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## **Review on the Opinions about the Application of Diminishing Returns Law**

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### **Abstract**

The importance of human needs upon food causes an opinion that agricultural sector is a productive sector with its surplus between the production and consumption results. The role of land is very essential for realizing the fulfilment of food needs. The combination between land and other production factors will result in food.

The economic thinkers from Physiocracy and Classical School stated that a theory on land rent which initially found in the framework of Turgot (1766) and David Ricardo (1821), as well as Thomas Robert Malthus (1820), brought a consequence on the application of Diminishing Returns law in agricultural production.

**Keywords:** input; output; production elasticity; production function.

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## 1. Introduction

The development of human population along with the passage of time must be balanced with the efforts in increasing the number of food production whose minimum amount is equal with the percentage of human population development, thus the food need per capita can be maintained. Quesnay [5] suggested that only in agricultural sector, the surplus could be generated, or only in agricultural as well that the output exceeded the input that used for producing the intended output.

Obviously, Quesnay's statement describes that the relation between input and output, for the farmers as producers of agricultural products, must be able to combine variable input and fixed input in such way in order to create a surplus of agricultural products above the used input. A mathematical description of various possibilities on technical production is stated as the production functions that give maximum output in physical measurement of each input in its physical measurement as well.

Considering that there is only one variable input, and respectively, each unity of variable input will be added in a certain number of other inputs, there will be some possibilities of relation, namely: (1) output increases in the same amount, (2) output increases greater than earlier unities, and (3) smaller increase in production result than earlier increases. Moreover, remembering that the balance between variable input and fixed still shows a greater ratio with the addition of variable input units, then if the experiments are conducted from period to period, the output resulted will show a greater increasing, and continued with smaller increasing until reaching its maximum output. Such condition is regarded as the application of diminishing returns law.

In the event that the maximum output is already achieved, the addition of variable input consumption must be stopped or no longer necessary, because it will precisely decrease the amount of output compared to the previous period. Reference [1] stated that this law of diminishing returns showed a condition where comparisons from the input were changed, thus the law of diminishing returns was regarded as the *law of variable proportion*, namely the law of technology that depicted the physical relation between input and output.

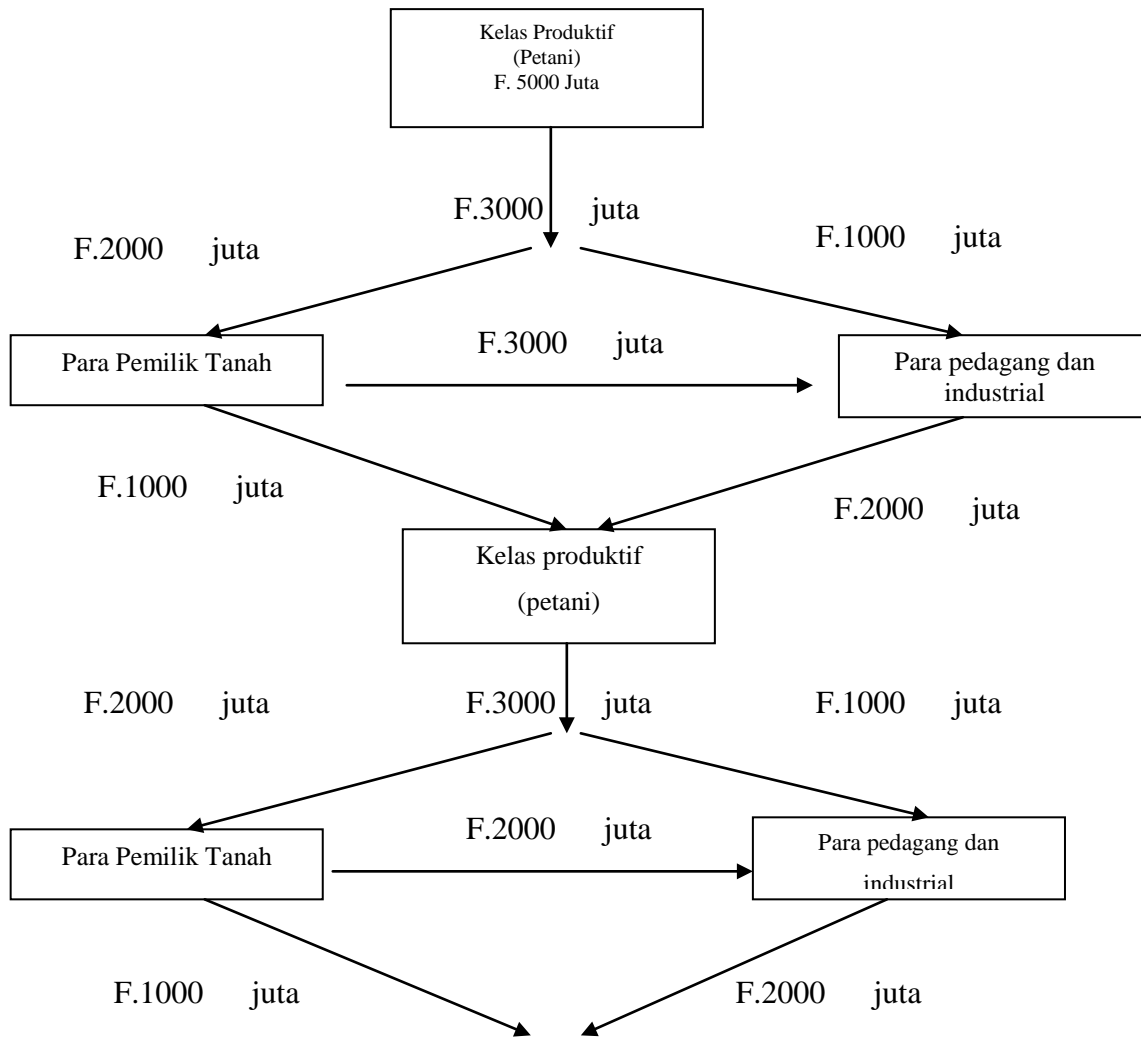
## 2. Review of Literatur

### 2.1. Opinions From Physiocracy School

Two well-known figures from Physiocracy school are Francois Quesnay (1694-1774) and Jacques Turgot (1721-1781 [2]. The term of Physiocracy was first used by Quesnay. Physiocracy comes from two words, which are *physic* (nature) and *cration* or *cratos* (power). The Physiocrats suggested that this nature as God's creation was full of balance and harmony that spread anywhere and anytime. According to Quesnay, the law of economy that is in accordance with the law of nature will make nature as the source of prosperity. Certainly, the logical nature is the land along with water and air, as well as the sun, in human's intervention to grow plants and to breed animals in the activities of agriculture, animal husbandry and fisheries. From the said activities, human beings may gain prosperity.

The land is able to produce output that exceeds the raw material and equipment used in the production. Therefore, the land produces surplus for the society in a whole. Furthermore, agriculture must be modernized.

Quesnay argued that the investment in a new technology will be more beneficial. The agriculture must be more capitalistic, thus it will increase the agricultural productivity or surplus produced by the agriculture. Surplus from agriculture becomes the most essential result for the capital accumulation in agricultural field. Quesnay's opinion, stating that only land that is capable to produce, becomes the base of thought set forth in the form of *tableau economique* as shown in figure 1 below:



**Figure 1:** *Tableau Economique* [7]

The above tableau was first compiled by Quesnay in 1759 [6]., depicting that the economy had three different classes or sectors, which were (1) agricultural sector that produced food, raw material, and other crop plants, (2) manufacturing sector that produced factory's goods, and (3) the land owners that not produced any values, but they received the rent as surplus payment over the land used for producing output. Quesnay realized that the assumption of such input-output relation depended on the production techniques utilized in agriculture. In Quesnay's tableau, it assumes that all incomes are spent, and such expenditure is equally divided between agricultural products and manufacturing goods. The productive class produces 5000 million francs. From the

said 5000 million francs, 2000 million francs is out of distribution, which is kept by farmers for their own needs, livestock, and seeds. Then, from the remaining 3000 million francs, it is divided into 1000 million francs that distributed to the *sterile class* (traders and industries) for purchasing industrial products, while 2000 million francs is sent to the land owner as the land rent. With 2000 million francs, the land owner uses it for buying food amounting to 1000 million francs, meaning that it flows to the farmer itself, and another 1000 million francs is used for purchasing industrial goods, thus the money is for the sterile class. Finally, *tableau economique* illustrated above is explaining about a theory of static division, in which the entire community's result and any portion received by each group for time to time do not change. In such *tableau*, Quesnay clearly shows the relation among various economic life.

In line with Quesnay's thinking, Turgot views that the net product created by farmer is the only one source that can sustain the life of other community's groups, because the farmer will be able to hire labors. Such paid labors gain salary as the reward for their services, given by the land owners. Surplus that resulted in agricultural field is mostly enjoyed by the land owner as the land rent, which is in its turn; such land rent will be increasingly accumulated. According to Turgot, the high and low level of the land rent is different, based on different fertility of the land used for producing the output. This definition, by Turgot, is called as a tendency in agricultural production that increasingly decreases, which is then in economic theory known as ***Law of Diminishing Return***.

Although the agricultural production has multiple capital addition, it does not give physical production according to the multiple capital addition. Even though in an absolute manner the physical production result or output increases, but, relatively, the said increase in the balancing with the amount of capital used shows that the output increases with decreasing percentage. Farmer in a good quality (with fertile soil) is always limited in producing agricultural products. In the efforts to increase production, a larger land is necessary. But, because a good quality land is limited for producing food, it uses a land with lower fertility. Such condition can admittedly increase the physical result, but with lack of increases, the addition of larger land will arrive in another condition where the addition of production is zero; it means that the output has reached its maximum.

## ***2.2. Opinions From Classical School***

Turgot's thinking about the application of *the law of diminishing returns* in agriculture becomes a starting point that grounding the thinking of Thomas Robert Malthus in 1820 [2] about theory of population. According to Malthus, the number of population and their life has a close relation with the availability of production resources. Malthus explained about the existing relation between population growth and the availability of production resources, in which the number of population will grow if the production resources grow also. Remembering that the production resources are rare, Malthus states that there will be a condition where people is unable to consume as in the normal life, which is called as *Theory of under consumption*. In this kind of condition, the people's consumption is at levels that fall below the needs of normal life.

The production resources in its increasingly rare condition, qualitatively and quantitatively, will be decreasing the physical results, while in another side, the people continues to grow, both in an absolute manner and relative terms, in the balancing of available resources. This will complicate the human's life, unless if the population

growth arrives at its own limitation. That circumstance can happen naturally, such as in natural disaster, contagious diseases, war and mass starvation, causing a massive death. However, it can also happen due to the humans' behavior itself, such as avoiding child's birth through *abstinence*, prohibiting any actions that cause to birth, including prohibition to have a sexual relationship.

The core of Malthus' population theory at that time was really impressive among the global society as its statement saying that the world population could grow faster than their ability in maintaining their level of life. The population grows geometrically (1, 2, 4, 8, 16, 32), while food increases arithmetically (1, 2, 3, 4, 5, 6). The gloomy perspective of Malthus' view, according to Malthus, could be calmed down with preventive actions, such as through family planning and postponement of marriage period. According to Malthus, the application of *diminishing return* in agricultural sector would occur when the land planted became larger. Each addition of new land planted would produce in less food addition than the production gained from previous planting in one land. A faster growth of population compared to the food increasing will cause less availability of food than it shall be needed.

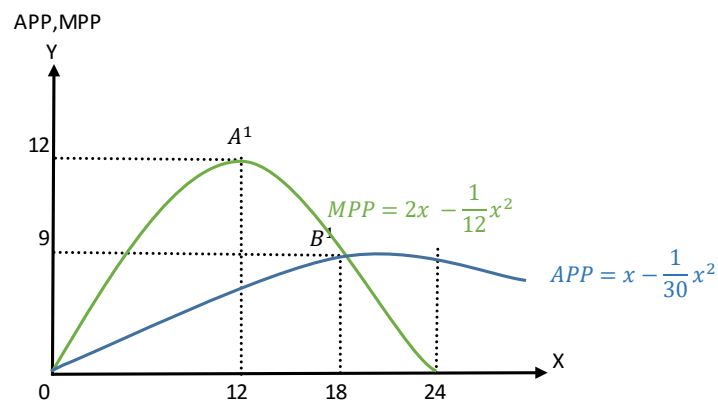
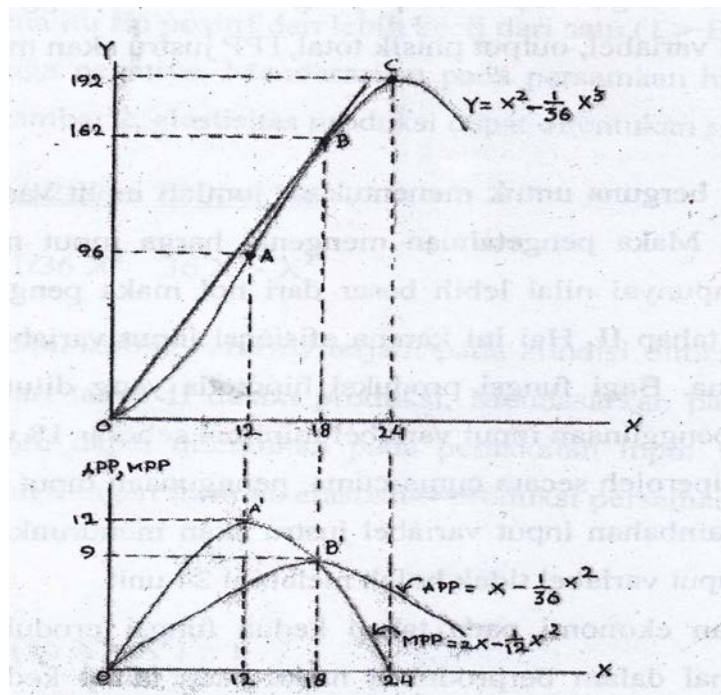
Another opinion from classical school that relates to agricultural sector is stated by David Ricardo (1772-1823) [4] regarding the value and price. He said that the value and price of goods sourced from the work of human labor. Later, this statement is underlying the theory of salary. Salary as a reward for human labor is required for maintaining and continuing the life of labors. When the food production cost increases due to the higher payment of land rent, the food price must also increase. This condition gives impact on the salary increasing, because with higher salary, the labors will be able to buy food in higher price as well. In a consequence, the labors will be also able to maintain their standard of life. The opinion by David Ricardo in the theory of goods value and price and theory of salary and *land-rent* may lead to a thought on the application of diminishing returns law in agriculture, as expressed by a thinker from Physiocracy school named Jacques Turgot.

### **2.3. The Law Of Diminishing Returns In Agriculture**

The law of diminishing returns developed by David Ricardo from Classical school is started from the thinking of Physiocracy school. The said law describes a relation between production result (output) and a variable production factor (input) by assuming that the amount of another production factor is fixed. The law of diminishing returns can be stated as follow: *If the unities of a unit are respectively added to numbers of another certain input, it will reach to a point where the additional production result per the unity of additional input will decrease [1].*

The law of diminishing returns in production theory is called as the *law of diminishing productivity* or the *law of variable proportions* [3]. Such law explains that the production method does not change, but the changes are in the proportions between variable input and fixed input. The physical relation between variable input X and output Y is described in the production function. For example, the formula is:  $Y = X^2 - \frac{1}{36} X^3$ , in which Y is showing *Total Physical Product (TPP)*. The form of cubic production function is generally known as Classical production function. From the form of said production function, it can be gained the function of *Average Physical Product (APP)* and the function of *Marginal Physical Product (MPP)* as follow:

$APP = X - 1/36 X^2$  and  $MPP = 2 X - 1/12 X^2$ . Those three function of Classical production are shown in figure 2



**Figure 2:** Classical Production Function

The classical production function is divided into three stages or production areas. In stage I, as shown in figure 2, *Total Physical Product (TPP)* initially increases higher up to point A, then it moves down to point B. The point A in production curve is called as *inflection point*, namely a point where production curve changes from convex to concave toward horizontal axis in using input of 12 units and its total amount is 96 units. Therefore, MPP curve reaches its peak on point A'. Through point A', MPP curve moves down, and APP increase until APP reaches the maximum of point B' in using input of 18 units by producing 162 units of TPP. In stage I, MPP

> APP. When it is no longer using input of 18 units in stage I, APP will be maximum, and  $MPP=APP$  amounting to 9 units. The first stage is irrational and also inefficient stage, because every unit in the addition of variable input usage gives a larger production result than before. In this first stage, the balance for variable input used is smaller than the fixed input provided. Stage II in APP decreases and  $APP > MPP$  ends at  $MPP = zero$  in using input of 24 units and TPP reaches its maximum amounting to 192 units. Therefore, stage II is called as rational and efficient stage in agricultural production. The second stage is started at APP with its maximum amounting to 9 units in using input of 18 units and it ends when TPP reaches its maximum of 192 units in using input of 24 units. Stage III is indicated by a decrease in TPP and  $MPP < 0$ . Stage III is regarded as irrational and inefficient stage, because too much variable input are used compared to available fixed input, thus in this stage III, the use of variable input and total physical output are reduced, and TPP will increase.

### 3. Economic Implications

The production function is very useful for determining the amount of variable input and the number of most profitable output. Thus, knowledge about input and output price is very important. If the output has higher value than zero, the use of variable input must be continued up to stage II. This is because the efficiency of variable input that measured by APP is increasing in the first stage. For hypothetical production function as shown in figure 2 and also the equation  $Y = X - 1/36 X^3$ , the use of variable unit is minimally in the amount of 18 units. Although the variable input is free goods which can be obtained without any charges, the use of variable input will be not conducted on third stage; the addition of variable input will precisely decrease total physical output. Therefore, in figure 2, the use of variable input may not exceed 24 units.

At last, according to the economic view upon second stage of production function, including its limits, it can be said as rational stage in production. So, in this stage, the farmer shall produce. However, in order to determine exactly the amount of variable unit used, it must know the price for input and output.

### 4. The Law Of Diminishing Returns And Production Elasticity

The application of diminishing returns law in agricultural production will bring us to the determination of a certain point that commencing the decrease of such result. In inflection point, MPP exactly reaches its maximum, but it occurs in the first stage of production function, using 12 units of input. Meanwhile, APP starts to move down (APP reaches its maximum) when using 18 units of input, and TPP decreases (TPP reaches its maximum) when using 24 units of input. It shows to us that the point that commences the decreasing of such result depends on the side which will be used, namely MPP, APP, or TPP. Therefore, Cassels suggested to use production elasticity for such solution, measuring the degree of sensitivity in output changes that caused by the changes of input uses. [3] 40) show with the following formula:

$$E_p = (\text{percent change in output}) / (\text{percent change in input}) \quad (1)$$

The said formula can be written as follow:

$$E_p = MPP/APP \quad (2)$$

In stage I, MPP is greater than APP. Thus,  $E_p$  is greater than one. In stage II, MPP is lower than APP. Thus,  $E_p$  is positive and smaller than one ( $1 > E_p > 0$ ). Meanwhile, in stage III, MPP is negative and  $E_p$  is also negative. Based on the hypothetical equation of  $Y = X^2 - 1/36 x^3$ , the classical production function, in figure 2, and the production elasticity can be exactly determined as follow:

$$E_p = MPP = \frac{2X - 1/12 X^2}{36 X - X^2} = \frac{72 X - 3 X^2}{36 X - X^2} \quad (3)$$

$$APP = \frac{X - 1/36 X^2}{36 X - X^2}$$

The point of *diminishing returns* occurs in the condition where  $E_p = 1$ , namely a condition (2) when  $MPP = APP$  or the beginning of stage II in production. Based on the amount of production elasticity coefficient that is equal to one, it can determine the amount of variable unit used when the *diminishing return happens* under the following formula of production elasticity equation (3):

$$E_p = MPP/APP = 1$$

$$E_p = (72 X - 3 X^2)/(36 X - X^2) = 1$$

It means that:

$$72 X - 3 X^2 = 36 X - X^2$$

$$72 X - 3 X^2 - 36 X + X^2 = 0$$

$$36 X - 2 X^2 = 0$$

$$2X(18 - X) = 0$$

$$18 - X = 0$$

$$X = 18$$

Thus,  $E_p = 1$  occurs when using 18 units of variable input. In figure 2, it is shown that APP reaches its maximum at point B'. The use of variable input will be always added until  $MPP = 0$ , and  $E_p = 0$ , when using 24 units of variable input. This is the end of stage II in the production. A relevant interval for the farmers in production is in the use of efficient variable input from 18 units to 24 units, in which the coefficient of production elasticity is positive and smaller than one ( $1 > E_p > 0$ ).

## 5. Conclusions And Suggestions

### 5.1. Conclusions

- a. The importance of agricultural sector is stated by an economic thinker from Physiocracy school, namely Francois Quesnay (1694 - 1774) and Jacques Turgot (1721 - 1781), in which agricultural sector



is the only productive sector;

- b. The fact that the source of land production is getting rare, while the population grows increasingly, causes the birth of *theory of under consumption*, as stated by Thomas Robert Malthus;
- c. Theory of *land rent* from Turgot, David Ricardo, as well as the concept of population from Thomas Robert Malthus, is that if the land planted is getting larger, the *diminishing return* applies to agricultural sector;
- d. The concept of production elasticity is useful in determining the interval of relevant input usage in agriculture.

## 5.2. Suggestions

- a. In the agricultural field, it is necessary to determine the form of input-output physical relation in production function for knowing the use of relevant input in the production;
- b. Knowledge on the input and out price is necessary for determining the amount of the most profitable input used.

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