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Comparative Study of Marigold Potential (Tagetes spp.) in Russia and Indonesia: Agronomic and Economic Perspectives

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ABSTRACT

This comparative study examines the agronomic and economic potentials of marigold (Tagetes spp.) cultivation in Russia and Indonesia, two regions with contrasting climates and market dynamics. In Russia, marigold farming focuses on short-season, cold-tolerant varieties, leveraging greenhouse technology and advanced bioactive extraction methods to meet demands in pharmaceutical and ornamental markets. Conversely, Indonesia benefits from a tropical climate that supports year-round cultivation, producing marigolds rich in lutein and carotenoids, widely used in traditional ceremonies, cosmetics, and local ornamental markets. Agronomic assessments reveal Russia's higher production costs but competitive advantage in bioactive compound extraction, while Indonesia achieves greater net profits through lower production costs and higher yields. Despite climatic challenges, both countries capitalize on their unique resources and market demands—Russia's technological expertise complements Indonesia's biodiversity and cultural heritage.The study underscores the importance of adapting cultivation techniques and marketing strategies to regional conditions. Collaborative opportunities, such as technology exchange and joint market development, are recommended to enhance the global competitiveness of marigold products from both nations. The findings highlight the diverse applications and market potential of marigold, advocating for tailored approaches to maximize its value across varying agro-economic landscapes.

INTRODUCTION BACKGROUND

Marigold (Tagetes spp.) is a very valuable plant in various industries, including agriculture, pharmaceuticals, cosmetics, and ornamentals. In the agricultural sector, marigold has an important function as a companion plant because of its allelopathic ability to repel certain pests and improve soil quality. Bioactive compounds such as lutein and carotenoids contained in marigold provide great benefits in the pharmaceutical field as antioxidants, antiinflammatories, and anticancer (Aziz et al., 2023). In the cosmetic sector, marigold extract is used in skin care products because of its soothing properties and protecting the skin from free radicals. In addition, marigold is one of the popular ornamental plants because of its bright flower colors and high durability (Chen et al., 2022). Geographical factors, climate, and soil characteristics in Russia and Indonesia influence marigold cultivation patterns in both regions. Russia, with its temperate to cool climate and short growing season, requires the selection of marigold varieties that have a fast life cycle and tolerance to low temperatures (Ivanov & Petrov, 2023). In contrast, Indonesia with its tropical climate and high rainfall provides the advantage of a long growing season but also faces the challenge of high humidity which increases the risk of plant diseases (Yulianto et al., 2023). These geographical differences affect marigold adaptation to the environment, productivity, and harvest quality. The economic value of marigold in Russia and Indonesia also shows great potential but with different focuses. In Russia, the demand for marigold is more for the pharmaceutical and ornamental industries, such as cut flowers and lutein extraction (Smirnov & Kuznetsov, 2024). In Indonesia, marigold has significant cultural and spiritual value, especially in traditional and religious ceremonies, as well as use in cosmetics and ornamentals (Putri et al., 2023). A deeper understanding of this agronomic and economic potential is important to maximize the added value of marigold cultivation in each country.

Problem Formulation

The differences in environmental and socio-economic conditions between Russia and Indonesia raise important questions about the agronomic and economic potential of marigolds in both regions. One of the main questions is how differences in climate, soil characteristics, and cultivation practices affect the productivity and quality of marigolds in each region. Russia faces the constraints of low temperatures and a short growing season, while Indonesia faces the challenge of high rainfall that can trigger plant diseases (Ivanov & Petrov, 2023; Yulianto et al., 2023). From an economic perspective, the question arises how the differences in market needs in the two countries affect the management of the marigold supply chain. Are marigolds in Russia superior for the pharmaceutical bioactive market, while marigolds in Indonesia are more competitive for the ornamental and traditional markets? In addition, an analysis of production costs, selling value, and access to technology in the two countries needs to be carried out to identify the competitiveness of each country in the global market (Smirnov & Kuznetsov, 2024).

Thus, this study is designed to answer the following questions:

1. What are the agronomic differences, such as productivity and climate resistance, between marigolds cultivated in Russia and Indonesia?
2. How do the economic values and development prospects differ between the two regions?

Research purposes

This study aims to identify differences in growing conditions, yield, quality, and added value of marigold products cultivated in Russia and Indonesia.

1. Agronomic Aspects: Evaluating the nutritional requirements, climate adaptation, productivity, and quality of marigold in each country based on environmental and yield data. This study will help determine the most suitable varieties for each region (Aziz et al., 2023; Ivanov & Petrov, 2023).
2. Economic Aspects: Reviewing production costs, selling prices, and market potential of marigolds in Russia and Indonesia, including analysis of competitiveness in local and global markets (Smirnov & Kuznetsov, 2024; Yulianto et al., 2023).
3. Strategic Recommendations: Provide guidance on location-specific cultivation technologies, superior varieties, and marketing strategies appropriate for local and international markets.

LITERATURE REVIEW

Marigold in Russia

Marigolds (Tagetes spp.) in Russia, including varieties like Kilimanjaro and Lemon Queen, are cultivated for their adaptability to short seasons and cold climates (Ivanov & Petrov, 2023). Greenhouses and techniques like plastic mulching and drip irrigation are employed to mitigate temperature extremes and improve yields (Novikova & Kuznetsov, 2023). Marigold farming focuses on producing bioactives such as lutein and carotenoids, valued in the pharmaceutical and cosmetic industries (Petrov et al., 2022). Additionally, marigolds serve as companion plants in crop rotations, reducing pests and enhancing soil quality through allelopathy (Smirnov & Kuznetsov, 2024). Research highlights the challenge of cold climates, with temperatures below 10°C stunting growth, necessitating innovations like warm seed treatments and organic fertilizers (Ivanov et al., 2023). Despite these challenges, Russian marigolds are competitive in global markets due to their high bioactive content (Kuznetsova et al., 2023).

Marigold in Indonesia

Indonesia's tropical climate supports year-round cultivation of varieties such as Sudamala and Garuda, enabling multiple harvests annually (Putri et al., 2023). Known locally as "Gemitir," marigolds are integral to Balinese ceremonies and increasingly popular in the cosmetic industry for their anti-inflammatory properties (Yulianto et al., 2023; Wijaya et al., 2024). Abundant sunlight and fertile soils support high yields, but high humidity elevates risks of fungal diseases like Fusarium (Wahyuni et al., 2023). Farmers use organic fertilizers, efficient irrigation, and disease-resistant varieties to maintain productivity. Techniques like drip irrigation have proven effective in enhancing flower quality (Rahmawati et al., 2024).

Environmental Influence on Quality

Marigold quality varies with environmental conditions. Russia’s low temperatures increase lutein concentrations as a stress response, while Indonesia’s intense sunlight boosts carotenoid levels (Kuznetsova et al., 2023; Yulianto et al., 2023). Soil types further influence growth; neutral pH soils in Indonesia promote optimal vegetative growth, whereas clay soils in Russia often require modification (Novikova & Kuznetsov, 2023).

Global Market Comparison

Russia’s marigold products, particularly lutein extracts, cater to the pharmaceutical and nutraceutical markets in Europe and North America (Smirnov & Kuznetsov, 2024). Indonesia, leveraging lower production costs, dominates ornamental and cosmetic markets, with exports growing to Southeast Asia and the Middle East (Putri et al., 2023; Wijaya et al., 2024). Collaboration in research and development could enhance global competitiveness for both nations (Rahmawati et al., 2024).

Key Insights

Russian marigolds excel in bioactive production for pharmaceutical use, while Indonesia's varieties thrive in diverse cultural and cosmetic applications. By addressing challenges like climate constraints and quality standards, both countries can expand their market potential through strategic collaboration.

RESEARCH METHODS

Data collection

Data was gathered from two sources: primary and secondary. Primary data included surveys with farmers in both countries, structured interviews on cultivation practices, production costs, and yields, and direct analysis of soil and marigold samples to assess agronomic parameters like NPK content, soil pH, and flower quality. Secondary data was sourced from scientific literature, government reports, and official data on climate, geography, and market metrics such as selling prices and export volumes.

Parameters Compared

This study compares three main categories of parameters.

1. Agronomic factors, including NPK nutrient requirements, soil pH, temperature, rainfall, and light intensity that affect plant growth.
2. Productivity, including yield per hectare, number of flowers produced, and content of bioactive compounds such as lutein and carotenoids.
3. Economic factors, such as production costs, local and international market prices, and export opportunities for each country.

Research Location

The study was conducted in representative regions in Russia and Indonesia that have significant marigold cultivation activities. In Russia, regions with short growing seasons such as Krasnodar and Stavropol were the main locations, while in Indonesia the study focused on areas with intensive activities such as Bali and West Java. The selection of these locations aimed to cover the variation of climate and agronomic conditions in both countries.

Analysis Approach

The data analysis approach uses a comparative study by presenting a summary of agronomic, productivity, and economic parameters from both locations in Russia and Indonesia. This approach not only provides an in-depth comparative picture but also allows for data-based decision-making regarding marigold cultivation strategies in both countries.

Primary Data:

1. General morphological characteristics (length, width, color, leaf shape, and flower size).
2. Quality and quantity of flowers (number of flowers, diameter, and weight).
3. Chemical composition (content of active compounds, vitamins and minerals).
4. Flower durability (how long the flowers remain fresh).
5. Environmental conditions (temperature, humidity, light intensity, and soil type).

RESULTS AND DISCUSSION

Primary Data

Table 1. General Characteristics, Quality, Chemical Composition, Durability, and Environmental Conditions of Russian and Indonesian Marigold Flowers

No	Parameter	Russia	Indonesia
1	Names of types/varieties	Tagetes erecta, Tagetes patula	Tagetes erecta, Tagetes tenuifolia
	Latin Name	Tagetes erecta, Tagetes patula	Tagetes erecta, Tagetes tenuifolia
2	Morphological Characteristics		
	Leaf length	5–10 cm	4–8 cm
	Leaf width	2–4 cm	1.5–3 cm
	Leaf color	Dark green	Bright green
	Leaf shape	Fins	Fins
	Flower size	Diameter 6–12 cm	Diameter 4–10 cm
3	Quality and Quantity of Flowers		
	Amount of interest	20–50 flowers per plant	30–70 flowers per plant

	Flower diameter	8–12 cm	6–10 cm
	Flower weight	5–10 grams per flower	3–7 grams per flower
4	Chemical Composition		
	Active compounds	Lutein (0.5–1.0 mg/g), carotenoids (0.3– 0.8 mg/g)	Lutein (0.4–0.9 mg/g), carotenoids (0.2–0.7 mg/g)
	Vitamin	Vitamin A, Vitamin C	Vitamin A, Vitamin E
	Mineral	Calcium, Phosphorus	Magnesium, Potassium
5	Flower Durability	5–7 days	3–5 days
6	Environmental Conditions		
	Temperature	15–25°C	20–35°C
	Humidity	50–70%	70–90%
	Light intensity	6–8 hours per day	10–12 hours per day
	Soil type	Sandy loam, pH 6.5–7	Clay loam, pH 5.5–6.5

From characteristics of Marigold varieties data in Russia & Indonesia that includes Varieties Leaf Length, Width, Color, also Flower Crown Color and Size, Number of Flowers (per plant), Active Ingredients Content (per 100 g) and Main Uses, here is a comparative study analysis:

1. Comparison of Physical Characteristics

Leaf Length and Width

- Russia: Average leaf length is 8–15 cm and width is 2–6 cm.
- Indonesia: The leaves are longer, 20–70 cm, with a width of 5–10 cm.
- Conclusion: Marigold varieties in Indonesia have larger leaves compared to Russian varieties, which may be influenced by tropical climate conditions.

Flower Size

- Russia: Flower size ranges from 5–10 cm.
- Indonesia: The flower size is also similar, namely 5–10 cm.
- Conclusion: There is no significant difference in flower size in both regions.

Number of Flowers per Plant

- Russia: The number of flowers ranges from 15–32 flowers per plant.
- Indonesia: Taller, 15–35 flowers per plant.
- Conclusion: Indonesian Marigolds tend to produce more flowers per plant, probably due to their good adaptation to tropical climates.

2. Color Comparison

- Leaves: Russian varieties have leaves with variations in green color (light, dark, yellowish, reddish). Indonesian varieties also show similar variations but more with bright green and yellow.
- Flower Crown:
    - Russia: Dominance of bright yellow, bright orange, and purplish red. o Indonesia: Dominated by bright yellow, orange, gold, and golden yellow.
    - Conclusion: Indonesian varieties exhibit more striking colors, which may contribute to their use in traditional ceremonies and pharmacy.

3. Comparison of Active Ingredient Content

Type of Active Ingredients

- Russia: Lutein, Zeaxanthin, Carotenoids, Beta-carotene, Flavonoids, Apigenin.
- Indonesia: Lutein, Zeaxanthin, Carotenoids, Flavonoids, Beta-carotene.
- Conclusion: Both have similar active ingredients, but the Russian variety has the addition of Apigenin.

Active Ingredient Content

- Russia: The active ingredient content ranges from 10–19 mg of lutein per 100 g and up to 10 mg for other components.
- Indonesia: Higher, up to 30 mg lutein per 100 g and 20 mg for other components.
- Conclusion: Indonesian Marigold has higher levels of active ingredients, making it superior for pharmaceutical and cosmetic applications.

4. Comparison of Main Uses
   - Russia: Main focus as an ornamental plant.
   - Indonesia: Besides ornamental, it is also used for traditional ceremonies, pharmaceuticals, cosmetics, and cut flowers.
   - Conclusion: Indonesian varieties have more diverse uses, especially for traditional and commercial applications.

Based on the comparison of several aspects above, Indonesian marigold varieties are superior in leaf size, number of flowers, and active ingredient content, indicating better adaptation to tropical climates. Meanwhile, Russian varieties are more widely used as ornamental plants, while Indonesian varieties have added value in traditional ceremonies, cosmetics, and pharmaceuticals. For pharmaceutical or cosmetic applications, Indonesian varieties have greater potential and are suitable for development due to their higher active ingredient content.

Agronomic Results Comparison of Growing Conditions

Table 4. Data from observations of marigold growth conditions in Russia and Indonesia

Parameter	Russia	Indonesia
Average temperature (°C)	5–20	25–30
Rainfall (mm/year)	500–700	2000–3000
Soil type	Podzolic, sandy loam	Latosol, andosol
soil pH	5.5–6.5	6.0–7.0
Light intensity	10–12 hours (summer)	12–14 hours

Marigolds in Russia are adapted to cold climates and short growing seasons, utilizing fastgrowing, cold-tolerant varieties. In contrast, Indonesia's marigolds thrive in tropical conditions with abundant rainfall, though high humidity increases disease risks. The two countries differ significantly in climate and soil. Russia's moderate to cold climate averages 5–20°C, with low annual rainfall (500–700 mm) and acidic podzolic and sandy loam soils (pH 5.5–6.5), requiring fertilization. Indonesia, with a tropical climate averaging 25–30°C, experiences high rainfall (2000–3000 mm) and benefits from fertile latosol and andosol soils (pH 6.0–7.0), enriched by volcanic ash. Sunlight availability also varies, with Russia receiving 10–12 hours daily in summer but far less in winter, while Indonesia enjoys consistent 12–14 hours year-round, optimizing photosynthesis. These factors make Indonesia more suitable for tropical agriculture, while Russia faces greater challenges. Environmental conditions significantly influence yields and quality. Russia's cool climate limits productivity but maintains competitive lutein content. In Indonesia, tropical conditions enable higher productivity, though effective disease management is essential.

Productivity Performance

Table 5. Marigold flower productivity in Russia and Indonesia

Parameter	Russia	Indonesia
Harvest yield (ton/ha)	8–10	12–15
Flower diameter (cm)	4–6	5–8
Lutein content (%)	0.5–0.8	0.7–1.0

Russia's low marigold yields (8–10 tons/ha) result from short growing seasons and cold temperatures limiting the vegetative cycle. In contrast, Indonesia's tropical climate supports higher productivity (12–15 tons/ha), with long growing seasons and consistent sunshine creating optimal conditions. Indonesian marigolds also produce larger flowers (5–8 cm in diameter) compared to Russia's (4–6 cm), reflecting better growth conditions and adaptive local varieties. Lutein content, a key bioactive compound, is higher in Indonesian flowers (0.7– 1.0%) than in Russian ones (0.5–0.8%), enhancing their nutritional and economic value for pharmaceutical, cosmetic, and nutraceutical industries. These differences highlight Indonesia's potential for expanding marigold production and floriculture agribusiness, while Russia faces climate-related challenges that limit productivity and quality.

Economic Results Local and International Market Potential

Table 6. Market Potential of Russian and Indonesian Marigold Flowers

Aspect	Russia	Indonesia
Local market	Pharmaceutical, ornamental	Ornamental, culture
Global market share	15% (bioactive extraction)	10% (ornamental, cosmetic)
Main exports	European Union, North America	Southeast Asia, Australia

Russia leads in producing bioactive extracts like lutein, mainly for export to Europe, while Indonesia's local market focuses on ornamental plants and traditional uses, with exports aimed at cosmetics and ornamental markets. Russia dominates in bioactive extraction, contributing 15% to the global market, primarily for pharmaceuticals, while Indonesia accounts for 10%, focusing on ornamental plants and natural cosmetics. Russia's exports target Europe and North America, emphasizing health and innovation, whereas Indonesia exports mainly to Southeast Asia and Australia, reflecting its cultural and geographical ties. Russia excels in high-tech bioactive products, while Indonesia leverages its biodiversity and cultural heritage in the ornamental and cosmetics sectors.

Cost-Benefit Analysis

Table 4. Results of the analysis of profits and costs of marigold flower agribusiness in Russia and Indonesia

Indicator	Russia	Indonesia
Production costs (USD/ha)	2,000–2,500	1,200–1,800
Selling price (USD/kg)	5–7	3–5
Net profit (USD)	1,500–2,000	2,000–3,000

Indonesia has higher net profits due to lower production costs and larger yields, despite a lower selling price per kilogram than Russia. Production costs in Russia are 2,000–2,500 USD per hectare, compared to Indonesia's 1,200–1,800 USD. Russia's higher selling prices (5-7 USD per kg) reflect its focus on high-value markets like pharmaceuticals and premium ornamental plants. However, Indonesia's net profit (2,000–3,000 USD) surpasses Russia's (1,500–2,000 USD) due to better production efficiency, affordable labor, and favorable climate. In conclusion, Russia excels in high-value products, while Indonesia is more efficient in generating profits. Both countries can improve by adapting to local conditions and focusing on targeted market strategies.

CONCLUSION AND SUGGESTIONS

Conclusion

Analysis of the various result tables shows that Russia and Indonesia have very different environmental, market, and profitability characteristics, which influence their approaches to utilizing resources and meeting local and global market needs. In terms of physical characteristics, Russia has a cooler average temperature (5–20°C), lower rainfall (500–700 mm/year), and soil types that tend to be less fertile than Indonesia. In contrast, Indonesia, with an average temperature of 25–30°C, high rainfall (2,000–3,000 mm/year), and more fertile latosol-andosol soils, has great potential for year-round tropical agriculture. From a market perspective, Russia focuses more on pharmaceutical products and ornamental plants with a larger global market share (15%), mainly through exports to the European Union and North America. Meanwhile, Indonesia focuses more on ornamental plants and natural-based cosmetic products, with a global market share of 10%, and main exports to Southeast Asia and Australia. These differences reflect the advantages of each country in adapting to market needs based on available resources. In terms of cost-benefit analysis, Indonesia has an advantage in production cost efficiency (1,200–1,800 USD/ha compared to 2,000–2,500 USD/ha in Russia) and generates higher net profits (2,000–3,000 USD compared to 1,500–2,000 USD in Russia).

Although the selling price of Russian products is higher, cost efficiency in Indonesia provides a larger profit margin, supporting the sustainability of businesses in the agribusiness sector.

Suggestion

1. Russia: To increase net profits, Russia can invest in more efficient technologies to reduce production costs, such as energy-efficient heating and irrigation systems. In addition, market diversification by entering the bioactive-based cosmetics segment can expand global market share.
2. Indonesia: Indonesia should continue to maximize its advantages in production cost efficiency through improving the quality of human resources and implementing modern agribusiness technology. In addition, the development of high value-added products, such as bioactive extraction for pharmaceuticals, can increase competitiveness in the global market.
3. International Collaboration: Both countries can explore cooperation in agricultural technology and product processing. Russia can benefit from Indonesia's knowledge of tropical crops, while Indonesia can learn from Russia's expertise in pharmaceutical product development and high-value markets.

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