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Technological Interventions in Fisheries: Enhancing Productivity in Aquaculture and Wild Capture Systems

Dawood Ibrahim S, Ishani S Gowda, A. Jaiprakaesh and V. Senthilkumar
Department of Fisheries Extension, Economics & Statistics, Fisheries College and Research Institute
Thoothukudi, Tamil Nadu

SUMMARY

Advanced technologies in fisheries production have become an integral answer to the rising seafood demand if aquatic ecosystems are to remain intact and healthy. This article shows some of those recent technologies applied in both wild capture fisheries and aquaculture operations, investigating how such technologies impact production efficiency, sustainability, and the environment. The technological interventions that have been discussed in this study are precision aquaculture, remote sensing for stock assessment, technologies related to genetics, block chain for traceability, autonomous underwater vehicles and AI-driven predictive models. The technologies bring considerable improvements in productivity, sustainability, and management practices. Despite these developments, challenges still persist in terms of high upfront costs, accessibility to small-scale operators, and public acceptance for some of the technologies.

INTRODUCTION

Technological innovations are playing a crucial role in transforming the fisheries and aquaculture industries, bringing about significant advancements in efficiency and sustainability. These technologies, ranging from advanced monitoring systems to automated operations, are essential in managing the increasing global demand for seafood while simultaneously protecting and preserving aquatic ecosystems. By integrating these solutions, the industry not only enhances its production capabilities but also contributes to global food security, ensuring a sustainable future for both human consumption and the environment.

Overview of Recent Technologies

Precision aquaculture

Precision aquaculture integrates Internet of Things (IoT) devices, Artificial Intelligence (AI), and big data analytics to optimize fish farming operations. IoT sensors continuously monitor water quality parameters (temperature, pH, dissolved oxygen), fish behavior, and feeding patterns. This data is analyzed using AI algorithms to make real-time adjustments to feeding schedules, water treatment, and other farming practices. Big data analytics help identify long-term trends and optimize overall farm management.

Uses

- Improves efficiency,
- Reduces waste,
- Enhances fish health and growth rates.

Remote Sensing and Stock Assessment:

Satellite technology and machine learning algorithms have revolutionized fish stock assessments in wild capture fisheries. Satellites can track ocean conditions like temperature, chlorophyll levels, and currents over vast areas. When combined with machine learning algorithms, this data can predict fish distribution and abundance with much greater accuracy than traditional methods.

Uses

- Helps identify optimal fishing locations,
- Supports sustainable fisheries management by providing a more comprehensive view of marine ecosystems.

Genetic Technologies:

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) gene-editing techniques have been refined for use in aquaculture. This technology allows for precise modifications to fish genomes, enhancing

traits like disease resistance and growth rates. For example, researchers can identify and modify genes responsible for immune responses, making farmed fish more resistant to common pathogens. Similarly, genes affecting metabolism and growth can be optimized, leading to faster-growing fish that convert feed more efficiently.

Uses

- This technology has the potential to significantly improve aquaculture productivity and sustainability.

Blockchain for Traceability

Blockchain technology is being implemented in the seafood supply chain to improve transparency and reduce illegal fishing. Each step of the fish's journey from catch or farm to consumer is recorded on a decentralized, immutable ledger. This creates a transparent and verifiable record of the fish's origin, processing, and distribution.

Uses

- Blockchain helps combat illegal, unreported, and unregulated (IUU) fishing
- Reduces fraud, and allows consumers to make more informed choices about the seafood they purchase

Autonomous Underwater Vehicles (AUVs):

AUVs are robotic submarines that can operate independently to map and monitor marine habitats. These vehicles are equipped with various sensors and cameras to collect data on ocean floor topography, water chemistry, and marine life. This information is crucial for understanding fish habitats, spawning grounds, and ecosystem health.

Uses

AUVs enable more informed and effective fisheries management decisions, supporting both conservation efforts and sustainable fishing practices

AI-driven Predictive Models:

Advanced machine learning models are being developed to predictfish migration patterns and identify optimal fishing locations. These models analyze vast amounts of data, including historical fishing records, oceanographic data, climate patterns, and satellite imagery. By identifying complex relationships within this data, AI can predict whereand when fish are likely to be abundant.

Uses

- This technology helps fishing fleets operate more efficiently, reducing fuel consumption and bycatch while optimizing catch rates.
- It also supports conservation efforts by helping to avoid overfishing in sensitive areas.

CONCLUSION

The integration of advanced technologies in fisheries production offers significant potential to meet global seafood demand while ensuring environmental sustainability. Precision aquaculture, AI-driven systems, and genetic technologies have improved efficiency, reduced environmental impacts, and enhanced disease resistance in farmed species. Blockchain and autonomous underwater vehicles have strengthened supply chain traceability and informed sustainable fishing practices. However, challenges such as high costs and ethical concerns remain, particularly for small-scale operators. To ensure a sustainable future, these technologies must become more accessible, with supportive policies and continued innovation driving equitable and responsible adoption.

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