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Analysis of the Effects of Public Expenditure on Agricultural Growth in Mali

Abdoulaye Maïga[1*], Amadou Bamba[2], Boubacar Sy[1], Georges Hady Keita[1], Issoufou Soumaïla Mouleye[1] and Moussa Diallo[1]

[1]University of Social Sciences and Management of Bamako, Mali.
[2]University of Letters and Human Sciences of Bamako, Mali.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study is to analyze the effects of government spending on agricultural growth in Mali using data from 2000 to 2019. The lagged autoregressive model (ARDL) was used to perform the estimation. We conducted a descriptive analysis of the data from the World Bank database. Several specification tests were performed to confirm the validity of the chosen model. The results of this study show that the public expenditures have positive and significant effects on agricultural growth, except for agricultural expenditures that have negative effects. Similarly, the agricultural employability rate and fertilizer consumption also have negative effects. This implies that the government needs to review its resource allocation policy in all sectors, including the agricultural sector.

Keywords: Public expenditure; economic growth; ARDL; Mali.

**Corresponding author: E-mail: maigis@yahoo.fr;*

1. INTRODUCTION

The role of the agricultural sector in the sustainable economic development of a country is well-established [1]. The importance of agricultural growth in the economic development of countries is reinforced by Rostow's stages of growth, which emphasise agricultural growth as a precondition for the take-off stage [2]. Agriculture is the major sector in many countries in terms of its contribution to national income and employment [3]. As agriculture remains the economic engine of rural Africa, the promotion of economic transformation will largely depend on stimulating growth, mostly driven by smallholders. Africa can achieve the high level of agricultural growth. The underlying assumption is that through large-scale structural transformation that reduces poverty [4,5]. This notion that the agricultural sector is the engine of economic growth dates back to the 1950s [6]. The World Bank has indicated a development strategy for rural and developing countries with the increase of agricultural productivity as a starting point. However, it was not until the 1990s that policy makers prioritised agriculture and by 2000, it had become a key area in discussions on development and growth.

Public expenditure is perhaps the most important policy instrument available from governments in most developing countries to promote growth and equitable distribution [7]. Governments in these countries tend to have less fiscal instruments than rich countries because of the large informal sector that is effectively tax-sheltered, and imposing taxes on some sectors of the economy and not on others creates strong economic distortions [8]. In addition to being used to improve technology, human capital and infrastructure development necessary for growth, public spending is also intended to provide the incentives and environment for the promotion of private sector investment to foster further growth. Given the meaningful role, that agriculture plays in the development strategy of most developing countries [9,10].

Furthermore, most of the world's poor derive their income-generating activities from agriculture and related activities and reside in rural areas. This suggests that agricultural development is critical to both economic development and poverty reduction, particularly in rural areas where the majority of the world's poor live. The development of efficient agriculture in developing countries must be a top priority and effective government instruments must be put in place to drive cost-effective public spending in the agricultural sector [11] and [12].

On the macroeconomic side, econometric models of emerging countries such as China, Brazil and India. According to the work of [13,14] suggests convincing links between public agricultural expenditures and the good performance of the agricultural sector in these countries, particularly in Ghana and Burkina Faso. Some analyses decompose public expenditure into several components in order to analyse their effects on agricultural output growth [15,16]. The main findings of these developments show that public spending in the agricultural sector has both a short- and long-term effect on the performance of the agricultural sector. Spending on infrastructure, technology, R&D, training and extension are known to increase agricultural productivity over time, with the R&D component having delayed effects. While various aids and subsidies and credit are aimed more at farmers' income than at factor productivity.

Indeed, aware of the importance of public investment in agriculture and with a view to concretising their commitment to the development of the agricultural sector. The African states, at the African Union meeting in Maputo in 2003, decided to increase the share of public expenditure allocated to agricultural production to 10% in order to achieve agricultural growth of at least 6%, to create employment opportunities for at least 30% of young people in agricultural value chains and of course to increase the participation of women in the agricultural labor market. This decision supports the commitment of African governments to develop the agricultural sector in order to improve agricultural productivity, ensure food security and guarantee sustainable and sustained economic growth, particularly in Mali.

As noted in the literature, the role of government in economic development has been the subject of much debate in development economics [7]. Over the past 60 years, the field of development economics has witnessed the evolution of growth models. Different schools of thought have emerged to try to explain the concept of government involvement in an economy. These schools of thought include classical theory, Keynesian theory, neoclassical theory and endogenous growth theory. Several empirical studies have been adopted from different schools of thought in recent years, in an

attempt to shed more light on the debate about whether government spending stimulates growth in an economy [11]. Most of these studies have found contradictory results. Since previous studies do not reflect agreement on the significant and causal relationship between public spending and growth, further empirical research is needed. Therefore, in light of the above gap in the literature, this study aims to contribute to the current literature by empirically estimating the impact of disaggregated public expenditure on agricultural growth in Mali.

Following previous work by [1,17], which used value added per worker as the dependent variable in this study, the impact of public expenditure on agricultural GDP per worker is analysed as a means of assessing the effectiveness of public expenditure. In order to determine the return on investment in specific types of public expenditure, public expenditure was disaggregated by categories of agricultural expenditure, health, education in the presence of agricultural employability and fertilizer consumption as control variables.

2. METHODOLOGY AND DATA SOURCE

In this section, the data source and study methodology will be discussed in different subsections. The study was conducted with annual time series data from 2000 to 2019. These secondary data are from RESAKSS and the World Bank's Development Indicators. The study analysed the effect of public expenditure on agricultural growth in Mali. Agricultural value added per labour is the dependent variable, while public expenditure on agriculture, education, health, the number of workers in the agricultural sector and fertiliser consumption are the independent variables.

2.1 Model Specification

To show the influence of public expenditure on agricultural value added per worker in Mali, the multiple regression model is used as presented below. The following previous studies by [1,18] have used the same econometric model as presented below to study the relationship between public expenditure and agricultural value added per worker. The basic equation is written as follows:

$$\mathrm{PIBAGR\_TRA_t} = \alpha_0 + \alpha_1 \mathrm{DEPAGR}_t + \alpha_2 \mathrm{DEPEDUC_t} + \alpha_3 \mathrm{DEPSANT_t} + \alpha_4 \mathrm{EMP\_AGRI_t} + \alpha_5 \mathrm{CONS\_ENGR_t} + \alpha_6 \mathrm{DEPEDUC_t} + \varepsilon_t$$

GDPAGR_TRA: Agricultural value added per worker
DEPAGR: Expenditure on agriculture
DEPEDUC: Expenditure on education
DEPSANT: Expenditure on health
EMPL_AGRI: Number of jobs in the agricultural sector
CONS_ENGR: Fertiliser consumption

Public spending on agriculture is very important for agricultural productivity. According to the Maputo Agreement in 2015, a 10% expenditure in the agricultural sector of the total budget would increase agricultural value added by 6%. Also, public spending on education is an important explanatory variable, which significantly affects agricultural and economic growth [28]. Several economists such as Adam Smith, Lucas, Rome and Solow have developed numerous theories and models of economic growth in which they prescribed education as an important factor of growth. Public spending on health plays an important role in overall agricultural output [11]. The number of jobs created by the agricultural sector is incorporated as an important variable in the model as it is considered very crucial for agricultural growth in developing countries. Finally, fertiliser consumption is introduced into the model as an independent variable to study the effect of its use on agricultural value added per worker.

2.2 Presentation of the Model Estimated

Several econometric models have been proposed to study the long-run cointegration relationship in the context of time series [19,20,21]. In our case, we choose the ARDL model (Autoregressive Distributed Lag Model) which is a model developed by [22,23]. Our choice is justified by the advantages of the latter, compared to the other models already mentioned. This model gives us the possibility to estimate simultaneously the short and long-term parameters of the tested variables,

moreover, and contrary to the other models, the ARDL approach does not require that the series be integrated in the same order, i.e. this approach allows estimating variables with a different integration level I (0) and I (1). Thus, in the case of small samples, this approach is more efficient and gives more meaningful results in determining the cointegration relationship [24]. This equation is written according to the ARDL model in the following form:

$$\Delta \text{PIBAGR\_TRA}_t = c + \alpha_1 \text{PIBAGR\_TRA}_{t-1} + \alpha_2 \text{DEPAGR}_{t-1} + \alpha_3 \text{DEPEDUC}_{t-1} + \alpha_4 \text{DEPSANT}_{t-1} + \alpha_5 \text{EMPL\_AGRI}_{t-1} + \alpha_6 \text{CONS\_ENGR}_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta \text{PIBAGR\_TRA}_{t-1} + \sum_{i=0}^{q1} \beta_{2i} \text{DEPAGR}_{t-1} + \sum_{i=0}^{q2} \beta_{3i} \text{DEPEDUC}_{t-1} + \sum_{i=0}^{q3} \beta_{4i} \text{DEPSANT}_{t-1} + \sum_{i=0}^{q4} \beta_5 \text{EMPL\_AGRI}_{t-1} + \sum_{i=0}^{q5} \beta_6 \text{CONS\_ENGR}_{t-1} + \varepsilon_t$$

Avec : c = La constante Δ= la premiere différence εt = le terme aléatoire, p, q1, q2, q3, q4, q5 = le nombre de retard maximal pour chaque variable de l'étude α_1 , α_2 , α_3 , α_4 , α_5 = Les parametres de la relation de long terme.

β_1 , β_2 , β_3 , β_4 , β_5 = Les parametres de la réaction de court terme (correction d ′ erreur)

2.3 Source of Data

Table 1. Data source

Variables	Source	Unit
Agricultural value added per worker	World Bank	Constant 2010 USD, Billion
Expenditure on agriculture	World Bank	%GDP
Expenditure on education	World Bank	%GDP
Expenditure on health	World Bank	%GDP
Number of jobs in the agricultural sector	RESAKSS	Number of jobs in the agricultural sector
Fertiliser consumption	RESAKSS	Kilogram per hectare

3. RESULTS AND DISCUSION

The empirical results of the ARDL model estimated in the discussion are presented in Tables 2-7. After investigating stationarity using the unit root test (Dickey - Fuller) and Phillips Perron, we will test for the presence of long-run relationships using the "Bounds test". Then, we will perform the estimation using the ARDL model. The most optimal model according to Cimonieux corresponds to the number of lags that minimizes the Akaike criterion.

3.1 Descriptive Analysis

The results in Table 2 show that the average agricultural value added per worker (GDPAGR_TRA), public expenditure on agriculture (DEPAGR), education expenditure (DEPEDUC), health expenditure (DEPSANT), agricultural employability rate (EMPL_AGRI) and fertiliser consumption (CONS_ENGR) are 963.75, 10.8035, 3.447929, 11.067, 68.0515 and 31.40685 respectively. The dispersion on all variables is low. However, the results show us that the maximum income does not exceed $1243, with a small deviation from the mean of 279.25.

As we can see from the graph above, Mali was able to meet its commitments in terms of public spending on agriculture from 2004 to 2011, thanks to the commitment of the Malian government, through several agricultural policies in place to boost this sector.

For example, the Loi d'Orientation Agricole (LOA), the National Agricultural Sector Investment Program (PNISA) and the Agricultural Development, to name but a few, have helped the agricultural sector achieve 6% growth for several years. In the last ten years, 2011 and 2013 have been difficult for the agricultural sector, despite an average expenditure of 10%

invested. The years 2018 and 2019 are affected by an expenditure of less than 10%, which leads to a decrease in the agricultural growth rate from 5.9% to 5.1% respectively.

3.2 Root Unit Test

Before testing for cointegration between variables, it is important to perform a descriptive analysis and then conduct the unit root test to ensure that no variable is integrated of order 2, i.e. I(2). This is essential because the ARDL procedure assumes that all variables are integrated of order I (0) or I (1). If a variable is considered to be I(2), the calculated F-statistics produced by [25] can no longer be valid. In this respect, the most common and widely used test is the Augmented Dickey-Fuller (ADF) test [26]. However, [27] However, a non-parametric correction of the Dickey-Fuller (DF) statistics has been proposed to take into account heteroscedastic errors. The table below presents the results of the Dickey-Fuller unit root test for each of the variables. Table 3 shows that the DEPAGR, DEPEDUC and DEPSANT series are stationary at the level while the GDPAGR_ TRA, EMPL_AGRI and CONS_ENGR variables are stationary in first difference. This confirms our choice to use the ARDL.

3.3 Determination of the Number of Lags

To select the optimal ARDL model that allows us to obtain meaningful results, we use the Akaike information criteria (AIC). We have the following graph, which informs us about the optimal ARDL model. The ARDL (1, 2, 2, 2, 2, 2) model is the most optimal of these twenty models, as it has the lowest AIC value.

3.3 Bound Test

In order to ensure the existence of a long-term cointegration relationship between the variables of our model [7]. we perform the Bound Test under the following assumptions:

- ✓ H0 = $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5$ (Lack of a long-term relationship)
- ✓ H1 ≠ $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5$ (Existence of a long-term relationship)

Table 2. Descriptive statistics

Variables	Obs	Mean	Std. Dev	Min	Max
Agricultural value added per worker	20	963.75	152.28	715	1243
Agricultural Expenditure	20	10.80	1.79	8.10	15.53
Educational Expenditure	20	3.45	.345	2.66	3.87
Expenditure on health	20	11.07	2.50	4.74	14.81
Number of jobs in the agricultural sector	20	68.05	3.29	62.27	72.64
Fertiliser consumption	20	31.40	12.47	5.95	50.53

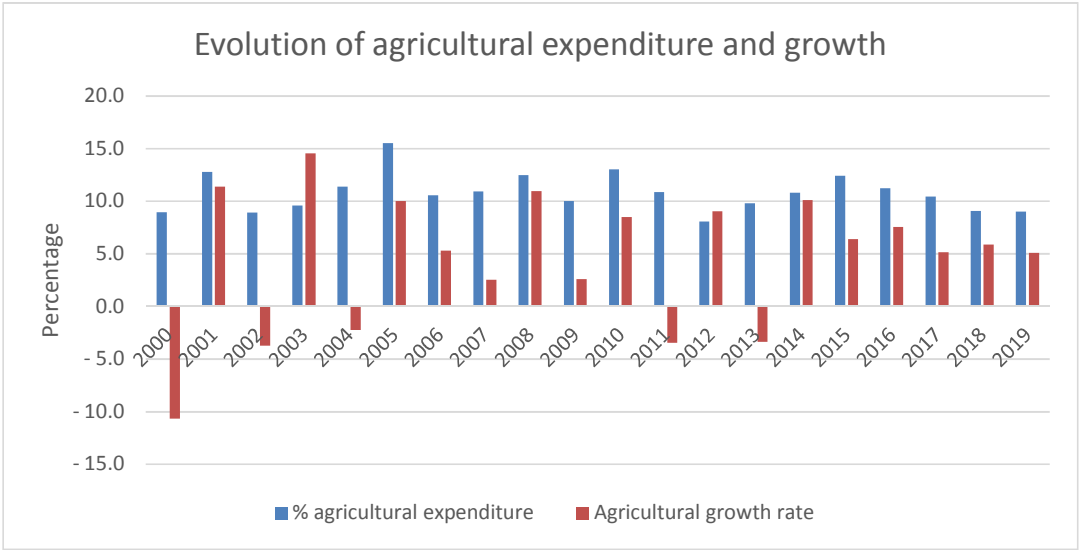

Fig. 1. Expenditure trends and agricultural growth

Table 3. Root unit test

Variables	A level		In first difference		Order of integration
	ADF	PP	ADF	PP	
Agricultural value added per worker	0.990	0.834	-8.586	-8.586	I (1)
Expenditure on agriculture	-4.152	-18.305	-6.474	-22.489	I (0)
Expenditure on education	-3.564	-12.334	-6.259	-23.045	I (0)
Expenditure on health	-2.979	-8.385	-5.146	-22.964	I (0)
Number of jobs in the agricultural sector	-0.505	-0.120	-7.266	-25.796	I (1)
Fertiliser consumption	-2.003	-0.120	-4.830	-18.144	I (1)
	Conventional thresholds				
1%	-3.750	-17.200	-3.750	-17.200	
5%	-3.000	-12.500	-3.000	-12.500	
10%	-2.630	-10.200	-2.630	-10.200	

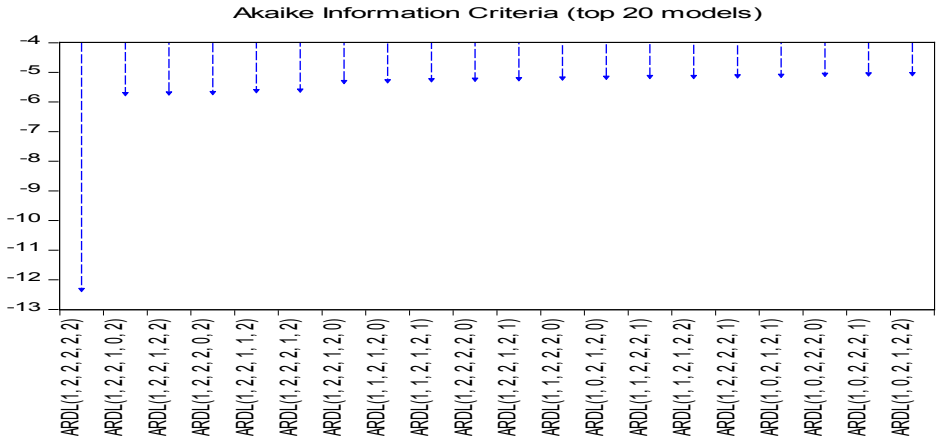

Fig. 2. Selection of the number of lags

Table 4. Bounds test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Mean	I(0)	I(1)
F-statistic		10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

The results of the bounds test show that the Fisher statistic (F=2687.866) is above the upper bound of the critical value interval corresponding to the 1% error level. Therefore, rejecting the hypothesis of no long-run relationship, we conclude that there is a long-run cointegrating relationship for the estimated model.

3.4 Estimation of the Short-Term Relationship (1 2 2 2 2 2)

According to the results below, we notice that the adjustment or error correction coefficient (Coint Eq (-1)) is statistically significant (Prob. = 0.0018), which confirms the existence of a long-term relationship between the variables. Concerning the short-term relationship between the independent variables and the dependent variable (GDPAGR_TRA), we find a negative relationship between agricultural value added per worker and expenditure on agriculture, education, health, agricultural employment and fertilizer consumption, all of which are significant.

3.5 Estimation of the Long Term Relationship (1,2,2,2,2,2)

According to the results in the table above, all variables are statistically significant at the 5% to 1% level, i.e., these variables have long-term effects. The results show that the variable (DEPAGR) that corresponds to public expenditure allocated to the agricultural sector has a negative and significant influence on

agricultural value added per worker. This result is surprising, as agricultural expenditures are generally expected to have a positive effect on agricultural growth in the short and long run [28]. However, beyond this result, [29] wrote a report on trends in public spending on agriculture in African countries. Their study assessed the performance of countries to see if they are meeting the requirements set by the Maputo Declaration. According to the work of [29]. Although many countries increased their public expenditure on agriculture (PFA) in 2012, Africa as a whole did not meet the 10% target. One of the reasons why public spending on agriculture is still very low in African countries is the small size of their revenue base. Low revenues prevent many governments from investing in critical economic activities such as agricultural research and infrastructure development [18]. The transition to modern, intensive agriculture must necessarily involve the development of a comprehensive agricultural policy. This policy takes into consideration several aspects (irrigation, use of inputs and organization of circuits) and ultimately leads to sufficient agricultural production capable of ensuring food security for the population and an active agricultural sector well integrated into the economy of African countries [30].

Public expenditure on education (DEPEDU) has positive and significant effects on agricultural value added per worker. This can be explained by the free study up to rural areas. This result is supported by the work that argued that public spending on education contributes significantly to agricultural growth. This result further corroborates with the work of [31] analysing the effects of education on agricultural growth in the WAEMU zone. Similarly, public spending on health (DEPSANT) has a positive and significant influence on agricultural value added. Public spending on health has a strong impact on the health of farmers. Improved health not only enhances the growth of agricultural production, but also increases farmers' income, as poor health negatively influences farmers' income and productivity [32].

The results of agricultural employability (EMPL_AGRI) have a negative effect on the dependent variable, this statement does not corroborate with the theory, however studies explain it by the fact that the agricultural labour force is not sufficiently qualified to better boost agricultural productivity [31]. However, the result for fertilizer consumption (CONS_ENGR) shows a negative effect on agricultural value added per worker and is highly significant. These results confirm the work of [33] in the analysis of public agricultural expenditure and growth in Indonesia, showing the negative influence of fertilizer consumption on agricultural growth. According to the literature, fertilizer consumption should have a positive effect on agricultural growth; this theory is confirmed by the work of [34] the negative effect can be explained by the higher market price of fertiliser.

3.6 Validation Test

After the interpreting of the results of this model, in this next step, we are interested in testing the three main hypotheses. Such as, the hypotheses of normality of the errors, test of heteroscedasticity and test of stability of the coefficients of the model in order to keep the model globally significant, for an overall relevance of the regression and to avoid falling into spurious regressions. In Table 7, we therefore accept the hypothesis of homoscedasticity (ARCH (0.495) > 0.05), test for normality (0.479) > 0.05 and find no autocorrelation (Breusch Godfrey (0.100) > 0.05.

Table 5. Short-term relationship

Dependant variable : D(PIBAGR_TRA)				
Variable	**Coefficient**	**Std. Err.**	**t-Statistic**	**Prob.**
D(Expenditure on agriculture)	-0.001222**	5.66E-05	-21.57402	0.0295
D(Expenditure on agriculture (-1))	-0.026063***	7.20E-05	-361.9539	0.0018
D(Expenditure on education)	-0.513264***	0.001184	-433.6532	0.0015
D(Expenditure on education (-1))	0.139364***	0.000353	395.0024	0.0016
D(Expenditure on health)	-0.096267***	0.000250	-384.3800	0.0017
D(Expenditure on health (-1))	0.016845***	6.32E-05	266.3699	0.0024
D(Number of jobs in the agricultural sector)	-0.057939***	8.89E-05	-652.0737	0.0010
D(Number of jobs in the agricultural sector (-1))	-0.044447***	0.000136	-327.7494	0.0019
D(Fertiliser consumption)	-0.003223***	8.63E-06	-373.2802	0.0017
D(Fertiliser consumption (-1))	-0.006956***	2.16E-05	-321.6260	0.0020
CointEq (-1) *	1.629100***	0.004489	362.9124	0.0018

*NB: conventional threshold; 1% = ***, 5% = **, 10% = **

Table 6. Long-term relationship

Dependant variable : PIBAGR_TRA				
Variable	**Coefficient**	**Std. Err.**	**t-Statistic**	**Prob.**
Expenditure on agriculture	-0.013843**	0.000449	-30.83802	0.0206
Expenditure on education	0.383399**	0.010155	37.75589	0.0169
Expenditure on health	0.026209***	0.000284	92.42497	0.0069
Number of jobs in the agricultural sector	-0.048286***	0.000140	-344.1918	0.0018
Fertiliser consumption	-0.004287***	5.61E-05	-76.40844	0.0083
C	8.789288***	0.040658	216.1742	0.0029

*EC = PIBAGR_TRA - (-0.0138*DEPAGR + 0.3834*DEPEDU + 0.0262*DEPSANT - 0.0483*EMPL_AGRI - 0.0043*CONS_ENGR + 8.7893) ; NB: conventional threshold; 1% = ***, 5% = **, 10% = **

Table 7. Validation test

	Test de normalité	**Test Breusch-Pagan-Godfrey**	**Test ARCH**
Long terme	1.4701	0. 2982	0.4882
	(0.479)	(0.100)	(0.495)

4. CONCLUSION

The study analysed the effect of public expenditure on agricultural growth in Mali. Our results show that agricultural expenditure, sector employability and fertilizer consumption have significant negative effects and that education and health expenditure positively influence agricultural value added per worker in Mali. The results of the effects of public agricultural expenditure are contrary to the literature and several empirical works. For the value added of the agricultural sector per worker to increase, the government should increase and properly monitor its expenditures in all sectors in order to have an efficient allocation and mainly the agricultural sector, which is the backbone of this country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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