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Convergence in the agricultural economic industry in Indonesia: A dynamic

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Abstract

So far, from the existing papers, there are few empirical examinations that link or combine health, education, and technology into the factors that affect national agricultural income. In general, the discussion is limited to the relationship between labor, investment, consumption, government spending, and exports to agricultural GDP. In addition to labor, investment, consumption, government spending and exports, this work attempts to include elements of health, education and technology which are seen as important in strengthening the agricultural sector. A series of data series were observed in simultaneous and partial regression modeling. The case study is Indonesia, where testing was conducted during 2010–2022. The empirical findings conclude two points: (1) involving health, education, and technology, results are better on agricultural GDP growth than without including all three; and (2) although initially health, education and technology were very essential, only health has positive implications for GDP growth. Without these three variables, in the short term, labor, investment, consumption, government spending and exports also play a role in the development of the agricultural economy in Indonesia. Thus, labor, consumption and exports remain to be increased for the future of agricultural GDP by optimizing human capital through health, education and technology.

Keywords: GDP of agricultural, Income growth, Data series regression, Indonesia.

1. Background

In any nation, agriculture is a guarantee of human survival. In the development landscape, agriculture plays a primary role in driving other sectors. Take an example in developing markets, for example from Indonesia, where the majority of agricultural capabilities are still conventional. When talking about the conventional system, the added value of Indonesian agriculture is increasingly losing competitiveness compared to other product maneuvers such as manufacturing and services (Utomo et al., 2023).

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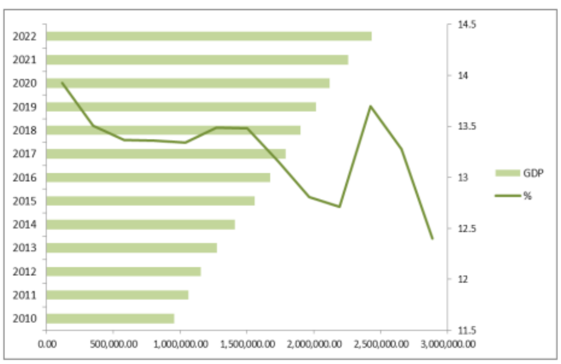
Naturally, agricultural productivity is supported by investment, labor, consumption, government spending, and export volume (Amare et al., 2021; Arifah & Kim, 2022; Blanco & Raurich, 2022; Borsari & Kunnas, 2020; Edeh et al., 2020; Hamilton et al., 2022; Kipruto & Nzai, 2018; Liu et al., 2022; Nyiwul & Koirala, 2022; Petre & Ion, 2019; Siaw et al., 2018; Wangusi & Muturi, 2015; Xing et al., 2023). However, advances in ecosystems and the existence of agriculture also need to change traditional ways to become more modern. Nolte & Ostermeier (2017) and Saleh et al. (2022) claim that in order to encourage agricultural aggressiveness, professional worker insights must be improved. Besides, agricultural governance also requires expansive technological stimulation (Self & Grabowski, 2007; Sinha, 2019).

From the era of reform to democracy, the root of the problem of the agricultural cycle lies in the adoption of technology and the level of mastery or knowledge surrounding intense planning, business incubation, procedures and strategies. Sometimes, agriculture is only used as a popularity project without thinking about long-term progress. At the same time, the obstacles to the revival of agriculture are the weakness of health, education, and innovative technology (Bawono & Widarni, 2021). Ironically, this contrasts with the agricultural portrait of nations that have spectacular agriculture. Agricultural progress is not only created by economic factors, but also brought about by education, farmer health, and strategic quality of technology. Superiorly, the benefits of an agricultural economy focused on revolutionizing technological capital, healthcare, and human resource competences play evidence of being inclusive of well-being in China and the United States (Huffman, 2001; Huffman & Orazem, 2007; Kang & Hu, 2018).



Graph 1. Profile of the GDP and economic growth of agricultural in Indonesia
Source: Central Bureau of Statistics-Indonesia (2023a,b).

From year to year, the current price Gross Domestic Product (GDP) and Indonesia's agricultural economic growth are positive. In quantitative terms, the average nominal value reached IDR 1,659,876.92 billion with an average growth of 13.27 percent. Until 2022, there will be a significant increase in the contribution of agricultural GDP. When viewed based on growth, there is an inconsistent polarization. The downward trend in growth in 2010–2014, to be precise, was from 13.93 percent to 13.34 percent. Then, it rose again to 13.49 percent in 2015 and contracted again in 2016–2019, where it was shown by 13.48 percent to 12.71 percent. Then, it increased by 13.7 percent in 2020 and decreased again since 2021-2022 which was confirmed to grow from 13.28 percent to 12.4 percent. Indonesia's agricultural GDP production capacity is indeed impressive, but it has not been matched by comprehensive growth. The peak of relatively rapid growth was detected in 2010 reaching 13.93 percent, while the smallest in 2022 was 12.4 percent (see Graph 1).

The lack of disbursed investment has triggered uncertainty about the future of agriculture in Indonesia. Smaller access to capital indicates lower agricultural performance, including the socio-economic resources used. In a more holistic lens, the premise built is how agriculture can absorb employment, attract investment, stimulate consumption, motivate the government to provide loans and guide partnerships, and establish collaboration in trade ties with exporters. So far, the focus on resolving the agricultural polemic has only been oriented towards its potential, but the main key is centered on a structure that accommodates and emphasizes the urgency of health, education and technology.

So far, scientific magazines are still limited to identifying the role of the economic and financial dimensions of agricultural GDP. As is the case from Pakistan (Cloud & Alam, 2015; Chandio et al., 2016; Khan et al., 2021), Ethiopia (Emeru, 2023; Ketema & Negeso, 2020), Indonesia (Nugroho, 2017), Tanzania (Epaphra & Mwakalasya, 2017), Nigeria (Verter & Bečvářová, 2016), and developing countries (Nugroho et al., 2021) that the labor force, investment, consumption, government spending, and exports can grow agricultural GDP systematically. In other words, there are other endogenous aspects that are not investigated, giving rise to conceptual gaps. In the context of human capital, Czyżewski et al. (2021), Mehdi (2011), Wang et al. (2022), Zaika & Gridin (2020), and Zubović et al. (2009) argued that the pillars of health-education-technology are crucial for the agricultural chain. Ideally, the interactions between the three are also integrated and become an integral part of the agricultural economic corridor. Referring to the theoretical foundation, terminology, and relevance from an agricultural perspective, this work inspires the following two motives:

- Exploring collective causality between labor, investment, consumption, government spending and exports to agricultural GDP without elements of health, education and technology.
- Analyze the implications of labor, investment, consumption, government spending and exports on agricultural GDP in synergy with health, education and technology.

The contents of the paper are organized into six points: 1–Background introducing the purpose and objectivity of the research; 2–Materials and methods of mapping data design, variable instruments, and econometrics; 3–Results and discussion show empirical findings and to explore studies with literature-comparative arguments; 4–Conclusion reinforces evidence, proposes policy recommendations, simulates long-term ideas, and clarifies weaknesses in studies that invite new scientific treasures; and 5–Reference detailing bibliography.

2. Research methods

2.1. Database and core of variables

In general, the focus on the agricultural sector includes 3 subs: (1) agriculture, animal husbandry, hunting, and agricultural services; (2) forestry and logging; and (3) fisheries. The composition of the data is within 13 periods or is set throughout 2010–2022. The observation component adapts, collects, and compiles secondary data. Data information materials are taken from official government documents. The statistical data authority sorted by the Central Bureau of Statistics-Indonesia publishes annual data via the website in several versions according to the data format. The standard operationalization of the variables is described below.

- GDP (percent): agricultural GDP at current prices;
- Labor force (farmers, including laborers): workers aged 15 and over who work in the agricultural sector;
- Investment (IDR billion): realization of domestic investment in agriculture;
- Consumption (index): the exchange rate of farmers in consuming machinery expenditure, labor wages, land rent, transportation, wages, equipment, seeds and fertilizers, as well as other needs in the agricultural business;
- Government spending (IDR billion): central government spending allocated to agriculture;
- Exports (percent): growth in exports of agricultural products;
- Health (age): life expectancy at birth on an agricultural scale;
- Education (years): average length of schooling for agricultural activists; and
- Technology (percent): proportion of computer use and information skills in agricultural commodities.

The nine variables have different arithmetic measures. Each variable describes its characteristics and definition, so it is useful to describe the construction of indicators. In essence, to understand the shape of the variable, it is broken down into two packages. GDP reflects the dependent variable which is controlled by independent variables including: labor, investment, consumption, government spending, exports, health, education, and technology. In principle, the independent variables are categorized to cover GDP.

2.2. Statistical models

After the compilation phase, the data is modified and processed using data series regression. This technique aims to tabulate, verify data, and present an analysis that elaborates on whether there is a change or vice versa in the relationship between the linked variables. Basic statistics combines 4 mechanisms: descriptive statistics–analysis of variance (ANOVA)–coefficient of determination and correlation–partial effects. Fundamentally, the equation function of labor, investment, consumption, government spending, and exports to GDP were written as follows:

$$GDP_t = \alpha_0 + \beta_1 lnLAB_t + \beta_2 lnINV_t + \beta_3 lnCON_t + \beta_4 lnGOV.SPE_t + \beta_5 EXP_t + e_1 \quad (1)$$

For the second formulation, facilitating additional variations (health, education, and technology) expressed as follows:

$$GDP_t = \alpha_0 + \beta_6 lnLAB_t + \beta_7 lnINV_t + \beta_8 lnCON_t + \beta_9 lnGOV.SPE_t + \beta_{10} EXP_t + \beta_{11} lnHLT_t + \beta_{12} EDU_t + \beta_{13} TECH_t + e_2 \quad (2)$$

where: β_0 = intercept; $\beta_1,..\beta_{13}$ = slope coefficient; *ln* = log; *t* = time/period; *e* = error.

Furthermore, relying on the function equation above, the decision making hypothesis is transformed as follows:

$$Null\ hypothesis = \rho > 5\ or\ 1\ percent \quad (3)$$

$$Alternative\ hypothesis = \rho < 5\ or\ 1\ percent \quad (4)$$

The articulation of the two hypotheses offers: if the degree of significance is above 0.05 or 0.01, then the null hypothesis is accepted and the alternative hypothesis is rejected. Conversely, if the significance level is below 0.05 or 0.01, then the alternative hypothesis is accepted and the null hypothesis is rejected.

3. Result and discussion

3.1. Descriptive statistics

The first parameter is descriptive statistics. Table 1 highlights the items in the descriptive statistics including: mean, standard deviation, minimum, and maximum. Uniquely, of all the variables, there are two (capital and government spending) and three (GDP, exports and technology) which have the same benchmark. On the other hand, the other four variables: labor, consumption, health, and education have different units of measurement.

Table 1. Descriptive statistics from variables

Variables	Mean	Std. Dev.	Min.	Max.
Labor	40,302,137.77	1,405,167.29	38,296,298	42,825,807
Investment	214,202.72	141,342.01	37,799.8	447,063.6
Consumption	106.22	4.88	98.3	112.67
Government spending	259,194.01	152,718.45	57,359	511,338.1
Export	2.57	7.94	-9.98	14.02
Health	70.86	.63	69.81	71.85
Education	8	.42	7.46	8.69
Technology	60.69	24.14	27.59	93.21
GDP	1,659,876.92	473,309.4	956,119.7	2,428,900.5
N	13	13	13	13

Source: output from SPSS v.29.

Table 1 displays the three items in the descriptive statistics: mean and maximum for all variables sorted from highest to lowest score. Starting from labor, GDP, government spending, investment, consumption, health, technology, education, and exports. The standard deviation and minimum scores are exactly the opposite, where there is an anomaly between the two items. Hierarchically, the level of consumption which was previously ranked 5th in terms of mean and maximum, specifically in terms of the standard deviation, obtained 4.88 or was ranked seventh and health, which was originally ranked 6th, is now ranked eighth with a score of 0.63. Likewise, education is found in rank 7, in the standard deviation it is in the lowest position with a score of 0.42. In substance, at the minimum value, exports are the smallest and consistent with the mean and maximum values. There is a recession to export growth which is explained by the minimum score of -9.98. Interestingly, fantastic changes to the consumption and health of the minimum items. In outline, the authentic sample is 13.

3.2. ANOVA

In this subchapter, we dedicate an ANOVA test that examines the interrelationships of factors in agricultural GDP growth including: labor, capital, consumption, government spending, and exports without health, education, and technology or with these three dimensions. Concretely, the parallel effects among the variables are summarized in Table 2.

Table 2. Simultaneous levels excluding health, education, and technology

Model	Sum of Squares	Mean Square	F-statistic	Sig.
Regression	1.432	.286	2.056	.024*
Residual	.656	.094		
Total	2.088			

(*) Significant level at 5%.
Source: Output from SPSS v.29.

Implicitly, Table 2 tells that labor, investment, consumption, government spending, and exports have an effect on GDP. This is justified by a positive F-statistic score (*F-statistic = 2.056*) and a probability below 5 percent (*ρ = 0.024*). This means that without health, education and technology initiatives, Indonesia's agricultural GDP could be significantly boosted by labor, investment, consumption, government spending and exports.

Table 3. Simultaneous levels with health, education and technology approaches

Model	Sum of Squares	Mean Square	F-statistic	Sig.
Regression	1.788	.224	3.986	.008**
Residual	.299	.075		
Total	2.087			

(**) Significant level at 1%.
Source: Output from SPSS v.29.

The results of the second evaluation still address employment, investment, consumption, government spending and exports on GDP growth, but take initiatives to empower health, education and technology. An ANOVA test targeting the relationship of labor, investment, consumption, government spending, and exports complemented by health, education, and technology proves a dominant influence (*F-statistic = 3.986*; *ρ = 0.008*) or below 1 percent. The aspects of health, education and technology present more positive effects than without these three elements, thus allowing for a significant influence on increasing Indonesia's agricultural GDP (see Table 3).

3.3. Coefficient of determination and correlation

The strength of the relationship between variables, grouped into two. First, the coefficient of determination tests the critical level and error value in a relationship. Second, the attention of the correlation coefficient to correct the sensitivity of the relationship of the independent variable to the dependent. Table 4 and Table 5 give signals on the determination and correlation scores. The results of both classifications show that labor, investment, consumption, government spending, and exports (excluding health, education, and technology) have a determining power of 82.8 percent, of which it is undeniable that there are still confounding factors reaching 17.2 percent. Unfortunately, this was also followed by the acquisition of a correlation whose coefficient score reached 68.6 percent indicating that the preference for the model built was "moderate". Normally, the critical point of the relationship in agricultural GDP is reached by interconnected lines, where it has not been shown by integrative linkages.

Table 4. Correlation and determination (excluding health, education and technology)

Model	R	R-Square	Adjusted R-Square	Std. Error of the Estimate
1	.828	.686	.461	.30612

Source: Output from SPSS v.29.

Table 5. Correlation and determination (including health, education and technology)

Model	R	R-Square	Adjusted R-Square	Std. Error of the Estimate
1	.926	.857	.570	. 27360

Source: Output from SPSS v.29.

In the second model, the strength of the relationship in employment, investment, consumption, government spending, and exports to GDP growth upgraded by health, education, and technology is concluded to be "high". This superiority is indicated by a coefficient of determination of 92.6 percent and a correlation score of 85.7 percent. Rationally, by applying health, education and technology, labor, investment, consumption, government spending and exports are the most reasonable options to boost Indonesia's agricultural GDP. With a residual score of 7.4 percent, it is considered outside the variables that support GDP growth.

3.4. Partial estimation

Individually, Table 6 examines the interrelationship of variables without the mediation of health, education and technology in the GDP growth cycle. The constant implies short-term causality, which is positive (*β = 209.496*; *ρ = 0.039*). Yet, flows of investment and government spending have had a negative impact on agricultural GDP. Unstandardized coefficients and significance on investment (*β = -0.678*; *ρ = 0.405*) and government spending (*β = -0.166*; *ρ = 0.795*) describe inequality. The suitability of the hypothesis is actually shown by labor (*β = 11.084*; *ρ = 0.001*), consumption (*β = 1.720*; *ρ = 0.029*), and exports (*β = 0.017; ρ = 0.006*) which have a significant impact on Indonesia's agricultural GDP in the long term.

With the involvement of health, education and technology, it is proven that it does not guarantee short-term effects in influencing Indonesia's GDP. Table 6 also presents a decreasing trend when including elements of health, education, and technology in agricultural GDP productivity, where the slope is constant, and the probability is negative (*β = -292.808*; *ρ = 0.453*). Of the variables selected in the second model, five variables were found that had a significant effect on agricultural GDP growth. These variables are labor (*β = 1.648*; *ρ = 0.019*), consumption (*β = 2.696*; *ρ = 0.000*), government spending (*β = 2.121*; *ρ = 0.042*), exports (*β = 0.054*; *ρ = 0.028*), and health (*β = 74.467*; *ρ = 0.007*). Practically, investment (*β = 0.766*; *ρ = 0.524*), education (*β = -0.240*; *ρ = 0.867*), and technology (*β = -7.045*; *ρ = 0.109*) which are validated do not significantly affect GDP. Education and technology have proven not to actualize Indonesia's agricultural GDP in the long term. Too, the status of the two around the variable model also indicates that they cannot replace the role of the other five endogenous factors.

Table 6. Partial prediction without HET and using HET

Model	Without HET		Using HET	
	β (*p*-value)	*t*-statistic (SE)	*β* (*p*-value)	*t*-statistic (SE)
Constant	209.496*	2.054	-292.808	-.831
	(.039)	(101.989)	(.453)	(352.472)
ln_Labor	11.084**	1.847	1.648*	1.630
	(.001)	(.061)	(.019)	(.131)
ln_Investment	-.678	-.885	.766	.696
	(.405)	(.765)	(.524)	(1.100)
ln_Consumption	1.720*	2.226	2.696**	3.019
	(.029)	(.156)	(.000)	(.242)
ln_Government	-.166	-.270	2.121*	1.437
spending	(.795)	(.614)	(.042)	(.476)
Export	.017**	1.201	.054*	2.066
	(.006)	(.014)	(.028)	(.026)
ln_Health	–	–	74.467**	1.465
			(.007)	(.389)
Education	–	–	-.240	-.179
			(.867)	(1.342)
ln_Technology	–	–	-7.045	-2.055
			(.109)	(3.429)
Obs.	13	13	13	13

(*) Significant level at 5% and (**) Significant level at 1%; Abbreviation: HET (health, education and technology) and SE (std. error).
Source: Output from SPSS v.29

The wave of globalization allowed the economy to open up to agricultural markets. Besides that, it is at the same time risky and raises a fatal alarm if it is not followed by permanent cross-layer optimization. As this work illustrates, even though the acceleration of agriculture in Indonesia is not only handled by elements of labor, domestic investment, consumption, government spending, and exports, but also includes aspects of health, education, and technology, the results are inconsistent with an integrated commitment. Therefore, it cancels the growth of the agricultural economy. The consequences of the human capital development program are contradictory in quality, triggering a crisis towards the planned mission. Surprisingly, although the simultaneous effect of concluding naturally and post-implementing health, education, and technology can boost GDP growth, it contrasts with the partial effect. The statistical output actually concludes that the inclusion of education and technology in the regression model is proven to reduce agricultural GDP.

The analogy above has been discussed by Kabiru (2020), Lin & Wu (2021), Ninh (2021), Njura et al. (2020), O'Donoghue & Heanue (2018), Pingali et al. (2019), and Yu et al. (2023) explained that educational creativity and technology transfer will determine continuous agricultural management. From Katsina–Nigeria, Vietnam, Kenya, Ireland, China and India, the more these two pillars are enhanced, the more they shape agricultural effectiveness. The level of agricultural maturity in a particular area is highly dependent on educational participation. By providing an equitable education, acceptance of technology is easily accepted. Ease of technology and education can also reduce some of the work, especially for those who have low understanding in operating agriculture.

From the existing issues, innovation in the world of health nutrition awakens farmers to take opportunities, learn, behave and stimulate better physique in the management of agricultural land. As a result, food security is a priority. Agriculture cannot be ignored as if it is a non-formal form of routine, but this profession can be developed and even open up employment opportunities widely. For the global case, middle and low income countries, India, rural areas–Ethiopia, and in Bima–Indonesia, prosperity is realized by a two-way connection between health and agricultural income (Donham & Thu, 1993; Hawkes & Ruel, 2006; Tenriawaru et al., 2021; Thow et al., 2018 Ulimwengu, 2009). By controlling the internal environment, conducive agricultural targets can be highlighted.

4. Conclusion

The synopsis of this work is related to clusters affecting agricultural GDP. The test links the effects of labor, capital, consumption, government spending, and exports on agricultural GDP and assumptions involving health, education, and agricultural technology. The regression results conclude that without the attributes of health, education, and technology, labor, consumption, and exports significantly influence agricultural GDP growth. Here, the most conspicuous variable is exports. In other schemes, apart from government spending and health, these three variables also have a significant impact on Indonesia's agricultural GDP. Regardless of health, education and technology, fixed investment has no effect on GDP. Unfortunately, through the involvement of health, education and technology does not change agricultural economic growth in a positive direction.

Realizing the facts, we criticize the reputation of agricultural stakeholders in overseeing regulatory forums, technocratic planning, and a literacy mindset. The reason is, for 13 periods, actors in macroeconomic policy have neglected education and technology in agriculture. Only health can catch the radar of the agricultural economy. The rest, education and applied technology, also do not create an investment climate. In the future, practical suggestions are proposed to regulators to prioritize the harmonization of the investment framework and remuneration for farmers. Besides that, the image of the agricultural sector which is increasingly sinking, must also be improved in a competitive manner. The limitations of scientific work lie in the less comprehensive variables of agricultural education and technology. Based on this experience, advanced expectations can think logically and review the actual indicators outside the analysis model to lead to a shining agriculture.

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