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Aquaculture extension services: an urgent necessity

Servicios de extensionismo en aquacultura: una necesidad urgente

Alejandro Mcdonal Vera[1]

[1]Laboratorio de Acuicultura Tropical, División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco, Carretera Villahermosa-Cárdenas Km 0.5, Entronque a Bosques de Saloya, Villahermosa C.P. 86039, México.

Corresponding author:
Alejandro Mcdonal Vera.
alejandromacdonald_vera@hotmail.com

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Abstract
The growing global demand for food has positioned aquaculture as a key activity for food security. In this context, aquaculture extension —understood as technical support and knowledge transfer to producers— takes on great importance. Its purpose is to support small-scale producers in becoming self-sufficient. This activity faces limitations due to the lack of specific public policies, scarce resources, and mistrust on the part of producers. In Mexico, extension services have been based on the US model, evolving toward a multifunctional approach that considers social, political, economic, and environmental dimensions. Despite its potential, aquaculture extension is still in its infancy and is generally merged with agricultural extension, which has hampered its specific development and effectiveness. Challenges include limited technological infrastructure, producers' lack of knowledge of fundamental technical aspects, and low investment in applied research. In addition, a lack of trust in extension workers, coupled with the poor adaptation of knowledge to the real conditions of producers, prevents a true conversion of knowledge into productivity. It is concluded that extension services must be professional, adapted to the local context, and supported by public policies and investment in research. Only then will it be possible to harness Mexico's aquaculture potential sustainably, promoting innovation, profitability, and well-being for rural communities.
Keywords: Aquaculture development, Knowledge dissemination, Rural extension systems, Aquatic food security, Applied aquaculture innovation

Resumen
La creciente demanda global de alimentos ha posicionado a la acuicultura como una actividad clave para la seguridad alimentaria. En este contexto, el extensionismo acuícola —entendido como el acompañamiento técnico y transferencia de conocimiento a productores— adquiere gran relevancia. Su propósito es apoyar a los pequeños productores hacia su autosuficiencia. Esta actividad enfrenta limitaciones por la falta de políticas públicas específicas, escasez de recursos y desconfianza por parte de los productores. En México, el extensionismo se ha basado en el modelo estadounidense, evolucionando hacia un enfoque multifuncional que considera dimensiones sociales, políticas, económicas y ambientales. A pesar de su potencial, el extensionismo acuícola aún es incipiente y generalmente está fusionado con el agropecuario, lo que ha dificultado su desarrollo específico y su efectividad. Los retos incluyen la limitada infraestructura tecnológica, el desconocimiento de aspectos técnicos fundamentales por parte de los productores y la escasa inversión en investigación aplicada. Además, la falta de confianza en los extensionistas, sumada a la poca adaptación del conocimiento a las condiciones reales de los productores, impide una verdadera conversión del conocimiento en productividad. Se concluye que el extensionismo debe ser profesional, adaptado al contexto local y respaldado por políticas públicas e inversión en investigación. Solo así se podrá aprovechar el potencial acuícola de México de forma sostenible, promoviendo innovación, rentabilidad y bienestar para las comunidades rurales.
Palabras clave: Palabras clave: Desarrollo acuícola, difusión del conocimiento, sistemas de extensionismo rural, seguridad alimentaria acuática, innovación acuícola aplicada.

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EDITORIAL

The increasing global demand for food, driven by population growth and shifting consumption patterns, has established aquaculture as a crucial activity for ensuring food and nutritional security. According to data from the Food and Agriculture Organization of the United Nations (FAO, 2024), aquaculture already supplies over 50% of fish for human consumption, with the estimated growth rate surpassing that of other agricultural sectors. In this context, technical support through knowledge and technology transfer is crucial, as it helps improve the productivity and sustainability of aquaculture systems. Extension services, which aim to support small and medium-scale producers in reaching economic and productive self-sufficiency (FAO, 2016), must be delivered professionally and responsibly. However, the impact of this activity in Latin America is limited by a lack of specific public policies and inadequate human and financial resources (FAO, 2020). This shortfall also represents an opportunity to create jobs, boost profitability, and establish more efficient, resilient, and sustainable production systems.

In Mexico, the extension model applied initially was inspired by the US model, which featured applied research and extension led by government agencies responsible for agriculture, livestock, and forestry. This approach aimed at solving production challenges and providing credit and input services (Aguilar et al., 2005). Over time, the model evolved toward a multifunctional approach that proposed a well-rounded profile for extension workers, incorporating social, political, economic, and environmental dimensions (Méndez, 2006). This change facilitated interaction among various actors and helped foster rural development at the regional scale (Rendón-Medel et al., 2015). This approach aligns with the modern vision of the FAO (2022), which emphasizes the need to strengthen agricultural innovation systems, where extension workers serve as links between science and producers.

Currently, extension is defined in Mexico as a service offered by research centers, educational institutions, and government agencies. It helps producers, rural organizations, and other players in the agricultural, fishing, and aquaculture sectors access knowledge, information, and technologies (Secretariat of Agriculture and Rural Development [SADER], 2016). Also referred to as technical assistance, extension involves ongoing support where specialists share research-based innovations with producers to enhance production systems and make them more profitable and sustainable (Aguilar *et al.*, 2005; Zavala, 2011). However, aquaculture extension is still developing and is often clustered with agricultural and rural extension, which limits its specialized growth (FAO, 2016; Celaya & Almaraz, 2018). The current challenge lies in reinforcing its unique motivation, recognizing the technical and biological complexity of aquaculture.

Despite the large amount of scientific knowledge generated in recent years to support aquaculture development, there is a huge gap between academia and producers. This has created communication barriers, particularly with small producers. Regarding this, Matus-Parada *et al.* (2015) argue that it is urgent to provide producers with a strategic vision to guide the direction of their development. These authors propose that the activity could be more substantial if extension services focus on knowledge that responds to the real needs of aquaculture producers, rather than on an arbitrary selection of these needs.

To this end, universities and research centers must develop permanent outreach programs that support the dissemination of cutting-edge aquaculture knowledge. A significant obstacle in this work is the lack of trust between producers and extension workers. Many aquaculture farmers believe that the knowledge offered does not address their real needs or that extension workers lack adequate training (Engel, 2004). This issue is exacerbated by limited technological infrastructure and poor biotechnological development in various regions, which dissuades producers' ability to expand their production competitively.

Without a solid scientific understanding of species biology, environmental conditions for farming, and suitable techniques, production systems lose efficiency and sustainability (Celaya & Almaraz, 2018). This gap in knowledge and trust has limited the implementation of

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innovations and the strengthening of value chains. To bridge this gap, aquaculture extension workers need to be well-rounded professionals with expertise in biology, aquaculture engineering, and economic and social management. Moreover, technology transfer is effective only when it is adapted to local conditions and when producers have the economic and organizational capacity to apply it (Pavitt, 2005; FAO, 2020).

Mexico has abundant water and biological resources, providing vast potential for developing aquaculture supported by specialized technical programs. Tilapia is the most commonly farmed species, but there are also opportunities to explore native species like snooks (*Centropomus* spp.) and catfish (*Ictalurus* spp.), which are in rising commercial demand (Celaya & Almaraz, 2018; FAO, 2022). To tap into this potential, it is crucial to invest in applied research, focusing on producing quality seed, diversifying species, and optimizing fattening processes. These actions would not only enhance food security but also create more inclusive and competitive value chains, paving the road for innovation, generating and applying knowledge for the improvement of producers and their communities. It is vital to build more productive, resilient, and sustainable aquaculture communities that contribute to the Sustainable Development Goals, especially those related to ending hunger (SDG 2) and responsible production and consumption (SDG 12; FAO, 2024).

In conclusion, the development of aquaculture in Mexico necessitates effective coordination among science, technology, society, and public policy. Achieving this integration is imperative for the sustainable exploitation of aquatic resources and the fulfillment of the mounting global demand for food. To this end, the role of specialized aquaculture extension workers must be enhanced to include technical and socioeconomic skills. This will increase the productivity and sustainability of production units and foster trust between producers, institutions, and the government.

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