Controlling Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms in Beel Gajna, Pabna, Bangladesh- A Management Plan

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ABSTRACT

Water hyacinth *(Eichhornia crassipes* (Mart.) Solms*)* poses a significant challenge in many parts of the world, prompting the application of diverse management techniques, including physical and mechanical removal, chemical methods, and biological control. Despite these efforts, an effective control strategy remains elusive.

This paper explores the multifaceted nature of water hyacinth, acknowledging its advantageous roles such as phytoremediation, biomass for biogas production, animal feed, compost, vermicompost, green manure, and raw material for various products. While water hyacinth traditionally served beneficial purposes, its proliferation, particularly in areas like Beel Gajna in Bangladesh, has become a major obstacle to crop cultivation, particularly onion farming.

The paper underscores the harmful and beneficial aspects of water hyacinth, emphasizing the need for immediate management in specific regions, notably Beel Gajna. It delves into the role of different control methods and proposes an emphasis on physical or manual removal from farmers' fields to address the limitations associated with other physical methods.

Keywords: Beel Gajna, management, control methods, uses, water hyacinth.

INTRODUCTION

Water is indispensable for life, and its significance cannot be overstated. However, the rampant proliferation of water hyacinth, a free-floating aquatic plant, poses a serious threat globally. Considered one of the most invasive weeds, water hyacinth's rapid growth, adaptive survival strategies, and profound impact on the environment, ecosystems, human health, and socioeconomic development have garnered attention (Hill et al., 2011).

With a doubling population rate every 5–15 days, water hyacinth thrives in warm temperatures (28 to 30 ºC) and nutrient-rich, slow to stagnant water environments (Ojeifo et al., 2000; Ntiba et al., 2001; Sharma et al.,

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2016). Its complex root system leads to the formation of dense mats, disrupting boat navigation, fishing, and causing blockages in canals. Furthermore, it impedes the penetration of light, dissolved oxygen, and essential nutrients, adversely affecting the ecology of water bodies. The consequences include reduced fish catch, hindrance to water supply, and the proliferation of disease-carrying organisms such as mosquitoes, snails, and snakes, while also displacing native flora and fauna (Malik, 2007).

Originating from South America, water hyacinth has become a pervasive issue in the tropics and subtropics since the early 20th century, affecting Central America, North America, Africa, India, Asia, Australia, New Zealand, and notably, Bangladesh (Bartodziej and Weymouth, 1995; Brendonck et al., 2003; Lu et al., 2007; Jimenez and Balandra, 2007; Hill et al., 1997).

While water hyacinth historically played a positive role, particularly in creating floating beds for seedling growth in the southern parts of the country, it has become a major problem in areas such as Beel Gajna, causing significant hindrances in crop cultivation, especially for onions.

The imperative for effective water management is clear, necessitating strategies to ensure safe utilization and the sustenance of life. Numerous techniques, including physical and mechanical removal, chemical methods, and biological control, are employed worldwide for water hyacinth management. However, integrated approaches utilizing multiple methods have yet to yield effective control strategies (Sharma et al., 2016; Byrne et al., 2010; Hill et al., 1997, 2011; Roberto et al., 2019).

This paper addresses both the detrimental and beneficial aspects of water hyacinth, explores various management methods, and focuses on immediate management strategies in Bangladesh, with special attention to Beel Gajna and the utilization of diverse control methods (Sharma et al., 2016; Byrne et al., 2010; Hill and Olckers, 2001).

IMPACTS OF WATER HYACINTH

The proliferation of water hyacinth exerts detrimental effects on the environment, human health, and economic development, particularly evident in the current crisis in Beel Gajna, Pabna. The vast landmass, designated for onion and other crop cultivation, is significantly impeded by the overwhelming presence of water hyacinth.

The dense mats formed by water hyacinth contribute to the blockage of rivers and canals, disrupting crucial aspects of infrastructure such as irrigation, power generation, and navigation. This interference extends to a reduction in fish catch, disruptions in water supply, and the fostering of breeding grounds for mosquitoes, snails, and snakes. Additionally, the invasive plant leads to the exclusion of native flora and fauna, further upsetting the ecological balance (Mailu, 2001; Masifwa et al., 2001; Mironga, 2004; Plummer, 2005).

Furthermore, water hyacinth plays a role in preventing stratification by stabilizing pH levels and temperature within lotic systems (Giraldo and Garzon, 2002). This stabilization, however, comes at a cost, as it adversely affects the productivity of phytoplankton, causing a ripple effect through the aquatic ecosystem. The plant’s tendency to exclude native vegetation and associated fauna exacerbates the imbalance within aquatic systems (McVea and Boyd, 1975; Brendonck et al., 2003; Mangas-Ramirez and Elias-Gutierrez, 2004).

In summary, the impacts of water hyacinth extend beyond the physical obstruction of water bodies, encompassing a wide array of ecological and economic disruptions, demanding urgent attention and effective management strategies in affected regions like Beel Gajna.

USES OF WATER HYACINTH

Water hyacinth, considered a pervasive issue, presents an opportunity for large-scale management through utilization in various applications (Goswami and Saikia, 1994; Sharma et al., 2016). Its versatility is showcased in multiple domains, making it an attractive resource for sustainable practices.

One of the notable applications of water hyacinth is in phytoremediation, where its rapid growth and ability to thrive in heavily polluted water contribute to the extraction of heavy metals, bio absorption of pollutants, and degradation of dyes (Macek et al., 2004; Xia et al., 2003). The plant’s potential for phytoremediation arises from its significant biomass production and metal ion accumulation capabilities (Xia and Ma, 2006; Malik, 2007).

Water hyacinth emerges as an efficient and economical alternative for accelerating the removal of agro-industrial wastewater polluted with heavy metals and various pollutants. Its low lignin content positions it as a valuable source of lignocellulosic biomass, suitable for biofuel and biomass production (Mishima et al., 2008; Sagar and Kumari, 2013).

The plant’s rapid growth and substantial biomass make it an attractive source for biogas production, ensuring a continuous supply of biomass for methane production. Rich in nitrogen and featuring a high C/N ratio, water hyacinth becomes a valuable substrate for animal and fish feed, addressing nutritional challenges in developing countries (Chanakya et al., 1993; Jafari, 2010).

Beyond its role in agriculture, water hyacinth serves as compost, vermicompost, and green manure, enhancing the productivity of various crops and vegetables (Abbasi and Ramasamy, 1996; Ismail, 1997). Its medicinal applications have been explored, further expanding its potential utility (Oudhia, 1999; Ogunlesi et al., 2010).

Water hyacinth’s value extends to industrial applications, serving as a carbon source for cultivating microorganisms and producing essential products like cellobiase, CMCase, FPI cellulose, and riboflavin (Gulati, 1980; Ismail et al., 1995).

Additionally, it can be used as a raw material for manufacturing pulp, paper, rope, baskets, and various other products, fostering small-scale industries in multiple countries (Jafari, 2010; Thyagarajan, 1983; Goswami and Saikia, 1994).

In rural areas, water hyacinth can serve as fuel for cooking, leveraging its ready availability, and the resulting ash can be utilized as fertilizers in crop fields. While water hyacinth has historically been beneficial for cultivating various crops on floating beds, its current impact on farmers in Beel Gajna, Pabna, necessitates innovative solutions. The Bangladesh Agriculture Research Institute’s ongoing efforts to enhance floating cultivation methods offer hope for addressing the water hyacinth challenge in Beel Gajna and beyond.

METHODS OF CONTROL OF WATER HYACINTH

Water hyacinth poses a formidable challenge once established, making the primary objective of management efforts the minimization of economic costs and ecological damage. Various physical, mechanical, and chemical methods have been employed for water hyacinth management; however, these approaches often prove expensive and unsatisfactory. A sustainable, long-term solution lies in biological control, which plays a pivotal role in water hyacinth management. Nonetheless, it’s essential to recognize that no single method is universally suitable for all situations (Byrne et al., 2010; Osmond and Petroeschevsky, 2013).

Biological control emerges as the most promising avenue for long-term and effective water hyacinth management. While physical, mechanical, and chemical methods have been utilized, their limitations and associated costs highlight the need for sustainable alternatives. The adaptability and resilience of water hyacinth make it crucial to explore diverse strategies, with biological control standing out as the most viable long-term solution.

Recognizing the inherent challenges, Byrne et al. (2010) and Osmond and Petroeschevsky (2013) underscore the significance of a comprehensive and adaptable approach. Biological control methods, incorporating the use of natural predators or competitors, present a promising avenue for managing water hyacinth sustainably. This approach not only addresses the existing infestations but also mitigates the risk of recurrence.

In conclusion, the complexities of water hyacinth management necessitate a shift towards sustainable and long-term solutions, with biological control methods demonstrating the most potential. Recognizing the need for adaptability and context-specific strategies, ongoing research and implementation efforts are crucial for effectively managing water hyacinth infestations and minimizing their adverse impacts.

Physical Methods of Water Hyacinth Control

The manual extraction of water hyacinth stands as the historically prevalent and most effective form of control, surpassing mechanical, chemical, and biological alternatives (Elenwo and Akankali, 2019; Osmond and Petroeschevsky, 2013). This method offers several advantages, such as environmental friendliness, suitability for small areas, complete eradication of water hyacinth, high potential for job creation, and poverty alleviation. Importantly, it avoids water contamination with herbicides, and the extracted plant material can be repurposed as biomass or natural materials. In countries like Bangladesh, this method holds promise as a means of employment creation.

However, physical methods are not without drawbacks. They entail high costs, substantial labor requirements, and challenges in the disposal of extracted weed. This method proves inefficient for extensive areas or dense infestations due to the exorbitant clearing costs. In large areas, labor faces difficulties, exacerbated by potential risks from aquatic animals like snakes and crocodiles. Additionally, the use of water-based vehicles, such as boats and steamers, is necessary for water hyacinth removal, further complicating the process. Leftover seeds and plant fragments pose a risk of rapid reformation.

Despite these challenges, the manual removal approach minimizes the creation of large volumes of decaying plant matter in water bodies, mitigating the risk of eutrophication and fish kills (Elenwo and Akankali, 2019).

The trade-offs between effectiveness and challenges underscore the importance of carefully considering physical methods for water hyacinth control, particularly in smaller, localized efforts where the benefits can be maximized.

Mechanical Control of Water Hyacinth

Mechanical control methods for water hyacinth encompass harvesting and in situ cutting, each with distinct advantages and disadvantages (Roberto et al., 2019). While offering benefits, a mechanical control strategy comes with inherent challenges.

Harvesting water hyacinth mechanically is labor-intensive and constrained by physical limitations. However, it does not impose water use restrictions and demands minimal technical expertise (Villamagna and Murphy, 2010). Immediate benefits include the creation of physical space for fish, boat traffic, fishing,

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and recreational activities.

In the case of in situ cutting, water hyacinth plants are left to decompose in the water, influencing dissolved oxygen levels and trophic structure. This process, akin to the physical method, accelerates eutrophication and can contribute to subsequent increases in water hyacinth or algae blooms (Perna and Burrows, 2005; Bicudo et al., 2007). The disposal of water hyacinth from polluted water bodies becomes a critical consideration due to its contaminant-absorbing capacity. In some instances, the cost of offsite disposal areas may surpass the removal process itself (Thayer and Ramey, 1986).

However, mechanical control faces challenges, particularly for large areas of water hyacinth, requiring expensive cutting or dredging equipment (Villamagna and Murphy, 2010). Similar to physical methods, seeds and plant fragments left behind can lead to rapid reformation, and decaying plant matter in water bodies poses risks of eutrophication and fish kills (Elenwo and Akankali, 2019).

In evaluating mechanical control, the trade-offs between immediate benefits and long-term consequences underscore the need for careful consideration and integrated approaches to effectively manage water hyacinth.

Chemical Methods of Water Hyacinth Control

Chemical control offers immediate impact on both high and low-density water hyacinth infestations in large or small areas, achieving results within six weeks of application (Guitierrez-Lopez, 1993). The herbicides employed in chemical control completely kill off the plants, minimizing the risk of regrowth from leftover plant material, a common issue in manual and mechanical control methods (Roberto et al., 2019). Chemical control proves less labor-intensive and more cost-effective than mechanical control, particularly on a large scale (Villamagna and Murphy, 2010).

Despite its efficacy, chemical control has notable disadvantages and potential negative environmental impacts (Julien et al., 1999). Concerns include water quality problems, spray drift, and the adverse effects of herbicides on non-target organisms. The use of herbicides may lead to contamination of sites used for drinking water, washing, and fishing, posing threats to human health (Villamagna and Murphy, 2010). Proper use of herbicides demands specialized training and safety measures, and it is found to be harmful to microorganisms and non-target plants that provide habitat for other organisms, negatively affecting fish production.

Chemical control may become expensive if repeated applications are necessary, and herbicides are less selective compared to mechanical or manual methods (Villamagna and Murphy, 2010). Effective herbicides include Bispyribac, Diquat, Glyphosate, Imazamox, Imazapyr, Penoxsulam, Triclopyr, 2,4-D, and Florpyrauxifenbenzyl, with different modes of action (Seagrave, 1988; Gutierrez et al., 1994; Lugo et al., 1998). Some are systemic herbicides, absorbed by the green parts of the plant, while others like Diquat are contact herbicides, acting quickly compared to systemic counterparts (Neves et al., 2002; Emerine et al., 2010; Gettys et al., 2014; Garlich et al., 2019).

New herbicides are continually being explored, but water use restrictions mandated by law following herbicide spraying can have significant socio-economic impacts if the beneficial or designated uses of the water body are affected (Villamagna and Murphy, 2010). Certain compounds such as acetic acid, citric acid, formic acid, and propionic acid have also shown effectiveness in water hyacinth control (El-Shahawy, 2015).

Biological Methods of Water Hyacinth Control

Biological control stands out as the most efficient and environmentally safe method for managing water

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hyacinth, particularly for achieving long-term results (Hill and Olckers, 2001). Embraced worldwide, this approach offers relatively low-cost requirements and sustainability over an extended period. In comparison to mechanical and chemical control, biological control provides a viable alternative, avoiding the introduction of toxic chemicals into the environment, requiring minimal labor or equipment, and holding the potential to be self-sustaining (Seagrave, 1988; Villamagna and Murphy, 2010; Koutika and Rainey, 2015).

Key biological control options for water hyacinth include various insect species, introduced plant pathogens, and allelopathic plants (Coetzee et al., 2007; Jimenez and Balandra, 2007; Malik, 2007). Highly virulent fungal parasites, such as *Acremonium zonatum*, *Alternaria alternata*, *A. eichhorniae*, *Bipolaris spp.*, *Fusarium chlamydosporum*, *Helminthosporium spp.*, *Cercospora rodmanii*, *Myrothecium roridum*, *Rhizoctonia solani*, and *Uredo eichhorniae*, have been identified as potential bioherbicides, known for causing diseases in water hyacinth. These fungi are cost-effective to produce and show promise for bioherbicide development (Coetzee et al., 2007).

Insects like *Neochetina eichhorniae* and *Neochetina bruchi*, originating from the plant’s native range, are commonly used weevil species for biological control. Additionally, aqueous leachate of *Lantana camara* has been observed to effectively combat water hyacinth. Fungal mycoherbicides derived from *Cercospora rodmanii* have demonstrated enhanced effectiveness in the presence of *Neochetina* weevils. The allelopathic potential of certain plants presents an opportunity for short-term bio-control, ensuring the safety of non-target flora and fauna. The utilization of bioherbicides has garnered significant attention in the ongoing efforts to manage water hyacinth effectively.

IMMEDIATE PLAN FOR WATER HYACINTH MANAGEMENT IN BEEL GAJNA

In addressing the urgent water hyacinth issue in Beel Gajna, a practical and immediate approach involves the physical or manual removal of water hyacinth from farmers’ fields. Farmers can swiftly collect the water hyacinth, storing them in their fields. To expedite decomposition, various microorganisms mentioned in the biological control section, along with a diluted solution of molasses, can be employed. Effective microorganism products like Trichoderma, available in markets, can also facilitate decomposition. Alternatively, after volume reduction and partial drying, burning the water hyacinth in the field is an option, with residues utilized as fertilizers. However, the labor-intensive and time-consuming nature of these methods, coupled with extra economic losses, challenges their cost-effectiveness.

Under the current circumstances, providing incentives to real farmers becomes crucial. The appropriate authority could offer non-refundable cash incentives per Bigha of land or extend soft loans to support onion cultivation. Failure to cultivate onions in Beel Gajna could result in a significant nationwide onion production shortfall, as the area is a major onion producer. Integrating physical removal with herbicides, biopesticides, and biological entities forms a comprehensive strategy for water hyacinth management in Beel Gajna. The mechanical control method, involving machine-based removal, may be applicable in other regions facing water hyacinth issues, like Esamoti Rivers in Pabna.

Despite controversies, herbicides remain a popular technique for global aquatic weed control, offering reliability despite water and media pollution concerns. Given the impracticality of physical and mechanical methods in Beel Gajna, the chemical method emerges as a crucial approach for immediate water hyacinth control, especially for onion cultivation. Biological control presents a sustainable alternative, but current deficiencies in pathogens, bioherbicides, and allelopathic plants hinder its immediate application. A comprehensive Control Plan should incorporate a water hyacinth survey map, suitable control methods, required resources, labor, equipment, safety measures, training needs, involvement of other stakeholders, and a budget with funding sources to ensure effective implementation.

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