credit needs to be paired with efforts to assess and support management capacity, loan repayment terms need to be adjusted to match the period during which small operators are able to achieve a return on investment, and targeted support is required to enable SMEs to meet certification and quality requirements for high-value export markets. Engaging with SMEs and communities in developing countries presents challenges for investors, but capacity building, business development skills, and organizational support to transition or 'incubate' promising SME aquaculture investments, combined with connections to finance, technology, and market partners provide a basis for scalable commercial investment.

For poverty reduction and food security, the sector has massive investment potential with excellent rates of return. In certain cases, internal rates of return of 20–30% over ten years are achievable in well-managed projects and companies.[3] A recent study of aquaculture SMEs carried out in Ogun State, Nigeria, for example, shows a positive impact of microfinance loans on small- and medium-scale aquaculture, as it increased overall production, improved the revenue of the farmers, mitigated rural-urban migration, and generated new employment opportunities.[4] Many aquaculture activities are performed by women, particularly in small-scale operations. Pro-poor aquaculture development may therefore also contribute to women's empowerment by enabling supplementary income and opening other opportunities for asset-building.[5]

Small-scale aquaculture in Cameroon

1 Phillips, M., M. Beveridge, F. Weirowski, W. Rogers, and A. Padiyar (2011). Financing Smallholder Aquaculture Enterprises. [Online] www.worldfishcenter.org/resource_centre/WF_2798.pdf.
2 Phillips, M., W. Rogers, W. Downing, M.C.M. Beveridge, P.A. Padiyar, M. Karim, and R. Subasinghe (2012). Inclusive aquaculture: Business at the bottom of the aquatic pyramid. FAO Aquaculture Newsletter 48: 44–46.
3 Aquasol (2012). Aquaculture Investment Advisory Services. [Online] http://www.fishfarming.com/services/aquaculture-investment-advisory-services.html.
4 Odebiyi, O., and O. Olaoye (2012). Small and medium scale aquaculture enterprises development in Ogun State, Nigeria: The role of microfinance banks. Libyan Agriculture Research Center Journal International 3(1): 1–6.
5 Thompson, B., and R. Subasinghe (2011). Aquaculture's Role in Improving Food and Nutrition Security. In B. Thompson and L. Amoroso, eds., Combating Micronutrient Deficiences: Food-Based Approaches, 150-162. CABI.

[17] Rodrik, D. (2006). Goodbye Washington consensus, hello Washington confusion? A review of the World Bank's economic growth strategy in the 1990s: Learning from a decade of reform. Journal of Economic Literature 54: 973–987; Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. Proceedings of the National Academy of Sciences 104, 15181–15187; Collier, P. (2008). The Bottom Billion. New York: Oxford University Press.

Box 7. Multi-stakeholder planning in Khulna, Bangladesh.

The south and southwest coasts of Bangladesh are among the most disaster-prone areas of the country, having experienced two major cyclones in the past 3 years. For the more than 8 million people living in these coastal floodplains, capture fisheries and aquaculture are the second highest source of income.

The Khulna area in southern Bangladesh, one of the first focal hubs of the AAS program, is challenged not only by exposure to extreme weather variation but also by declines in biodiversity and other ecosystem services, poor access to markets and information, and high incidence of poverty, malnutrition, and childhood stunting. In July 2012, a participatory stakeholder consultation workshop convened stakeholders from various sectors to help articulate an overall picture of the development challenge for the hub (Figure 1). This consultation is part of the diagnosis stage in participatory planning, which precedes detailed program design in each of the hubs.

Transformational Change	We seek positive transformational change in the lives and livelihoods of poor AAS-dependent farmers and their communities, particularly women and youth.
A Culture of Local Innovation and Learning	We strive for empowered communities that lead in the innovation and adoption of more productive, diversified, and resilient practices and technologies and demand a more equitable role in the management of natural resources.
Productivity and Adaptation	With this enhanced capacity and leadership they will make more productive use of water, land, and biodiversity resources, gain better access to information and markets, and continually adapt to a dynamic Khulna floodplain system.

Workshop participants agreed that transformational change in local livelihoods could not be achieved without addressing gender inequalities and concentration of decision-making power in the hands of local elite, who restrict access to markets. Participants asserted that prior development investments have rarely encouraged local leadership and action, instead fostering a culture of dependency. This means that building local capacity for collective action is a critical element in the development agenda. This has been shown, for example, to enable technology adoption and asset accumulation by women farmers.[1] They also identified a need for research to speed innovation in farming systems to increase productivity, reduce vulnerability to climate change, and help remove obstacles to market access.

Khulna hub stakeholder consultation

Figure 1. Khulna Hub development challenge.

[1] Kumar, N., and A.R. Quisumbing (2011). Does social capital build women's assets? The long-term impacts of group-based and individual dissemination of agricultural technology in Bangladesh. CAPRi Working Paper 97. Washington, D.C.: International Food Policy Research Institute. [Online] http://www.capri.cgiar.org/wp/capriwp97.asp.

5. Commitment to place, solutions at scale

By embedding our research in communities, enlisting beneficiary households as co-researchers, and working closely with development partners, the CGIAR is seeking not only to develop solutions to specific constraints currently felt by stakeholders, but also to initiate and support processes that can help transform these communities and the institutions that affect them, beyond the lifespan of individual projects.

The program is doing this by concentrating efforts on focal countries within three major aquatic agricultural systems: large Asian deltas (Bangladesh and Cambodia, extending subsequently to India and Vietnam), the Asia-Pacific islands of the Coral Triangle (the Philippines and the Solomon Islands, extending subsequently to Indonesia and the South Pacific), and African freshwater systems (Zambia, extending subsequently to Mali and Uganda). These are illustrated in Figure 2. The selection criteria for country focus include national dependence on aquatic agricultural systems (extent of aquatic agricultural systems, as well as their importance to the national economy and to the livelihoods of poor families), level of government commitment, quality of partnerships, and opportunities for scaling out. By selecting focal countries that exemplify the challenges in mega-delta, coastal-marine, and freshwater systems respectively, we also aim to maximize opportunities for exchange across countries and regions.

In each focal country, we work in a limited number of development hubs where aquatic agricultural systems are central to prospects for poverty reduction. Case study data show that the vast majority of households in these areas are dependent for their livelihoods on natural resources, including fish, crops, and livestock, and the ecosystem services that support these production systems. In most cases, fish represent the first or second most important source of household income.

These hubs provide a focus for innovation, learning, and impact through action research. In each hub we work with partners to identify communities and sites as the focus of our direct research investment. At each of these sites, we are conducting participatory diagnoses with selected communities and households, and our work will build upon this research to provide a basis for long-term learning with the communities in the area. We will develop learning alliances with all key stakeholders in the hubs and use participatory impact mapping to guide our investments in partnerships, capacity building, and knowledge management and learning.

The program's work in each hub builds on past and ongoing research and development activities. This involves bringing together learning from current CGIAR research projects and those of partners, as well as using the participatory diagnoses to identify how we can build upon them to improve integration and increase impact in the future. By working closely with development actors, notably local organizations, development NGOs, and governments, the program will build close links with ongoing and planned development investment. It will also invest in rigorous impact assessment, building on state-of-the-art practice to establish causal relationships between interventions and impacts in complex and dynamic systems.[18] In these ways, the program seeks to scale out the results of our work to reach beyond the communities we work with directly.

The program is designed to focus operations in focal countries and hubs within them, and to build on this research to harness global learning in the form of international public goods. In each country and hub, we will identify commonalities and differences in the constraints faced and in the solutions to these constraints, and distill a body of comparative learning and general principles. We will then work with partners to see these lessons applied in guiding development interventions elsewhere in focal countries, and indeed in other agricultural systems with similar challenges (see Box 8).

Focal systems	# people in each system	# people living in poverty	# people dependent on aquatic agricultural systems
Asia mega deltas	350m	120m	210m
GBM; Mekong	168m	57m	100m
Coral triangle	150m	42m	75m
Solomon Islands; Philippines	90m	28m	54m
African freshwater	250m	88m	175m
Niger; Victoria/Kyoga; Zambezi	110m	51m	77m

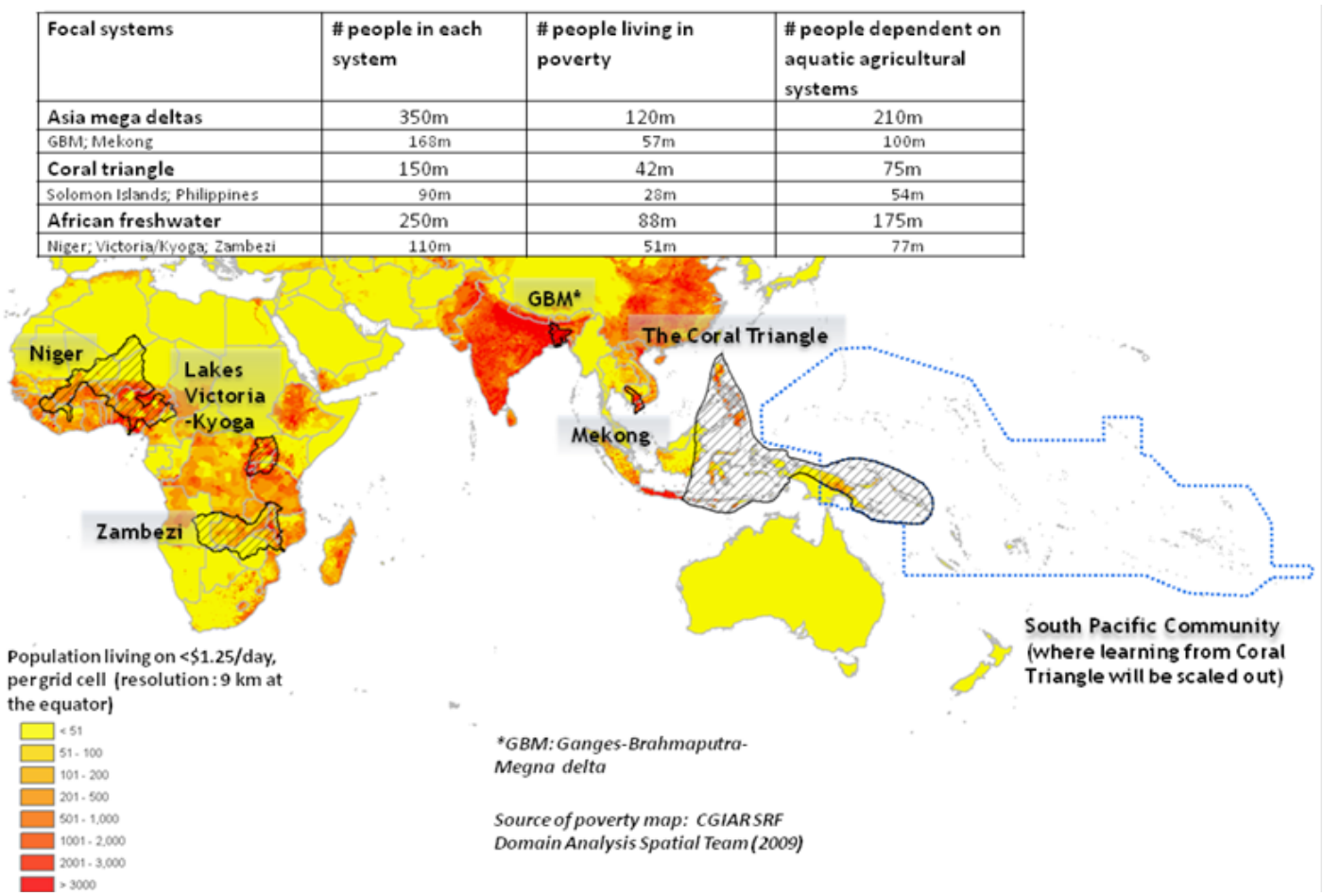


Figure 2. Current focal regions for the CGIAR Research Program on Aquatic Agricultural Systems.[19]

[18] Stern, E., N. Stame, J. Mayne, K. Forss, R. Davies, and B. Befani (2012). Broadening the range of designs and methods for impact evaluations. DFID Working Paper 38. London: Department for International Development. [Online] http://www.dfid.gov.uk/r4d/pdf/outputs/misc_infocomm/DFIDWorkingPaper38.pdf.

[19] Population estimates employed case study data on levels of dependence on aquatic agricultural systems to interpret population distribution data within countries. Additional information on population estimates and characterization of the distinct challenges in each system may be found in the CGIAR Research Program on Aquatic Agricultural Systems. [Online] http://www.worldfishcenter.org/resource_centre/WF_2936.pdf.

Box 8. Participatory resilience assessments in the Solomon Islands.

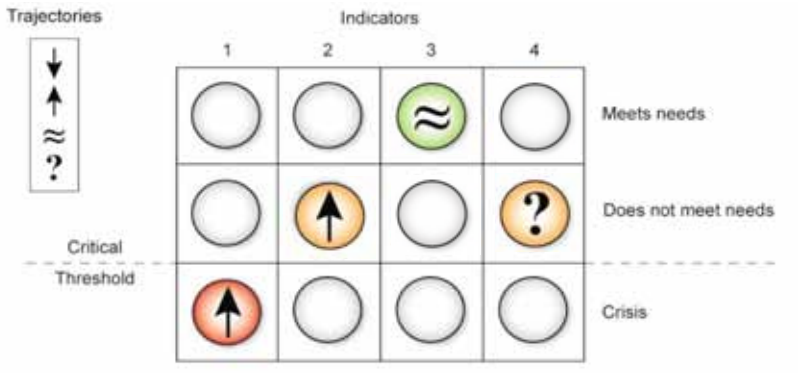
The Solomon Islands consists largely of coastal and aquatic ecosystems, with aquatic agricultural systems dominating the rural economy. Rural communities have identified increasing population, widespread poverty, sea level rise, climate change, diminishing marine resources, disease, and outsiders as key threats to their future livelihoods.

What does resilience mean in this context? A resilient fishery socioeconomic system in the developing world is one that absorbs shocks and reorganizes itself following stresses and disturbances while still delivering benefits for poverty reduction, responding to priorities that are locally defined.[1] In the data-poor context of aquatic agricultural systems in developing countries, it is critical that methods for assessing and pursuing resilience abandon the heavy data requirements that characterize classical natural resource management and look instead for ways to feed existing, often local, knowledge into management systems that are primed to learn.[2]

WorldFish has developed a set of diagnostic tools to facilitate locally grounded resilience assessment and resource management. The indicator dashboard (Figure 1) provides a simple visual aid for moving from community-based diagnosis to development of management indicators based on the ability of the system to meet community needs. In this simplest form, management performance is judged by whether each indicator improved (↑), worsened (↓), or remained about the same as last time it was assessed (≈). If no further information has been collected, then the current status is unknown (?). It specifies monitoring at a resolution that is appropriate for community-based systems and can feed directly into the learning processes.

These tools were used to develop a management plan for the bêche-de-mer (sea cucumber) fishery in the village of Kia, Santa Isabel Island. The diagnosis recognized that cash from the bêche-de-mer fishery had caused villagers to abandon their vegetable gardens in favor of purchasing food. When the government enforced the closure of the fishery in response to resource depletion, the lack of functional gardens compounded the impact of reduced income on households. A management intervention promoting garden cultivation and an indicator based on the number of productive gardens in the village were included in the management plan. At the instigation of villagers, this management plan was later expanded to cover all marine resources, showing the community's strong buy-in and ownership of the plan. In another application in the Jorio region of Vella Lavella Island, five communities used the tools in developing a marine resource management plan that addresses illegal fishing, as well as conservation of mangrove and reefs, monitoring of indicator species, and in some instances, forest and land management.[3]

A key feature of the AAS program approach is to enable the rapid spread of such innovations. In the case of the Solomons, individual communities, language groups, and provincial governments provide natural nodes in a multi-scale network. Innovation spreads quickly among communities and 'wontoks' (people who share language), but new ways of spreading impact will be required to jump the barriers of language and remoteness, and do so at minimal cost.



Indicator	Variable	States / Thresholds
Abundance of sea cucumbers	# of animals seen on 100m transect	1. > 100 animals / 100 m transect 2. 40 - 100 animals / transect 3. < 40 animals / transect
Reliance on sea cucumber for income	% of fisher households deriving primary income from the fishery	1. < 40% of households 2. 40 - 70% of households 3. 70 - 100% of households
Cultivation of gardens for subsistence	# of gardens cultivated	1. One new garden per family per year 2. Maintenance of old garden 3. No garden cultivated
High school attendance	# of students sent back to community due to lack of school fees	1. No students sent back 2. 1-3 students sent back 3. > 3 students sent back

Figure 1. Indicator dashboard for community-level resilience monitoring, example from Kia Village, Solomon Islands.

[1] Andrew, N.L., and L. Evans (2011). Approaches and frameworks for management and research in small-scale fisheries. In R.S. Pomeroy and N.L. Andrew, eds., Small-Scale Fisheries Management: Frameworks and Approaches for the Developing World. Oxfordshire, UK: CABI.
[2] Walker, B., J. Sayer, N.L. Andrew, and B. Campbell (2010). Should enhanced resilience be an objective of natural resource management for developing countries? Crop Science 50: S-10–S-19.
[3] Govan, H. (2011). Good Coastal Management Practices in the Pacific: Experiences from the Field. Apia, Samoa: Secretariat of the Pacific Regional Environment Program.

6. Objectives and impact pathways

The AAS program aims to improve the lives of 15 million poor and vulnerable users of aquatic agricultural systems by 2016. With the dissemination of new technology and knowledge to other aquatic agricultural systems, the goal is to benefit 50 million people by 2022.[20]

Poverty in aquatic agricultural systems is not simply about inadequate income or assets, but results from the interaction between income poverty and other factors, such as marginalization and vulnerability. Figure 3 illustrates these— often highly gendered—interactions and shows how the program's approach to understanding them helps identify research priorities. In contrast to much previous CGIAR research that focused mainly on ways to improve income and assets directly, the program's multi-dimensional approach to poverty is yielding stakeholder analyses of the wider constraints faced by the poor and of the pathways to overcoming these constraints. The six broad constraints and corresponding research priorities as initially identified are as follows:

1. Sustainable increases in system productivity.
Many AAS-dependent households suffer productivity gaps. These could be narrowed with better inputs and innovative production and postharvest practices. Existing and newly developed enhancements may be superior crops, livestock, trees, or fish; integrated management to improve quality, yield, or production efficiency; the timely provision of production inputs; or reduced postharvest losses. Work in this theme aims to increase benefits to AAS-dependent households from environmentally sustainable increases in productivity.

2. Equitable access to markets.
Many AAS households do not pursue opportunities to increase crop, livestock, and fish production because of barriers to accessing markets. The program is working to understand these barriers in the focal hubs and identify investments that can overcome them. In pursuing this work the program will, wherever possible, focus on the nutritional quality of the products and how value chains can best deliver positive nutritional outcomes, particularly for women, children, and other vulnerable groups. Outcomes of this research will include adoption of value-adding technologies and practices, private and public investment in value chains, creation or strengthening of producer and marketing organizations, and improved credit and business development services available to poor and vulnerable AAS households.

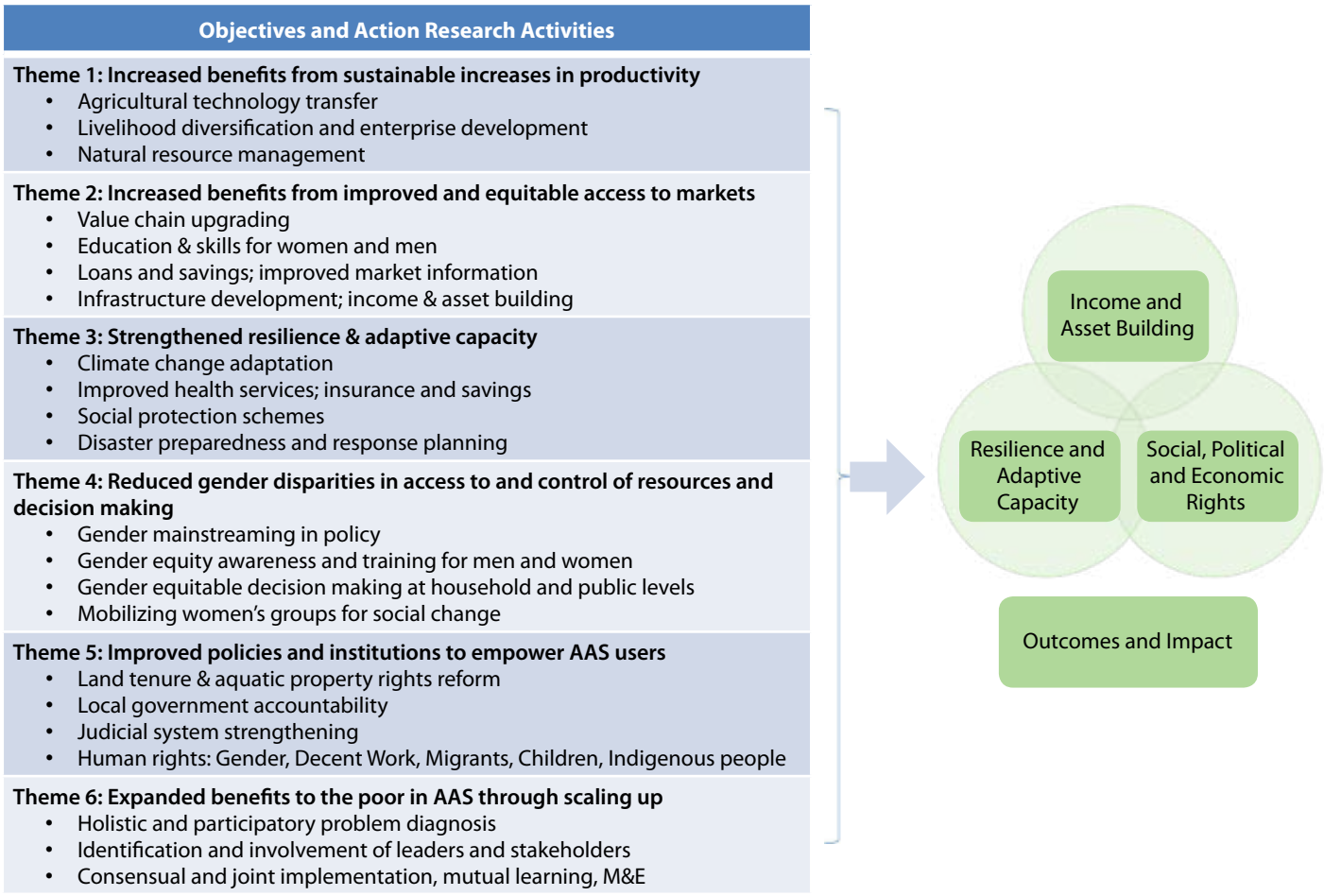


Figure 3. Program objectives, action research activities, and their impacts on drivers of poverty.

Note: The activities indicated do not map directly onto individual dimensions of poverty reduction, because these overlap. For example, to reduce the vulnerability of landless AAS users, it may be necessary to adopt new livelihood activities, such as small-cage aquaculture and floating gardens, to supplement and reduce pressure on wild common pool resources (Theme 1). This may entail developing new markets (Theme 2), investing in reducing disaster risk and early warning systems that reach mobile and itinerant populations (Theme 3), addressing gender inequity through gender-awareness activities and gender mainstreaming (Theme 4), and ensuring that the landless poor are not exploited in labor markets by promoting the application of the human right to decent work (Theme 5). Thus, vulnerability reduction activities are not confined to Theme 3.

[20] These five-year and ten-year targets are built up from country-level estimates of numbers of poor and vulnerable AAS users reached through current and anticipated program activities, comprising both direct implementation by program partners and impacts from adoption of lessons and strategies by other actors. Targets will be refined as detailed implementations are developed in each country during 2012–13, along with intermediate development outcomes. A comprehensive monitoring and evaluation strategy will track progress.

3. Socio-ecological resilience and adaptive capacity.
AAS users are vulnerable to natural disasters exacerbated by climate change, and many suffer oppression and discrimination. Insecurity born of vulnerability and marginalization dampens innovation and the responsible stewardship of resources for the long term. By helping strengthen rights that foster more equitable access to resources and services and enhancing capacity to adapt to irreducible risks, the program works to build resilience.

4. Gender equity.
Recognizing that gender disparities hamper communities' ability to harness the benefits of aquatic agricultural systems, the program pursues a dual strategy of mainstreaming gender in all research themes and focusing on research toward fundamentally transforming underlying gender norms and roles. In this way, the program supports efforts to strengthen women's roles and status in the home and beyond and improve women's equity of access to productive resources, such as land, water, technology, financing, and services.

5. Policies and institutions to empower AAS users.
Improved technologies in the field rarely offer long-term benefits without supporting institutions and favorable policies. The program examines how institutions and policies affect aquatic agricultural systems and their users, encourages the emergence and implementation of policies and institutional innovations that facilitate resilience in aquatic agricultural systems and their communities, and supports AAS communities' adaptation to unfavorable policies that cannot be changed.

6. Knowledge sharing, learning, and innovation.
This theme supports other themes' delivery of outcomes by catalyzing knowledge sharing and learning among partners and stakeholders. It advances the program strategy for scaling up by strengthening networks among partners for knowledge sharing, capacity building, and advocacy. Program monitoring, evaluation, and impact assessment strengthen the performance of program participants toward achieving greater outcomes and expanding the benefits to the poor in aquatic agricultural systems.

Figure 4, below, provides an illustrative example of an impact pathway for action research on the gender equity theme. Specific action priorities in particular hubs will trace selected routes among the interventions, outcomes, and intended impacts summarized here.

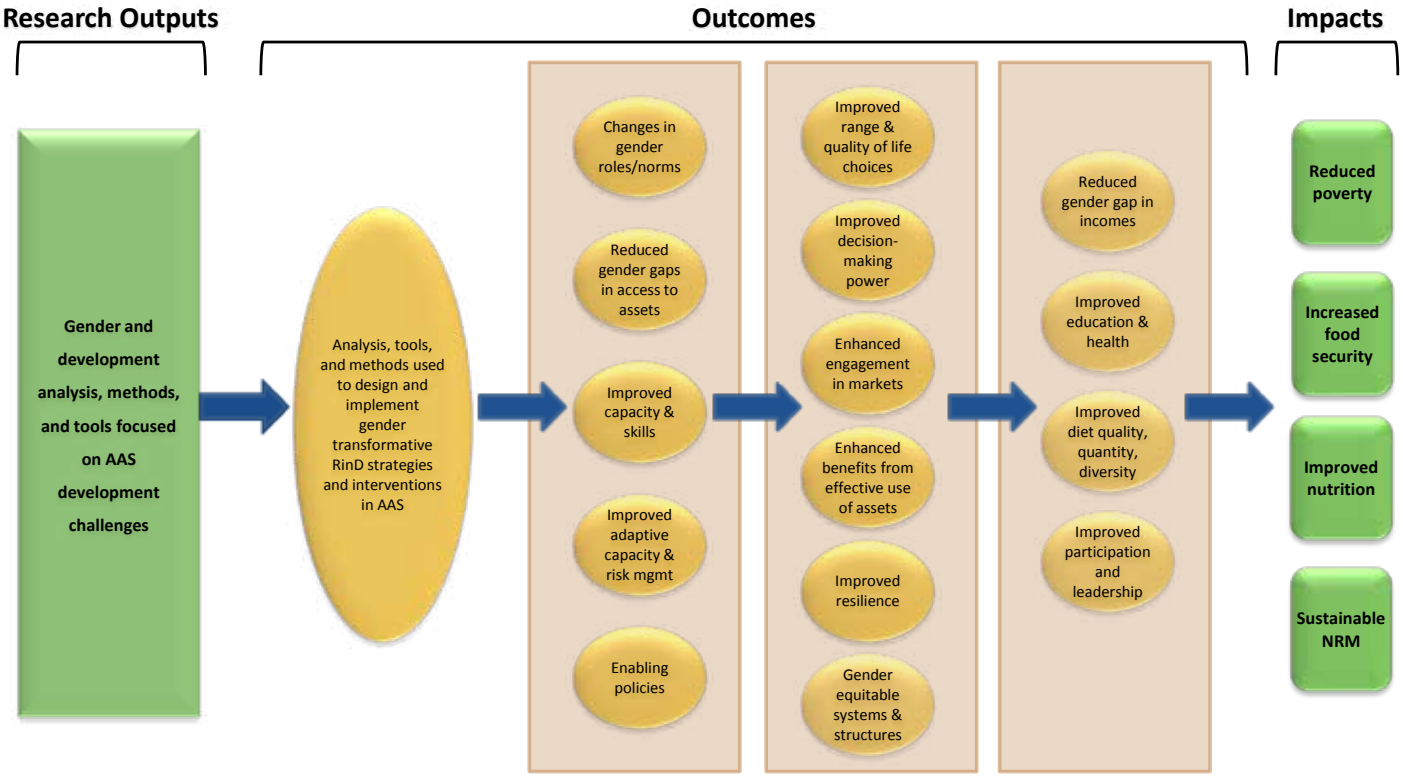


Figure 4. Impact pathway for gender transformative action research.

7. Opportunities for partnership

The AAS program represents a long-term commitment to transformative change aimed at reducing poverty, strengthening livelihood resilience, and increasing food security in very challenging development environments. Still in its formative phase, the program welcomes new partnerships to deliver results in the focal countries and hubs, as well as to scale out impacts more broadly. With a strong focus on learning, distilling, and communicating lessons, we are actively fostering opportunities to exchange experience at country, regional, and global levels. These are challenges that no single organization can address alone.

Fishermen in Bangladesh pool their strength to lift a boat

With communities, changing lives

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The CGIAR Research Program on Aquatic Agricultural Systems is a multi-year research initiative launched in July 2011. It is designed to pursue community-based approaches to agricultural research and development that target the poorest and most vulnerable rural households in aquatic agricultural systems. Led by WorldFish, a member of the CGIAR Consortium, the program is partnering with diverse organizations working at local, national, and global levels to help achieve impacts at scale. For more information, visit aas.cgiar.org.

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