availability is closely linked to biomineralization processes (Table 3). Maintaining these parameters within the recommended ranges helps reduce environmental stress, improves survival and growth performance of cultured mussels, and supports consistent pearl formation and overall production efficiency.

Table 2 Recommended soil quality parameters for pearl farming

pH	6.5~7.5
Organic carbon	1.0%~2.5%
Available nitrogen	25 to 75 mb/100 gm of soil
Hydrogen sulphide	Nil

Table 3 Recommended water quality parameters for pearl farming

pH	7.5~8.5
Total alkalinity	75 ppm~150 ppm
Total hardness	40 ppm~75 ppm
Dissolved calcium	25 ppm~50 ppm

9 Socioeconomic Significance

Pearl farming also offers some form of diversification of income to fishers and the rural population especially where other stable sources are unavailable. The level of adoption among farmers has gone up due to training, government subsidies, and technology transfer efforts, but issues of water quality, technical expertise, and markets have become more difficult (SATHIADHAS, 2009). The break-even analysis of the aquaculture practices reveals that pearl culture is a lucrative activity particularly where it is integrated with fish, crops and livestock.

Farmers in developing countries such as India lack the understanding of the modern aqua farming methods, such as pearl farming that should be used in their respective sectors. There are already many women, farmers, and business people, interested in this topic, who expressed their interest in the Grade "AAA" that is the highest grade with such wonderful properties as excellent shine, non-existence of surface faults, and needed symmetry. Surface of AA has couple of marks on its surface, even colour, and lustre is good. A medium quality, colour variation, medium lustre, few surface flaws, poor symmetry A B good lustre with some imperfections and an uneven surface and colour (Singh et al., 2023).

10 Environmental and Sustainability Challenges

Productivity and sustainability have also been affected by not only the quality of water but also climate change, unpredictable rainfall, and gaps in skills when managing aquaculture (Singh et al., 2022). In reaction to this, integrated aquaculture such as multi-trophic systems that combine fish, mussels and other aquatic plants or animals is suggested to recycle nutrients and minimize environmental impact, which increases system resiliency and sustainability (Saurabh et al., 2022).

10.1 Impacts of ocean acidification on calcium carbonate deposition in pearls

Near-future ocean acidification (pH ~ 7.6) can cause disruption in nacre deposition in pearl oysters. SEM observations shows that lower pH levels can lead to the production of irregular and disorganized nacre tablets, reducing overall strength of oyster shell. This not only degrade the pearl quality but also increases the vulnerability of oysters to predation. As the cultured pearl industries depends on production of high-quality nacre from cultured oysters, the ocean acidification may lead to devastating effects for them (Welladsen et al., 2010). Increased temperatures can accelerate the impacts of ocean acidification by altering cell membrane permeability, impairing protein activities linked in acid-base regulation and defence, and leading to metabolic stress in marine calcifers (Li et al., 2015).

10.2 Impacts of accelerating sea temperature on quality and growth of pearls

Temperature significantly affect the pearl growth rate in *Pinctada margaritif*era, fastest growth rates are observed between 26 °C~30 °C while the rate declines significantly at 34 °C, followed by reduction in biomineralizing capacity of pearl sac. According to the polynomial equation: G=0.05T2+ 2.65T–33.34 (r=0.81), the optimum