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TRADE OFF INDUSTRY LOCAL: ESTIMATING FOREGONE AGRICULTURAL PRODUCTION POTENTIAL ASSOCIATED WITH BATIK INDUSTRY WASTEWATER

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Abstract

The batik industry in Pamekasan Regency provides economic benefits through income and employment, while wastewater management may affect the productive use of agricultural land. This study estimates the value of foregone agricultural production potential associated with agricultural land affected by batik wastewater. Data were collected through questionnaires from 74 batik business operators and secondary data on agricultural productivity and commodity prices. Using the Potential Production Loss Approach, the estimated annual value of foregone agricultural production potential for tobacco, corn, and cassava was Rp5,493,312. This figure, equivalent to about Rp74,234 per business per year, represents potential production associated with the affected land rather than a directly measured or causal economic loss. Tobacco accounts for the largest estimated value of foregone production potential, primarily because of its higher market price compared with cassava and corn. The findings provide an economic perspective on the potential implications of wastewater management for agricultural land use and highlight the importance of considering environmental management alongside the economic activities of the batik industry.

Kata Kunci:

Lahan Pertanian;
Limbah Batik;
Valuasi Ekonomi;
Produksi yang Hilang;
Biaya Peluang;
Pamekasan;

Abstrak

Industri batik di Kabupaten Pamekasan memberikan manfaat ekonomi melalui pendapatan dan lapangan kerja, sementara pengelolaan limbah cair berpotensi memengaruhi pemanfaatan produktif lahan pertanian. Penelitian ini bertujuan mengestimasi nilai potensi produksi pertanian yang hilang pada lahan yang terdampak limbah cair batik. Data diperoleh melalui kuesioner terhadap 74 pelaku usaha batik serta data sekunder mengenai produktivitas pertanian dan harga komoditas. Menggunakan *Potential Production Loss Approach*, estimasi nilai tahunan potensi produksi pertanian yang hilang untuk tembakau, jagung, dan singkong mencapai Rp5.493.312. Nilai tersebut, atau sekitar Rp74.234 per usaha per tahun, merupakan estimasi potensi produksi pada lahan terdampak, bukan kerugian ekonomi aktual yang diukur secara langsung atau bersifat kausal. Hasil estimasi menunjukkan bahwa tembakau memiliki nilai potensi produksi yang hilang paling besar, terutama karena harga pasarnya lebih tinggi dibandingkan dengan singkong dan jagung. Temuan ini memberikan gambaran mengenai potensi implikasi ekonomi dari pengelolaan limbah cair terhadap pemanfaatan lahan pertanian serta pentingnya mempertimbangkan pengelolaan lingkungan dalam aktivitas ekonomi industri batik.

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INTRODUCTION

Economic growth in developing countries is driven by the development of the industrial sector, particularly small and medium-sized enterprises (SMEs). SMEs in developing countries play a key role in absorbing the labor force and can even serve as the primary engine of poverty alleviation and socioeconomic development (Irawan & Sukiyono, 2021). This sector has proven capable of strengthening the national economy by creating numerous new jobs and increasing community income (Sibiya et al., 2023). Generally, SMEs are categorized into several key sectors, such as food, chemicals and building materials, metals and electronics, as well as apparel and handicrafts. A key characteristic of SMEs is their ability to employ a large workforce (Pedraza, 2021). Among the various types of SMEs that have emerged, the apparel and handicrafts sector holds a strategic position in the national economic structure due to its significant contributions to GDP, employment, and exports (Suryanto et al., 2021). Batik can serve as a driver of the local economy by generating jobs, improving community well-being, and strengthening the culture-based creative economy (Sugiardi et al., 2023; Viky & Zakik, 2023).

In Indonesia, the batik industry is one of the key creative sectors that operates dynamically and provides tangible secondary economic benefits through job creation, household income, tourism, and the strengthening of the local economy (Sugiardi et al., 2023; Viky & Zakik, 2023). Batik fabric is not only produced as a high-value clothing commodity but is also developed as a globally recognized cultural heritage (Ladini et al., 2025). The contribution of the batik industry in East Java Province, which has developed local batik centers, serves as a driving force for the people's economy (Kharisma & Herdiansyah, 2024). The growth of the batik industry has extended to the regional level, notably in Pamekasan Regency, which is widely known as the area with the highest concentration of artisans and producers of hand-drawn batik on Madura Island. Batik businesses in the regency comprise 349 units spread across nine subdistricts, as shown in Table 1 (Dinas Perindustrian dan Perdagangan Kabupaten Pamekasan, 2025).

The village of Klampar in Pamekasan Regency has been designated as a center for the batik industry, which is one of the region's key sectors (Sugiardi et al., 2023). The characteristics of batik in western East Java differ from those of Pamekasan batik, whose production tends to be dominated by large-scale traditional hand-drawn batik and relies on the skills of the local community (Hakim & Rufaidah, 2021). The direct involvement of the majority of the community as artisans is able to drive household economies through production activities that have been passed down from generation to generation (Hakim & Rufaidah, 2021; Viky & Zakik, 2023). In terms of products, Pamekasan batik is highly competitive in the national market due to its distinctive, bold patterns and vibrant colors (Triandika & Dewi, 2022). These strengths are further reinforced by local government policies that actively prioritize the batik industry as a key program in regional economic development. Table 1 provides a concrete illustration of the potential of the batik industry across various subdistricts in Pamekasan Regency.

Table 1.
Distribution of Batik Business Units in Pamekasan Regency

Subdistrict	Number of Business Units
Galis	10
Kadur	17
Larangan	16
Pademawu	2
Palenggaan	76
Pamekasan	54
Pegantenan	16
Proppo	154

Subdistrict	Number of Business Units
Tlanakan	4
Total	**349**

Source: Dinas Perindustrian dan Perdagangan Kabupaten Pamekasan (2025)

The presence of hundreds of these businesses provides significant financial benefits to batik entrepreneurs while creating extensive employment opportunities for rural communities (Viky & Zakik, 2023). Job creation, coupled with increased community income, reflects improved economic well-being (Tantra & Anandari, 2025). However, the rapid growth of the batik industry faces major challenges related to waste management, which threaten the principles of sustainable development (Vibriyanto et al., 2025). The concept of sustainable development emphasizes that economic growth should meet present needs without compromising environmental sustainability, other economic sectors, or the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

The batik production process involves several complex stages, ranging from dyeing, boiling the wax, washing, to rinsing or removing the wax (Zakaria et al., 2023). Each of these stages produces liquid waste containing organic pollutants, solid sediments, extreme acidity levels, oils, fats, and hazardous synthetic substances (Fladinir et al., 2022). The main problem arises because this hazardous wastewater is discharged directly, without treatment, into waterways or onto farmland near where people live (Suci et al., 2024).

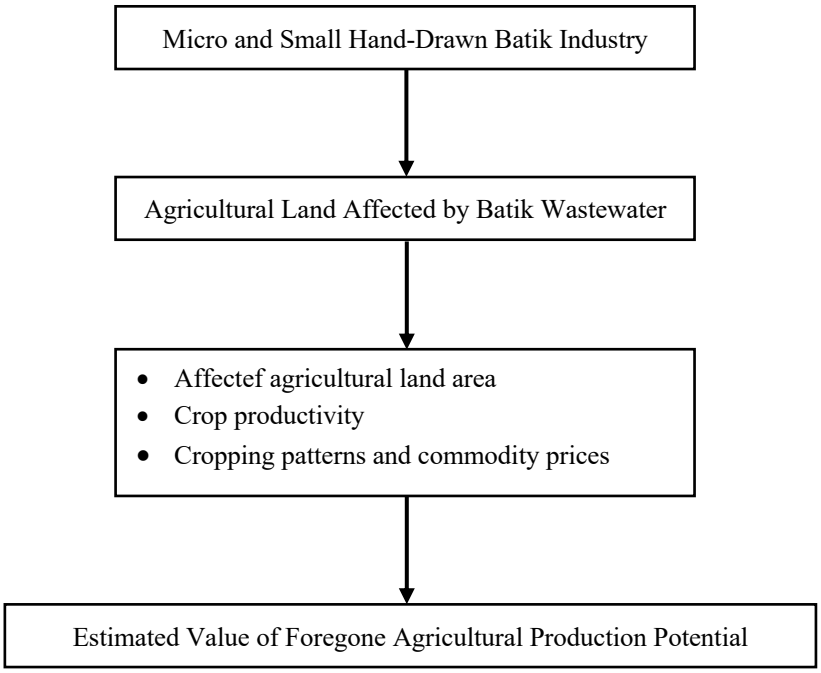
Previous studies have reported that the disposal of untreated industrial wastewater can contribute to environmental degradation, including impacts on agricultural land and soil quality (Handayani et al., 2025). Similarly, Laamouri & Khattabi (2025) reported that environmental degradation associated with economic activities can reduce the productive potential of agricultural land and may generate economic costs related to natural resource degradation. Batik and textile wastewater may also contain chemical compounds that are difficult to degrade and may contribute to environmental pollution (Münzel et al., 2023). These findings are based on previous studies and do not constitute direct measurements of soil quality, water quality, crop contamination, or changes in agricultural productivity in the present study area.

Previous studies have also reported that textile wastewater and synthetic dyes can have environmental impacts when discharged without adequate treatment (Methneni et al., 2021; Ben Slama et al., 2021). Rahman & Mostafa (2024) further reported concerns regarding the quality of irrigation water affected by textile dyeing effluent. These findings provide contextual support for the potential environmental implications of wastewater disposal in agricultural areas.

This situation highlights a potential economic trade-off in the batik industry hub of Pamekasan, where wastewater is discharged onto agricultural land owned or used by batik entrepreneurs. In this context, the potential agricultural production associated with the affected land can be considered a foregone private agricultural benefit, rather than a negative externality borne by unrelated third parties. Although the discharge occurs on private property, the potential productive value of the agricultural land may not be fully realized. Agricultural land has the potential to provide additional income through crop production and diversification, and its productive potential therefore represents an economic consideration for the landholders.

Limitations in the literature stem from the scarcity of studies that estimate the economic value of foregone agricultural production potential associated with batik industry wastewater on agricultural land, and map the commodities that are most vulnerable and suffer the greatest financial impact due to waste pollution. Whereas the study by Sulthonuddin & Herdiansyah (2021) only emphasizes the importance of constructing wastewater treatment plants (WWTP) and raising awareness among business operators. Previous studies have shown a strong tendency to focus on technical and environmental aspects, yet they have neglected the economic dimension as a tangible consequence of batik waste pollution. The study by Abdiyah & Vibriyanto (2026) estimated the economic impacts associated with batik waste pollution in the community through healthcare costs,

expenditures on clean water, and electricity costs as forms of economic impacts borne by households. However, that study did not estimate the foregone agricultural production potential associated with agricultural land affected by batik wastewater disposal. Therefore, this study aims to estimate the value of foregone agricultural production potential associated with agricultural land affected by batik wastewater disposal, taking into account the commodities and annual cropping patterns at the respondent level.



Source: Researcher, 2026

Figure 1. Conceptual Framework Diagram

RESEARCH METHODOLOGY

This study employs a quantitative descriptive approach. The quantitative descriptive approach was used to estimate the monetary value of foregone agricultural production potential in areas affected by batik waste disposal. This study was conducted in Pamekasan Regency, primarily because the area is the center of the batik industry in Madura. However, most batik business owners in this industrial center have not yet utilized a Wastewater Treatment Plant (WWTP), and untreated wastewater is discharged onto agricultural land surrounding the batik production areas. The respondents in this study were batik business owners in Pamekasan Regency who discharge wastewater onto agricultural land. The target population of this study was all batik business operators in Pamekasan Regency who discharge liquid waste onto agricultural land. The sample frame was developed based on the results of field data collection on batik businesses located in five production-center villages: Klampar, Kowel, Larangan Badung, Podhek, and Candi Burung. The study employed total sampling, meaning that all business units meeting the inclusion criteria were included as respondents. The inclusion criteria were: (1) batik businesses operating in Pamekasan Regency, (2) generating liquid waste from the batik production process, and (3) discharging liquid waste directly onto agricultural land used or potentially used for agricultural production. Based on these criteria, a total of 74 batik businesses were selected as study respondents.

The types and sources of data required for this study are primary and secondary data. Primary data were obtained directly from respondents through face-to-face interviews and the distribution of structured questionnaires. Meanwhile, secondary data were collected from publications by the

Pamekasan Industry and Trade Office (*Disperindag*), as well as supporting data on local commodity prices gathered through online searches of publications from the *Siskaperbapo* Jatimprov portal, Pamekasan Hebat, and Antara News.

Data analysis was conducted using the Potential Production Loss Approach to estimate the monetary value of foregone agricultural production potential on agricultural land affected by batik wastewater disposal. The values estimated in this study do not represent actual economic losses measured through a before-and-after comparison of agricultural production. Rather, they represent the estimated monetary value of agricultural production potential on the affected land. The estimates were based on the affected agricultural land area after wastewater spreading, the crops grown by the respondents, crop productivity, and market prices. Calculations were performed for one year, accounting for cropping patterns spanning two growing seasons.

This approach follows the change-in-productivity (effect-on-production) method of environmental valuation, in which the economic value of an environmental impact is estimated from the change in the value of marketed output (Dixon et al., 1994). Stojanov & Dimitrov (2021) apply a similar logic by estimating economic impacts from the value of production affected by disruptions to the production system. In this study, the formula is used to estimate the value of foregone agricultural production potential, as presented below:

$$VLP = \sum_{i=1}^{n}(L_i \times Pr_i \times P_i) \quad \text{.....(1)}$$

Explanation:

VLP (Value of Foregone Production Potential) = Estimated value of lost agricultural production potential (Rupiah/year).

L_i = Affected agricultural land area after wastewater spreading for the i-th commodity (m²).

Pr_i = Average crop productivity per unit area for the i-th commodity (Kg/m²).

P_i = Market price for the i-th commodity type (Rupiah/kg).

i = Reference agricultural commodity type being evaluated.

RESULTS AND DISCUSSION

Batik production in the study area generates liquid waste from dyeing, washing, and wax-removal processes, containing residues of synthetic dyes, wax, detergents, and cleaning soda. Previous studies have documented that untreated textile wastewater may alter soil properties, including soil acidity, pore conditions, and nutrient availability (Periyasamy, 2024), and that heavy metals from textile wastewater may accumulate in soils and crops (Hassan et al., 2024). These parameters were not directly measured in the present study.

The estimated value of foregone agricultural production potential was based on the observed cropping patterns reported by respondents, which included two growing seasons per year. Therefore, the annual estimate represents the cumulative production potential across the two growing seasons. Tobacco is an important agricultural commodity in Pamekasan, with substantial production and economic potential and strong linkages to the cigarette industry (Djazuli et al., 2021). Cassava has agricultural potential in Pamekasan, while corn serves as an alternative food source and livestock feed on dryland, with development potential (Layalie et al., 2024). The estimated values of foregone agricultural production potential for tobacco, cassava, and corn are presented in Table 2.

Table 2.
Estimated Value of Foregone Agricultural Production Potential by Commodity

Commodities	Affected Agricultural Land Area (m^2) (a)	Average Productivity (kg/m^2) (b)	Estimated Production Potential (Kg/Year) (c=a*b)	Market Price (Rp/kg) (d)	Estimated Value of Foregone Production Potential (e=c*d) (Rp/Year)
Tobacco	887.50	0.0431	38.25	Rp64,000	Rp2,448,080
Cassava	628.75	1.754	1,102.83	Rp1,350	Rp1,488,817
Corn	708.75	0.244	172.94	Rp9,000	Rp1,556,415
Total Estimated Value (Rp/Year)					Rp5,493,312

Source: Primary Data (processed), 2026

The estimated values of foregone agricultural production potential associated with agricultural land reported by respondents as receiving batik wastewater are presented in Table 2. Tobacco has the highest estimated value of foregone production potential, amounting to Rp2,448,080 per year. This relatively high estimated value is primarily associated with its substantially higher market price, despite its lower physical productivity per unit of land compared with cassava and corn. In comparison, cassava and corn have lower estimated values of foregone production potential because of their respective market prices and estimated production potentials. These differences also reflect variations in estimated crop productivity per unit of affected land. The estimates represent the potential economic value of agricultural production associated with the affected land and should therefore be interpreted as an estimate of foregone agricultural production potential rather than as a directly measured economic loss caused by batik wastewater.

Table 3
Percentage of Commodities by Cropping Pattern

Crop Pattern	Tobacco & Cassava	Tobacco & Corn	Cassava & Corn
Percentage	36%	45%	19%

Source: Primary Data (processed), 2026

Among the respondents, tobacco was commonly combined with food crops as part of the observed cropping patterns. As shown in Table 3, the most common cropping pattern was tobacco and corn (45 percent), followed by tobacco and cassava (36 percent), while cassava and corn accounted for 19 percent. These patterns indicate that the agricultural land associated with the respondents was used for a combination of cash and food crops across the observed growing seasons. The estimated foregone agricultural production potential presented in Table 2 therefore reflects the potential agricultural value associated with these cropping patterns. The disposal of untreated wastewater onto agricultural land may reduce the opportunity to use the affected land for agricultural production. In this study, this potential effect is represented as a foregone private agricultural benefit rather than as a measured external cost.

Table 4
Estimated Average Annual Foregone Agricultural Production Value

	Batik Production Costs (Rp/year)	Revenue	Profit	Average Annual Foregone Agricultural Production Value (Rp/year)
Value	Rp65,922,000	Rp99,795,000	Rp33,873,000	Rp74,234

Source: Primary Data (processed), 2026

Table 4 presents the reported average annual production costs, revenue, and profit of the batik businesses, together with the estimated average annual foregone agricultural production value. The reported average annual revenue from batik production was Rp99,795,000, with production costs of

Rp65,922,000 and an average profit of Rp33,873,000. In comparison, the estimated average annual foregone agricultural production value was Rp74,234 per respondent. This value was calculated by dividing the total estimated value of foregone agricultural production potential (Rp5,493,312) by the 74 respondents. Therefore, the two values represent different economic measures and should not be interpreted as equivalent types of economic loss. The comparison is intended only to show the magnitude of the estimated agricultural production potential relative to the reported economic performance of batik production.

From an environmental-economic perspective, the reported financial performance of batik production does not account for the foregone private agricultural benefit associated with wastewater disposal onto agricultural land. In this study, this benefit is represented by the estimated value of foregone agricultural production rather than by directly measured environmental damage. The comparison in Table 4 therefore highlights the economic importance of batik production alongside the potential agricultural value of the affected land.

Previous studies have raised concerns about the potential environmental and health implications of using agricultural land affected by textile wastewater for food production. Research by Hassan et al. (2024) reported that vegetables grown in soil contaminated with textile waste may accumulate heavy metals through their roots. Such findings indicate potential concerns regarding food safety when agricultural environments affected by textile wastewater are used for food production. However, the present study did not measure heavy metal concentrations in wastewater, soil, or crops, nor did it assess human health outcomes. Therefore, these potential health and food-safety implications are discussed as findings reported in the literature rather than as empirical findings of the present study.

Table 5
Batik Entrepreneurs' Perceptions of Batik Waste Management

Perception Category	Percentage
Perception of Small Waste Volume	41%
Perception of High WWTP Cost	36%
Perception of Distance from River	23%

Source: Primary Data (processed), 2026.

The reported wastewater disposal practices among batik entrepreneurs varied across business locations. Some respondents reported disposing of wastewater onto vacant land near production sites, while others reported discharging wastewater into residential drainage channels or gutters. For business units located near rivers, some respondents reported direct discharge into nearby water bodies. The perception of a relatively small wastewater volume was reported by 41 percent of respondents, as shown in Table 5. This finding indicates that the perceived quantity of wastewater was one of the considerations reported by respondents in relation to wastewater management. However, this perception does not constitute a direct measurement of the actual wastewater volume generated by each business. The demographic characteristics of the respondents provide additional context for interpreting their reported perceptions. Among the respondents, 42 percent had completed formal education at the junior high school level. This characteristic may be considered when discussing the information and decision-making context of the batik entrepreneurs.

The Theory of Bounded Rationality can provide a theoretical perspective for understanding how business operators make practical decisions under conditions of limited information and resources (Simon, 1955; Desiana et al., 2025). From this perspective, decision makers may rely on information and considerations that are readily available when making business decisions. In the present study, however, bounded rationality is used only as a theoretical perspective for interpreting the reported perceptions and is not directly tested as a causal explanation of wastewater disposal practices.

The availability of wastewater treatment facilities provides additional context for understanding wastewater management in the study area. Previous research has reported that wastewater treatment

facilities in Pamekasan Regency remain limited in relation to the number of batik businesses (Anna et al., 2025). From a rational-choice perspective, production costs and expected financial consequences may be considered in business decision-making (Mareta et al., 2025). In the context of this study, this perspective provides a theoretical interpretation of the reported perception that WWTP costs are high, rather than an empirically tested explanation of individual wastewater management decisions. As shown in Table 5, 36 percent of respondents perceived the cost of wastewater treatment facilities as high. This finding indicates that perceived treatment costs were among the considerations reported by respondents regarding wastewater management.

In this study, the average annual profit reported by batik entrepreneurs was Rp33,873,000, while the reported investment requirement for a batik-specific WWTP was Rp477,753,000 (Schipper & Taufik, 2023). The WWTP investment requirement was approximately 14 times the reported average annual profit of the surveyed batik businesses. This comparison illustrates the relative financial magnitude of individual WWTP investment compared with the annual profitability of the surveyed businesses. However, this comparison does not by itself establish that WWTP costs caused entrepreneurs to choose direct wastewater disposal. The finding that 36 percent of respondents perceived WWTP costs as high indicates that perceived treatment costs were among the considerations reported by respondents regarding wastewater management.

The perception of distance from rivers was reported by 23 percent of respondents (Table 5). This finding indicates that the location of business activities relative to water bodies was another consideration reported by respondents in relation to wastewater management. However, the present study did not directly measure the environmental effects of wastewater discharge based on the distance of business locations from rivers. Therefore, this perception should be interpreted as a reported consideration rather than as evidence that wastewater discharged farther from rivers does not affect environmental quality.

Based on these considerations, cluster-based communal wastewater treatment facilities could be considered as a potential alternative for sharing investment and operational costs among batik businesses (Khasna, 2021). Such an approach may be relevant where individual WWTP investment represents a substantial financial requirement relative to business profitability. Further research is needed to assess the technical feasibility, financing mechanisms, treatment capacity, operational requirements, and environmental effectiveness of such facilities in the local context.

The present study did not directly measure the long-term social and environmental costs associated with inadequate wastewater treatment, such as medical costs, changes in food self-sufficiency, or land degradation. Therefore, these potential impacts should not be interpreted as empirical findings of the present study. Instead, they represent areas that warrant further investigation when assessing the broader economic implications of wastewater management in batik-producing areas.

CONCLUSION AND RECOMMENDATION

Batik industry activities in Pamekasan Regency provide economic benefits through income generation for batik entrepreneurs, while wastewater disposal practices may affect the productive use of agricultural land. Based on the Potential Production Loss Approach, the annual value of foregone agricultural production potential associated with agricultural land affected by wastewater discharge is estimated at Rp5,493,312, or approximately Rp74,234 per business per year. Tobacco accounts for the largest estimated value because of its substantially higher market price, despite its lower productivity compared with cassava and corn. This value is small relative to the average annual profit of batik businesses (Rp33,873,000), indicating that the foregone agricultural production potential is not the main economic consequence of wastewater disposal; the more substantial potential costs may lie in environmental and health-related impacts, which were not measured in this study.

This study is subject to several limitations. The estimated value is based on affected land area, agricultural productivity, and market prices and should not be interpreted as a directly measured or causal economic loss, because it does not rely on a before-and-after measurement of agricultural production or a comparison between contaminated and uncontaminated land. The study also did not directly measure soil quality, water quality, crop contamination, health impacts, or other long-term environmental and social costs, and the economic feasibility and sustainability of wastewater treatment plant (WWTP) management were not analyzed.

Based on the reported perceptions of batik entrepreneurs and the financial magnitude of individual WWTP investment, cluster-based communal wastewater treatment facilities could be considered as one potential approach to share investment and operational costs among batik businesses located in geographically proximate areas. Local government could support such efforts by providing technical assistance and facilitating access to appropriate environmental financing mechanisms. These interventions should be evaluated based on their technical feasibility, financial affordability, treatment capacity, operational requirements, and environmental effectiveness in the local context. Future research should examine the actual effects of wastewater discharge on soil and water quality, agricultural productivity, crop safety, and human health, providing a stronger basis for distinguishing estimated foregone production potential from actual economic losses and for evaluating the broader costs and benefits of wastewater management interventions.

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