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Local Rice or High-Quality One: An Economic Analysis of Krong Bong District of Dak Lak Province, Vietnam

Do Thi Nga and Le Duc Niem*

Faculty of Economics, Tay Nguyen University, 567 Le Duan Street, Buon Ma Thuot City, Dak Lak Province, Vietnam
*Corresponding author's e-mail: ldniem@ttn.edu.vn

This study compares the economic efficiencies of high-quality versus local rice production to derive implications for rice farming in Krong Bong District, Dak Lak Province, Vietnam. We surveyed 98 rice-producing households in the district, evenly divided between high-quality and local rice producers. Our analysis focused on economic performance, specifically productivity and land use efficiency, and examined factors influencing rice productivity. The findings indicate that high-quality rice is significantly more profitable than local rice. Furthermore, Krong Bong District has substantial potential to enhance rice productivity and economic efficiency. We recommend adopting high-quality rice varieties, increasing investment in the sector, and applying advanced agricultural technologies. Additionally, a strategy for land accumulation to consolidate fragmented rice-growing areas is suggested, along with modernization of irrigation systems to improve overall production efficiency.
Keywords: Economic efficiency, high-quality rice, local rice, Vietnam, Rice Productivity, Land Use Efficiency, Rice-Producing Households.

INTRODUCTION

Rice is one of the three most essential grains for global food security, both now and in the future. Asia Pacific is the largest consumer of rice, resulting in significant market growth. The rising demand for high-quality rice from European and Gulf countries is accelerating the development of the general rice market, especially high-quality rice. Market demand, including organic and safe food, will continue to increase in developed and emerging countries. Thus, adopting new, high-quality rice cultivars for better quality and higher productivity challenges traditional rice production (Mahajan *et al.*, 2017; Oliveira *et al.*, 2020; Basu, 1994). Climate change, especially water scarcity, significantly complicates worldwide rice production (Zeng *et al.*, 2017). In 2022, the world's rice production decreased from 166 million hectares to 165 million hectares, and the output declined from 789 million tons to 776.5 million tons (FAO 2023). Vietnam is the third largest rice exporter in the world, after India and Thailand. Vietnam used to have a comparative advantage over other major rice-exporting countries such as India, Thailand, and Pakistan. However, this advantage has diminished recently and is now less favorable than in these countries (Pham and Zhengbing 2022). In 2021, Vietnam exported more than 4.6 million tons of rice, with an average export price of 401.2 USD/MT, 21.7% lower than the global average price (FAO 2023). Vietnam's rice exports are in fierce competition with those of exporting countries worldwide due to the low quality of rice. For a competitive advantage, it is necessary to increase the quality of rice so high-quality rice varieties are the choice for many rice production regions in Vietnam. Over the years, many rice varieties with high nutritional content, good quality, and high yield have been selected based on the standards of the International Rice Institute IRRI and Thailand (Quilty 2020). Many studies have shown that high-quality rice varieties produced in many localities of Vietnam have not only met market demand but also are resistant to pests and diseases and give high yields, contributing to improving economic efficiency and income for producers (Duong *et al.*, 2021; Khong, 2021; Le *et al.*, 2005; Nguyen *et al.*, 2019; Tran *et al.*, 2019; Truong *et al.*, 2019). Krong Bong is an agriculture-based district of Dak Lak province, between the Buon Ma Thuot plateau and the Truong Son Mountains. As a result, its topography is strongly divided, including three main types: high mountains, low mountains, and valleys. The valley terrain, with an area of nearly 22 thousand hectares distributed along large rivers, occupies more than 17% of the district's total area. The soil is mainly alluvial and gray, suitable for rice cultivation and yearly industrial crops. The total area of rice cultivation in the district in 2022 is 9,031

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hectares, with an output of 59,529 tons (Krong Bong Agriculture Office,2023). High-quality rice varieties, including ST24, ST25, and Dai Thom 8, have been mass-produced since 2017 and account for 70% of the district's rice cultivation area. The ST24 rice variety (one of Vietnam's most aromatic export rice) has achieved a 4-star OCOP product certification since 2020, giving an average yield of 8.7 tons/ha. The development of high-quality rice production in the Krong Bong district has contributed to forming a specialized rice production area, bringing farmers a stable source of income. Rice from the community has also been supplied and exported to many provinces and cities throughout the country. However, in the years 2020 - 2022, although the rice planted area of the district increased, the rice gross output stagnated due to low productivity in some locations. This fact affects the economic efficiency and income of farmers. This article aims to compare the economic efficiencies of local rice production to those of high-quality rice production to draw implications for rice production in Krong Bong district, Dak Lak province, Vietnam, and to propose solutions for improving the economic efficiencies of high-quality rice production in the study area.

MATERIALS AND METHODS

Primary data from rice farming households in Krong Bong district, Dak Lak province, are used in this article. The number of households surveyed was determined using Yamane (1967)

$$n = \frac{N}{1+Ne^2} \quad (1)$$

where N is the total number of families expected to grow rice in 2022 (N = 5,372 households), e is the allowable error (pick a confidence level of 90%, corresponding to e = 0.1), and n is the number of households expected to be surveyed (98 families). We studied 49 farms that produce high-quality rice and 49 families that produce local rice to assess the economic performance of the two types of rice production using a structured questionnaire. Notably, these farms were randomly selected based on two separate lists of households growing rice in the district (high-quality and local rice).

***t-test*:** Comparison of the mean values (productivity, income, and profit) of two groups of families producing local rice and high-quality ones using a two-sample test (T-test).

***Regression model*:** The Cobb-Douglas production function (CD) is used to examine the connection between output and inputs in rice production (David, 2012). The CD production function is specifically used in this study to investigate how inputs affect rice output using the following model:

$$Y = AX_1^{\alpha_1}X_2^{\alpha_2}X_3^{\alpha_3}X_4^{\alpha 4}X_5^{\alpha_5}e^{\beta D} \quad (2)$$

In particular, the dependent variable Y is rice productivity. A vector of inputs or independent variables $X_{i,}\ i = \overline{1..5}$ (rice area (1.000m^2/household), seed quantity (kg/ha), chemical fertilizer cost (thousand VND/kg), manure amount (kg/ha), and pesticide cost (thousand VND/ha). $\beta_i, i = \overline{1..5}$ is a vector of coefficients measuring the productivity elasticities of corresponding input variables. A dichotomous variable D is included in the production function (high-quality rice: 1, local rice: 0).

Following Bivens and Volker (1986); Spicka *et al. (*2019), criteria for assessing the economic efficiency of rice production include rice gross output (GO) per hectare, land use efficiency (production value, value addition, average income, and profit of 1 ha), and investment efficiency (ratio of production value, income, and return on invested capital). The total rice production cost (TC) includes intermediate costs (IC) such as seeds, tillage, inputs, harvesting, hiring labor, other expenses, machinery depreciation, and household labor's value.

$$VA = GO - IC \quad (3)$$

where VA is value addition, GO is gross output, and IC is intermediate costs. The mixed-income (MI) is derived from the following formula:

$$MI = GO - IC - D_e \quad (4)$$

The depreciation of the farm's fixed assets used in rice production is denoted as D_e.

The profit (P_r) equals:

$$P_r = GO - TC \quad (5)$$

where TC is the total costs regarding rice production.

RESULTS

***An overview of the rice production in the district*:** Two significant rivers, Krong Bong and Krong Ana, and several tiny streams dispersed evenly throughout the Krong Bong district provide the ideal environment for developing wet rice farming. In 2020, the district's total rice cultivated area was 8,536 ha, up 36% from 2010, with a total output of approximately 64 thousand tons, up 104% from 2010. The district's overall rice planting area in 2020 was 8,536 ha, a 36% increase over 2010, and production totaled 64 thousand tons, 104% more than in 2010. On the one hand, the district's rice production expanded quickly in ten years because of the cultivated area expansion. In 2020, about 8,536 acres were planted with rice in the community, an increase of 36% compared with 2010 (Dak Lak Statistics Service 2021).

The advent of superior rice cultivars like ST24, ST25, Dai Thom 8, and RVT is viewed as a breakthrough on the other hand. These rice cultivars are both high-yield and of excellent quality. High-quality cultivars like HT1, N25, and Q5 rapidly replaced the long-cultivated local kinds of rice. These cultivars are mass-cultivated on 70% of the district's rice-growing acreage. Switching to high-quality rice farming significantly impacts rice commodity production and food security. Between 2020 and 2022, the district's rice cultivated area expanded marginally on average by 2.86 percent a year, but the overall output of rice declined annually by 3.69 percent (Table 1). A decline in yield brought on a decrease in

Table 1. Changes in area, output, and rice yield of Krong Bong District.

Items	Unit	2020	2021	2022	Growth rate (%)
Total cultivation area	Ha	8,536	8,385	9,031	102.86
Gross output	Ton	64,182	55,905	59,529	96.31
Averaged productivity	Tons/ha	7.52	6.67	6.59	93.63
Winter-spring crop					
Cultivated area	Ha	3,701	3,628	4,047	104.57
Gross output	Ton	29,992	25,707	30,142	100.25
Productivity	Tons/ha	8.10	7.09	7.45	95.87
Summer-autumn crop					
Cultivated area	Ha	4,835	4,757	4,984	101.53
Gross output	Ton	34,190	30,198	29,387	92.71
Productivity	Tons/ha	7.07	6.35	5.90	91.31

Source: (Dak Lak Statistics Service (2021); Krong Bong Agriculture Office, 2022)

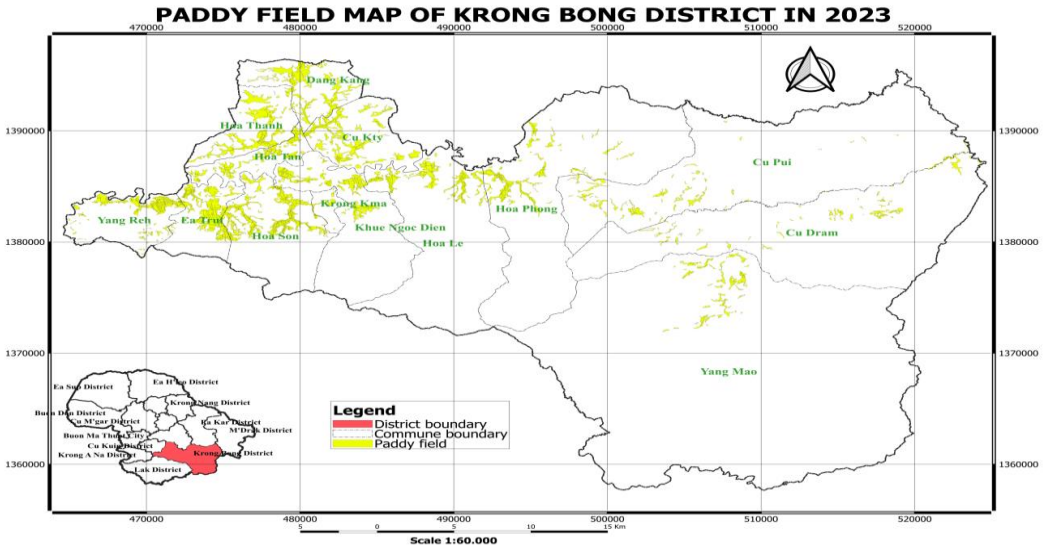

Figure 1. Paddy rice fields in Krong Bong District in 2023.

rice production. It is because that rice is grown in two seasons: winter-spring and summer-autumn. The winter-spring crop lasts from late December to early May with low rainfall. Thus, the rice production in this crop depends on irrigation water. The summer-autumn harvest begins in early June and ends in early October with more rain. Therefore, rice needs less irrigated water (see Figure 2).

Because the soil is rested and dried for an extended period, improving soil nutrition, the yield of rice planted in the winter-spring crop is more significant than that of rice produced in the summer-autumn harvest. Harvest yields are impacted by flooding rains and floods in the summer and fall. Because the district's irrigation infrastructure is insufficient to supply irrigation water for the winter-spring crop (it only ensures active irrigation water for more than 60% of the rice-growing area), some of the land has been used for other crops (such as corn and vegetables) or is left unoccupied.

Farmers follow the guidelines of the Agriculture Office for rice cultivation, manually sowing most of the fields and using machines for plowing and harvesting more than 85% of the time. Thang Binh Agricultural Cooperative has worked with local households to grow from 70 to 100 hectares of high-quality rice (using ST24 and ST25 varieties) per season, starting with the winter-spring crop in 2019–2020.

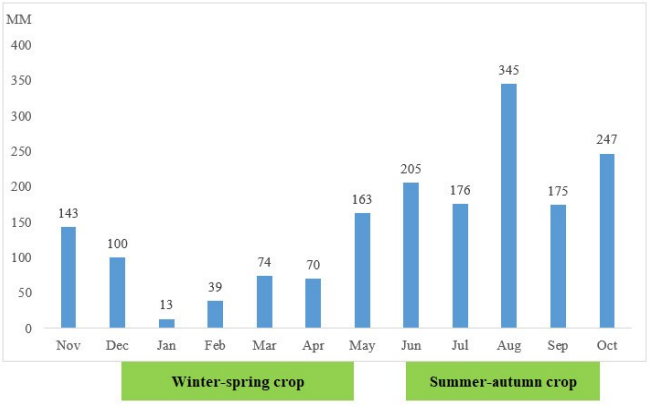

Figure 2. Rice crop seasons and averaged monthly rainfalls.

Source: Krong Bong Agriculture Office (2023)

Products are produced under VietGap standards and have received provincial 4-star OCOP product certification (for ST24 rice varieties). The cooperative handles tasks like the provision of services (tillage, irrigation, harvesting), the supply of inputs (seeds and other inputs), the management of the seasonal calendar, and the consumption of goods. Fresh rice produced per VietGap standards is costlier, by 1,000 to 1,500 VND/kg than mass-manufactured rice. The trend toward global economic integration of Vietnam and the tightening of food safety regulations make it necessary to improve rice quality and ensure its safety. Therefore, to increase quality and efficiency, satisfy market demands, and boost producer income, expanding rice production in the Krong Bong District in the future should go toward value chain linkage.

***Economic efficiency of high-quality rice production in household farmers*:** Farmers produce rice during the winter-spring and summer-autumn growing seasons. Still, most of the local rice production region is switched to other crops that need less irrigation water throughout the winter and spring seasons. High-quality rice requires more sophisticated farming methods. Households in the region tend to produce local rice rather than high-quality ones, even though high-quality rice is higher than local rice in terms of productivity (Table 2). The productivity of high-quality rice cultivars is 7.13 to 7.32 tonnes per hectare, 13% more than local rice varieties. The T-test results show a significant difference in the average productivity between 2 groups of families producing high-quality rice and local rice, with a 99% confidence level.

Table 2. Area, output, and rice productivity in Krong Bong district.

Items	Unit	Winter-spring crop	Summer-autumn crop	
		High-quality	High-quality	Local
Area	Ha/hh	1.17	1.17	0.95
Gross output	MT/ hh	8.57	8.36	5.98
Productivity	MT/ha	7.32	7.13	6.29

Source: Survey, 2022

Table 3 shows farmers' rice production expenses. In the summer-autumn crop, the overall cost of producing high-quality rice is 36.47 million VND/ha, 15.2 percent greater than local rice costs. The prices of growing high-quality rice include the expenses of seedling, tillage, and harvesting, in which most households rent machinery and services. In addition, high-quality rice production in the summer-autumn crop costs 4.88 percent more than the winter-spring crop. Because rice production in the summer-autumn crop occurs throughout the rainy and flood seasons, seedling, tillage, and harvesting expenditures are higher than for the winter-spring crop.

Table 3. Rice production cost structure (thousand VND/ha).

Costs	Winter-spring crop	Summer-autumn crop	
	High-quality rice	High-quality rice	Local rice
1. Intermediate cost (IC)	***25,053***	***26,755***	***23,132***
Land preparation	4,326	4,613	4,039
Rice seedling	3,374	3,697	3,064
Nitrogenous fertilizer	2,483	2,332	2,377
Phosphate fertilizer	2,109	2,079	2,083
Potassium fertilizer	778	492	518
NPK	2,907	2,899	2,392
Manure	1,934	1,957	1,645
Pesticides	2,177	2,486	2,385
Harvesting	3,729	4,966	3,570
Hiring labors	380	376	339
Other costs	855	859	719
2. Depreciation	***4,434***	***4,434***	***3,035***
3. Family labor	***5,283***	***5,276***	***5,485***
Total Cost (TC)	**34,771**	**36,465**	**31,652**

Source: Survey, 2022

Fertilizer accounts for the largest share (36 to 39 percent) of intermediate expenditures and significantly determines rice productivity (Figure 3). The overall cost of fertilizers for producers of high-quality rice is VND 10.21 million, or 4.63 percent more than for local rice growers. 15 to 18 percent of the total intermediate expenses associated with rice cultivation are attributable to tillage and harvesting.

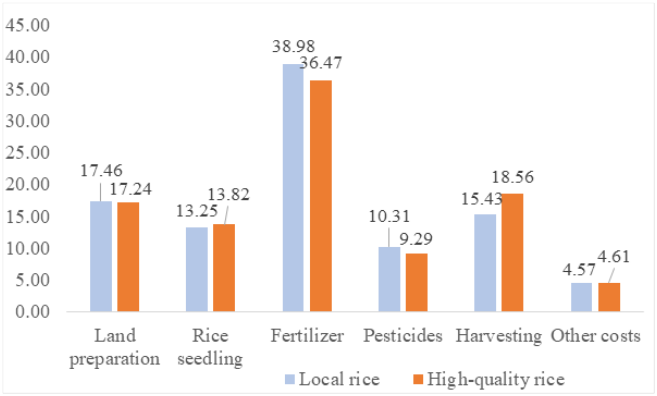

Figure 3. Structure of intermediate costs in the summer-autumn rice production.

Source: Survey, 2022

Table 4 describes the economic efficiency of rice production, comparing land use efficiency and investment efficiency in

producing high-quality and local rice. The average production value, income, and profit of 1 ha of high-quality rice reached VND 49.91 million, VND 18.72 million, and VND 13.44 million, higher than local rice by 44%, 123%, and 360%, respectively. The ratio of production value and income to intermediate costs of high-quality rice-producing households is 1.25 times and 1.92 times higher than that of local rice-producing families. The profit margin compared to total expenses is 3.99 times higher. The economic efficiency of high-quality rice far surpasses that of local varieties. This superiority is twofold: firstly, high-quality rice yields are significantly higher; secondly, its local selling price is elevated by 1.5 to 2 thousand VND/kg (roughly 20-30%). Furthermore, while local rice primarily caters to the local market, high-quality rice enjoys a broader reach, being distributed to other provinces and even exported to international markets such as New Zealand and Australia. However, economic efficiency in high-quality rice production varies by season. Due to the higher yield of the winter-spring rice crop than the summer-autumn crop and lower production costs, the economic efficiency of high-quality rice production in the winter-spring crop is higher. The average production value and profit of 1 ha of high-quality rice in the winter-spring rice reached VND 51.23 million and VND 16.46 million / ha, higher than the summer-autumn crop of 2.65% and 22.46%, respectively. The results of the T-test with heterogeneous variance (T-test: Two-Sample Assuming Unequal Variances) for two indicators of average income and profit of 1 ha in 2 groups of households producing high-quality rice and local one confirm that there is a difference in both revenue and profit between mean values with a 99% significance level.

Table 4. Economic efficiency of rice production.

Items	Unit	Winter-spring	Summer-autumn	
		High-quality rice	High-quality rice	Local rice
Land use efficiency	VND1,			
Gross output (GO)	000/ ha	51,230	49,906	34,576
Value addition (VA)		26,177	23,151	11,444
Mixed-income (MI)		21,743	18,717	8,409
Profit (Pr)		16,459	13,441	2,924
Investment efficiency	Times			
GO/IC		2.04	1.87	1.49
MI/IC		0.87	0.70	0.36
Pr/TC		0.47	0.37	0.09

Source: Survey, 2022

Rice productivity is an essential factor constituting farmers' efficiency in rice production. So, estimating the factors affecting rice productivity and deriving the potential to increase rice productivity is necessary. We used the Cobb-Douglas production function, with the dependent variable being rice productivity (tons/ha). The independent variables are rice area (ha), seed (kg/ha), chemical fertilizer cost (thousand VND/ha), the amount of manure used (kg/ha), the cost of pesticides (thousand VND/ha), and a qualitative variable - rice production varieties (high-quality versa local one). The results of running the regression function are summarized in Table 5.

Table 5. Regression analysis.

Variables	Coeff.	t-value	Sig	VIF
(Constant)	.679	2.178	.032	
LNAREA***	.094	4.462	.000	4.281
LNSEED	.038	1.313	.193	1.371
LNNPK*	.077	1.902	.060	2.125
LNPESTICIDE	.010	0.506	.614	2.648
LNMANURE***	.051	3.286	.001	2.406
VARIETY***	.081	4.994	.000	
n	90			
R^2	0.598			
F	22.60 (sig. =0.000)			

Note: *Statistical significance at the 10% level; ***Statistical significance at the 1% level.
Source: Regression outputs

Rice's rice productivity (LNPRO) was found to have a positive correlation with land area. Increasing the household's planted area by 1 percent boosts rice yield by 0.0943 percent. This finding indicates that rice production exhibits Increasing Returns to Scale (IRS). In other words, the more a farmer's rice growing area, the greater his rice yield. The chemical fertilizers (LNNPK) and manure (LNMANURE) are directly related to rice productivity. Every one percent increase in these inputs increases rice productivity by 0.077 and 0.051 percent, respectively (in case other factors remain unchanged). Thus, rice producers should expand their production scale and increase fertilizer investment to boost productivity and economic efficiency. Moreover, variable VARIETY is positively associated with productivity, and the selection of high-quality rice production also improves rice productivity.

DISCUSSION

***Implications for rice production in Krong Bong district*:** Krong Bong can enhance rice production by investing more significantly and introducing innovative rice cultivars. Thus, encouraging the spread of novel cultivars that are high-yielding, high-quality, and resistant to pests and diseases is critical. Farmers' production and marketing skills should be improved to enable them to use innovative production methods and get access to input and output markets. Krong Bong rice fields are widespread and small (typically less than 1 hectare per plot). This fact is the underlying cause of

insufficient mechanization and inconsistent rice quality. As a result, the district should support land accumulation and concentration, build a large-scale rice region, and expand fields to stimulate automation in highly competitive, concentrated rice-producing zones (Dak Lak Statistics Service 2021). The farmers are unaccustomed to contract farming. As a result, it is critical to implement extension approaches to increase farmers' understanding of the benefits of participating in the value chain or contract farming. Rice-producing zones in the Krong Bong district have a steep slope continually threatened by droughts and floods, increasing the cost of sowing, irrigating, and harvesting. The irrigation system remains insufficient because it does not respond to forceful and timely irrigation for rice production. The district should simultaneously boost its investments in lakes, reservoirs, drainage, and infield canals (Pham and Zhengbing 2022).

***Conclusions*:** We have evaluated the efficiency of high-quality rice production compared with local rice production. As the region's arable area increased between 2010 and 2020, rice production in Krong Bong surged. The development of improved rice cultivars, including ST24, ST25, Dai Thom 8, and RVT, has been hailed as a turning point. Although the district's rice agricultural area expanded by 2.86 percent annually between 2020 and 2022, annual rice production decreased by 3.69 percent. A decline in yield was the primary reason for the decline in production. Average rice productivity also differed considerably between households cultivating high-quality rice and those growing regional rice (high-quality rice yield is 13 percent greater than local rice yield). When comparing land use efficiency and investment efficiency, the average output value, revenue, and profit per hectare of high-quality rice cultivation were 44 percent, 123 percent, and 360 percent higher than local rice production. Compared to local rice-producing families, high-quality rice-producing households showed a 1.25- and 1.92-fold increase in production value and revenue relative to intermediate costs, respectively. The profit margin equals 3.99 times the total expenses. The rice productivity of farmers is proportional to the size of their farms and the amount they are willing to spend on chemical fertilizers and manure, according to our analysis of factors influencing rice production. These factors have positive effects on rice cultivation. The selection of high-quality rice production is proven to boost rice productivity. Prioritizing the distribution and selection of high-quality rice varieties and the selection and transmission of improved rice production technologies necessitates more investment and the implementation of technological advances in rice production. Increasing land concentration or expanding more extensive fields is vital to encourage mechanization and fallow periods. There is a catch, though, with this paper. Rare indigenous rice varieties may become extinct if the paper's recommendation to shift to high-quality rice production is implemented. In addition, the environmental aspect of rice production has not been addressed. These elements should be considered in future studies.

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***Consent for publication*:** All authors submitted consent to publish this research.

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