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Quack the Weeds Away: Ducks as Nature's Weed Fighters in Rice Fields

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Rice-duck farming is an integrated and ecologically based approach for weed management that combines rice cultivation with duck rearing. Ducks suppress weeds through direct grazing, trampling, uprooting and disturbance of soil and standing water, while their manure contributes to nutrient recycling. These combined mechanisms can reduce weed biomass and suppress diverse weed species, particularly during the early stages of weed growth. The effectiveness of the system depends on timely duck release, appropriate stocking density, crop establishment, water depth, grazing duration and proper field management. Reported stocking densities of 250 ducks ha^{-1} demonstrated that duck density should be adapted to local production conditions rather than applied as a universal recommendation. Rice-duck integration may also contribute to insect regulation, nutrient cycling, livestock production, farm diversification and reduced dependence on chemical weed control. However, limitations such as crop damage, predation, feed requirements, poor water conditions, variable weed palatability and additional labour must be considered. Overall, rice-duck farming offers a multifunctional component of integrated weed management, with potential to improve ecological sustainability while maintaining rice production when appropriately managed.

Keywords: Biological weed management; Duck grazing; Ecological farming; Rice-duck farming; Rice production and Weed suppression.

Introduction

Weed management is one of the major challenges in rice production because weeds compete with rice plants for water, nutrients, sunlight and space, particularly during the early stages of crop establishment. Conventional weed management in rice commonly relies on manual weeding, mechanical operations and herbicide application. Although these approaches can provide effective weed suppression, repeated herbicide use may increase production costs and can contribute to concerns related to herbicide resistance, environmental contamination and effects on non-target organisms (Beckie *et al*., 2019). In this context, biological approaches that integrate crop production with livestock offer an alternative pathway for reducing weed pressure. The integration of ducks with rice cultivation, commonly referred to as a rice-duck farming system, is an example of biological and ecological weed management (Du *et al*., 2025). In this system, ducklings are allowed to forage within the rice field after the rice

seedlings have become sufficiently established. The ducks interact continuously with the crop environment through feeding, movement and manure deposition. Their activities can suppress weeds while simultaneously contributing to nutrient cycling and other ecological functions within the rice ecosystem. The weed-suppressive effect of ducks is not simply due to their consumption of weeds but their grazing, trampling, swimming, stirring of standing water and disturbance of the soil surface collectively interfere with weed establishment. Young weeds and aquatic vegetation may be directly consumed, while emerging weeds can be uprooted or damaged by duck movement. Thus, rice-duck integration combines biological feeding with physical disturbance to reduce weed growth. The approach is particularly relevant to integrated and low-input farming systems because the duck component can provide multiple functions within the same production unit. Instead of considering weed management as an activity completely separate from livestock production, rice-duck farming integrates weed suppression, livestock rearing, nutrient recycling and agricultural diversification within a single system.

Ducklings as Biological Weed Managers

Ducklings are naturally adapted to foraging in wet environments. Their feeding behaviour enables them to search for small plants, insects and other organisms present in shallow water and wet soil. When introduced into an appropriately established rice crop, their movement creates continuous physical disturbance in the flooded field. The weed-control mechanism carried out by ducklings can broadly be divided into four interacting processes *viz*., direct grazing, uprooting and trampling, water and soil disturbance and nutrient recycling.

Direct grazing of weeds

Young weeds and soft aquatic vegetation are consumed when ducks forage in the rice field (Li *et al*., 2019). The removal of growing points and leaves reduces the competitive ability of weeds and prevents plants from developing into mature, seed-producing individuals. The effect is particularly relevant when ducks are introduced while weeds are still young and vulnerable.

Trampling and physical damage

Ducklings continuously move in rice fields while foraging, feeding on insects, weeds and other small organisms. Their feet disturb the soil and water surface and emerging weeds may be pressed into the mud, uprooted or physically damaged (Wei *et al*., 2019). Repeated disturbance can reduce the ability of young weeds to establish themselves.

Stirring of soil and water

The movement of ducks through standing water keeps the soil-water interface disturbed. This can interfere with the establishment of newly germinated weeds. Research from southern China demonstrated the importance of this physical means of duck-based weed management. Duck grazing combined with disturbance reduced weed biomass by about 98% compared with rice monoculture, whereas disturbance alone reduced weed biomass by approximately 84 %. (Zhang *et al*., 2009). These findings indicated that the weed-suppressive effect of ducks involves both feeding and physical disturbance.

Nutrient recycling

Duck excreta deposited in rice fields can serve as an organic nutrient source, supplying nutrients to the crop production system and strengthening the integration between livestock and crop production. In rice-duck system, this process facilitates on-farm nutrient recycling by returning nutrients from livestock production to the rice field, thereby reducing nutrient losses and dependence on external inputs (Khumairoh *et al*., 2021). However, nutrient recycling through duck excreta should not be regarded as a complete substitute for balanced crop nutrient management. The amount of nutrients contributed by ducks varies with factors such as stocking density, duration of field access, feed availability and overall management practices. Therefore, the nutrient contribution from ducks should be considered as a complementary component of an integrated nutrient management strategy rather than a sole source of crop nutrients.

Timing of ducklings release

Timing of duck introduction is critical for effective rice-duck integration. Ducks should be released only after rice seedlings are sufficiently established to avoid trampling and physical disturbance (Suh, 2014). Studies conducted under the agroecological conditions of Tamil Nadu have evaluated duck release at different stages between 20 and 40 days after transplanting (DAT), with controlled access demonstrating effective weed suppression. The optimum timing of duck introduction depends on several factors, including rice variety, crop establishment method, duck size, water depth and prevailing field conditions. Therefore, duck access should be carefully regulated according to the crop growth stage, with the duration of grazing adjusted to minimize crop damage while maintaining effective weed control.

How Ducklings Suppress Weeds

The weed-management potential of ducks is best understood as a combination of biological feeding and mechanical disturbance.

Grazing of young weeds

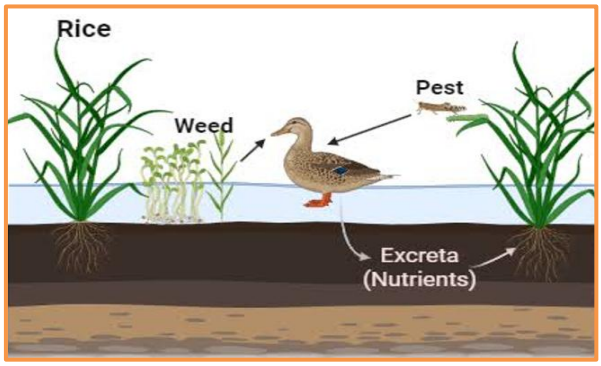
Ducklings actively forage in the wet rice environment, where they consume small weeds and soft vegetation. Repeated grazing helps suppress weed growth and reduces weed biomass, thereby limiting competition for light, nutrients, space and supporting better rice crop establishment.

Disturbance of emerging weeds

Weed seedlings are especially sensitive to repeated physical disturbance. Duck movement through the field can uproot small weeds or bury them in the mud. Continuous disturbance therefore prevents newly emerged weeds from becoming established (Wei *et al*., 2019).

Suppression of aquatic weeds

Rice fields contain a diverse range of aquatic and semi-aquatic weeds. Because ducks are well adapted to foraging in shallow water, they can feed on vegetation occurring both above and below the water surface. Their foraging and movement can therefore contribute to weed suppression and complement conventional weed-management practices in flooded rice systems.



Reduction in weed biomass

The ultimate result of grazing and disturbance is a reduction in weed biomass. Reduced weed biomass decreases competition with rice crop for available resources. When weed growth is suppressed during critical stages of rice development, the crop can effectively utilize available resources both below and above ground. Importantly, duck-based weed management should not be viewed as a universal replacement for all other weed-management methods (Du *et al*., 2025). Its effectiveness depends on several factors like weed community, crop establishment, water management, duck stocking density and duration of grazing.

Weed Species Affected

Rice-duck systems can suppress diverse weed species including *Monochoria vaginalis*, *Cyperus difformis*, *Fimbristylis miliacea*, *Lindernia procumbens* and *Echinochloa* spp. Weed response varies with species, growth habit, palatability, size and field condition; suppression may occur through direct consumption, trampling or physical disturbance. In Azolla-Aigamo-rice systems, *Echinochloa crus-galli* was suppressed by Azolla cover, while *Cyperus difformis* and *Lindernia* spp. were consumed by ducks. Thus, combining complementary biological components can improve suppression across different weed niches (Khumairoh *et al*., 2021).

Stocking Density and Field Management

Stocking density is a key factor influencing the efficiency of weed control in rice–duck systems. Low stocking densities may result in insufficient weed suppression, whereas

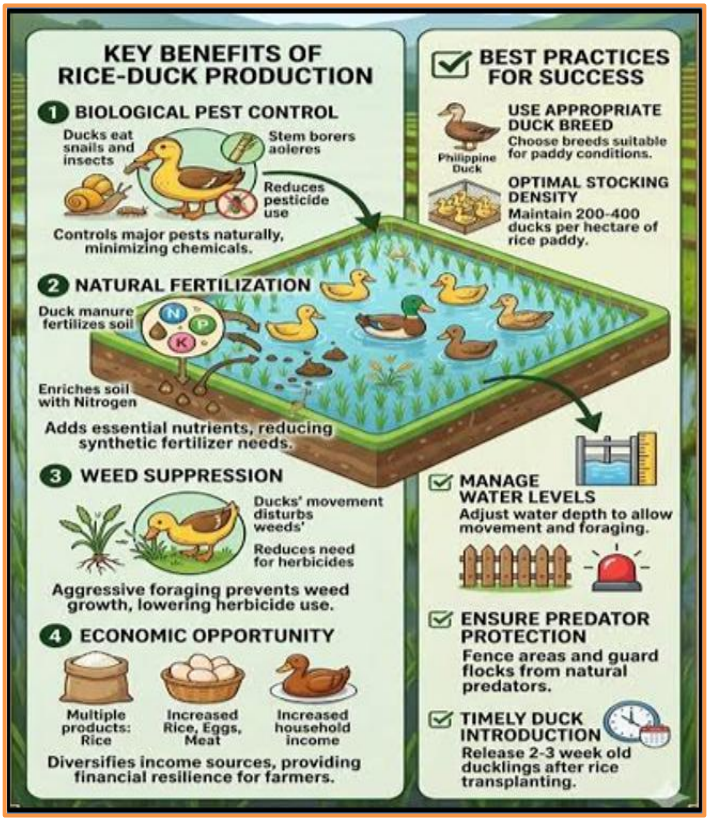
excessively high densities can increase crop disturbance and create additional management challenges. The appropriate stocking rate depends on several factors, including rice establishment method, duckling age and size, field area, water depth, weed pressure, availability of natural food, grazing duration, rice variety, fencing and supplementary feeding. Reported stocking rates of 375 ducks ha^{-1} and 300 Khaki Campbell ducks ha^{-1} illustrate that appropriate densities are system-specific rather than universally applicable (Thavaprakaash *et al*., 2026). Therefore, stocking density and grazing duration should be adjusted according to crop condition, duck behaviour, weed pressure and local field conditions, with complementary weed-management practices adopted when necessary.

Rice Growth and Crop Safety

Rice-duck integration should suppress weeds without impairing crop establishment or yield. Ducks should be introduced only after seedlings are sufficiently established to minimize uprooting and physical damage. Controlled grazing based on crop stage and weed pressure is preferable to continuous access. Field bunds, openings and temporary fencing should be maintained to prevent duck escape and protect adjacent crops.

Additional Benefits of Rice-Duck Integration

Rice-duck integration provides several benefits beyond weed control. Ducks can help manage insect pests through natural foraging (Li *et al*., 2019), while their manure recycles nutrients and organic matter back into the rice field. The system also diversifies farm income by providing products such as meat, eggs, or ducklings (Thavaprakaash *et al*., 2026). Effective duck grazing may further reduce the need for manual or chemical weed control, potentially lowering labour and input costs.



Integrated farming approach

Rice-duck farming represents a broader integrated farming concept in which different farm enterprises interact with one another. Rice serves as the main crop environment, while ducks utilize biological resources within the field and return nutrients through manure. Weed biomass and insects become part of the food resource available to the ducks, creating interactions between crop production and livestock rearing.

Rice-Duck Farming as an Ecological Weed Management Strategy

Rice-duck farming is a multifunctional ecological weed management system in which ducks suppress weeds through grazing, foraging and physical disturbance, while also contributing to insect regulation and nutrient recycling through manure. Effective implementation requires management based on rice growth stage, duck age, water depth and weed pressure**,** along with adequate housing, supplementary feed, labour, fencing and predator protection. Weed suppression is generally more effective under shallow-water conditions and at early weed growth stages**.** Since ducks may not adequately control dense or mature weeds, their use should be integrated with complementary cultural and biological weed-management practices when necessary.

Limitations and Precautions

Despite its potential, rice-duck farming has several limitations. Improper release timing or excessive stocking may cause crop damage, while inadequate stocking may reduce weed-control efficiency. Effective management requires secure bunds and fencing, predator protection, appropriate water depth and adequate feed**,** including supplementation when natural resources are insufficient. Weed suppression may also vary with weed species and growth habit**,** as some weeds are less palatable or accessible to ducks. In addition, the system requires regular labour and monitoring of both rice and ducks to maintain crop safety and production efficiency (Suh, 2014). These limitations emphasize that ducklings should be considered as one component of integrated weed management rather than as a universal replacement for all weed-control methods.

Practical Guidelines for Farmers

For successful implementation of duck-based weed management in rice, the following principles can be considered:

1. **Establish the rice crop first.** Avoid introducing ducklings immediately after transplanting when seedlings are vulnerable to uprooting.
2. **Introduce healthy ducklings.** Select active and healthy birds suitable for the local production system.
3. **Use controlled stocking.** Adjust duck numbers according to field size, crop stage and weed pressure.
4. **Regulate grazing duration.** Controlled exposure can reduce the risk of crop damage.
5. **Maintain adequate water depth.** The field should provide conditions that permit both rice growth and duck movement.
6. **Protect field boundaries.** Maintain bunds and use fencing where necessary.
7. **Monitor weed growth.** Observe whether ducks are effectively suppressing weeds across the entire field.
8. **Monitor rice plants.** Remove or restrict ducks if crop damage becomes evident.
9. **Provide supplementary feed when required.** Natural field resources may not always be sufficient for duck growth and production.
10. **Integrate with other practices.** Where duck grazing alone is insufficient, combine it with suitable cultural, mechanical or biological weed-management practices.

Conclusion

Rice-duck integration is a multifunctional biological weed-management strategy in which duck grazing, trampling, soil and water disturbance, weed uprooting and nutrient recycling contribute to weed suppression. Its effectiveness depends on appropriate duck release timing, stocking density, grazing duration, crop establishment, water management and field infrastructure. Reported densities of 250 ducks ha^{-1} should be considered system-specific rather than universal recommendations. With suitable local adaptation and management, rice-duck farming can enhance weed control, nutrient cycling, insect regulation and farm diversification, providing an ecologically based alternative or complement to conventional weed-management practices.

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