The Role of Investment in the Development of Agricultural Production

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ABSTRACT
In this article, a mathematical model of the development process of an investment in an agricultural enterprise, a farm, which produces a certain product, is created and analyzed

Keywords:

Due to a number of activities and efforts to attract foreign investments in order to raise the economy of our republic to higher levels, a large amount of investments are coming to our republic from abroad, and industrial and agricultural enterprises are being established in mutual cooperation.

The impact of investment in agriculture, especially in farming, on the development of economic activity is important.

Proper use of the investment leads to an increase in the size of the farm's output and profitability.

In this article, a mathematical model of the development process of an investment in an agricultural enterprise, a farm, which produces a certain product, is created and analyzed. $[1-4]$

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Let *x(t)* be the amount of investment in the farm, and let *y(t)* be the size of the farm's output after the investment. If the amount of investment at the initial moment *t=0* is *x(0)=0*, the volume of the farm's output will be $y(0)=y_0$. If the amount of investment made at time t is *x(t)=a > 0*, then the volume of the farm's output *y(t)* will grow in direct proportion to the amount of investment, that is, the relationship between these amounts can be expressed by the following differential equation:

$$\frac{dy}{dt} = kb(t) \qquad (1)$$

From this equation, if *x(t)=0*, then $\frac{dy}{dt} = 0$, and the solution of the differential equation is *y(t)=C=y(0)* equal to the output of the farm without investment. If the amount of investment is *x(t)=b*, the differential equation (1) becomes:

$$\frac{dy}{dt} = kb, \quad dy = kbdt$$

We find the solution of the resulting simple variable differential equation by integrating the equation:

$$\int dy = \int kbdt, \quad y(t) = kbt + C$$

If we use the initial condition, then the solution of the differential equation (1) will be:

$$y(t) = kbt + y_0 \qquad (2)$$

On the other hand, in market economic conditions, any production enterprise increases the volume of its manufactured product *y(t)* depending on the *Y(t)*-demand for its product. In order for the enterprise not to fall into crisis, the volume of its produced product should be equal to the amount of falling demand *y(t) = Y(t)*. That is, in proportion to the amount of investment *x(t)*, we have the following differential equation

$$\frac{dY(t)}{dt} = kx(t) \qquad (3)$$

From this, $x(t)=\frac{1}{k}\frac{dY(t)}{dt}$, if we set $\frac{1}{k} = \mu$, the following differential equation is formed

$$x(t) = \mu\frac{dY(t)}{dt} \qquad (4)$$

Here μ- is called proportionality (acceleration) coefficient.

So, in order for a product-producing enterprise or a farm to fully satisfy the demand for its products, it is necessary to increase the amount of investment in proportion to the increase in demand.

Of course, continuously increasing the amount of investment may not always give positive results. From the differential equation (4), depending on the demand for the product *Y(t),* the following conclusions can be drawn based on the features of the differential calculus:

1) If $Y''(t)=\frac{d^2Y}{dt^2}>0$, $x'(t)>0$ the function will be increasing and it will be necessary to increase the amount of investment;
2) If $Y''(t)=\frac{d^2Y}{dt^2}<0$, the function $x'(t)<0$ will be decreasing and the amount of investment should be reduced;
3) If $Y''(t)=\frac{d^2Y}{dt^2}=0$, then $x(t)$- the amount of investment should not change in a certain time interval.

In general, microeconomic processes, in particular, the activity of a product-producing agricultural enterprise or farm, can be expressed in the form of the following simple linear differential equation:

$$y^1+k(t)\cdot y(t) = b(t) \qquad (5)$$

Here *y(t)* is the price of the product produced by the farm at time *t*, *b(t)* is the amount of investment in the farm at time *t*.

In the process of growing grain, cotton, rice, livestock and other products, the farm uses equipment and tools necessary for production, and they wear out over time. As a result, the farm spends a certain part of its total funds on the repair of machinery and tools (in this case, $k=-k(t)<0$ in equation (5)) and on product production costs, consumption, and taxes. Partially taking these into account we can write differential equation (5) representing microeconomic processes as follows

$$y^1 = k(t)\, y(t) + b(t) \qquad (6)$$

An example. 120 million for the farm for 2 years. Soum investment was allocated. How to give this money:

1) 60 million per year. from soums for two years (Figure-1), or

2) a total of 120 million soums in the first year. giving soum will be beneficial for the farmer (Figure-2)

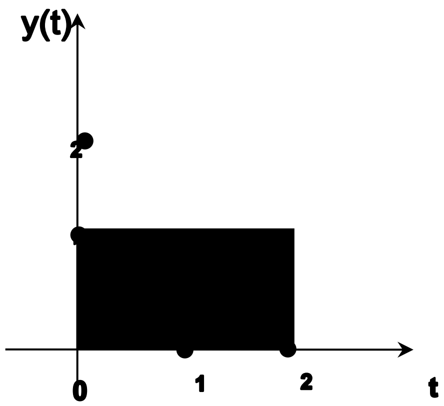

Figure-1

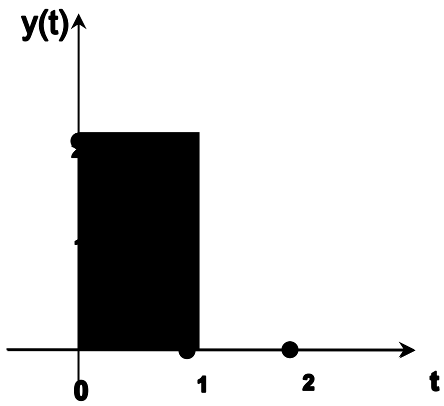

Figure-2

The farmer has just started work, let his output be $y(0) = 0$.

Based on the condition of the problem, the investor continuously transfers *x(t)*-sum units of money to the farm at *t*-time. If the product produced by the farmer is *b(t)* on the account of the input investment, it represents the following differential equation in the unit of money

$$Y^1(t)=x(t)\,,\, y(0) = 0.$$

1) With investment made in the first year, this equation is as follows: $x(t) = 1,\ 0<t<2.$

As a result, $Y'(t)=1$ is the solution of the differential equation

$$Y(t)=t+S,$$

based on the initial condition, $y(0)=0$, hence $Y(t)=t$ in the interval $0<t<2.$

The surface of the resulting triangle (Fig. 3, 1 unit per year from the t-axis, 1 unit per 60 million soums from the *Y(t)*-axis)

$$S=\frac{1}{2}\cdot ab=\frac{1}{2}\cdot 2\cdot 120=120$$

2) In this case, all the investment amount is given to the farmer in the first year and x(t) is conditionally determined as follows:

x(t)=2 if *0<t<1*, *x(t)=0* if *1<t<2*.

$Y^1(t)=2,\ y(0)=0,\ 0<t<1$. In this case, the solution of the differential equation is equal to $Y(t)=2t$ in the interval $0<t<1$.

When it changes in the interval $1<t<2$, the solution is $Y^1(t)=0$, $Y(t)=2$, $1<t<2$.

The surface of the formed trapezoid (figure-4)

$$S=\frac{1}{2}(a+b)\cdot h=\frac{1}{2}(2+1)\cdot 120=180$$

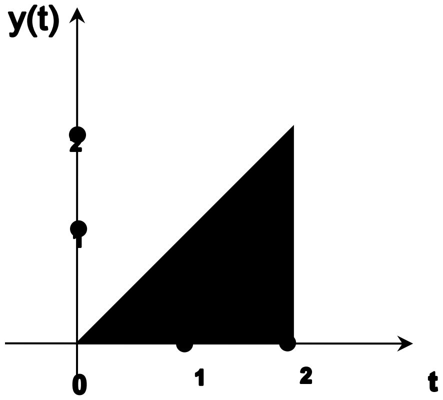

Figure-3

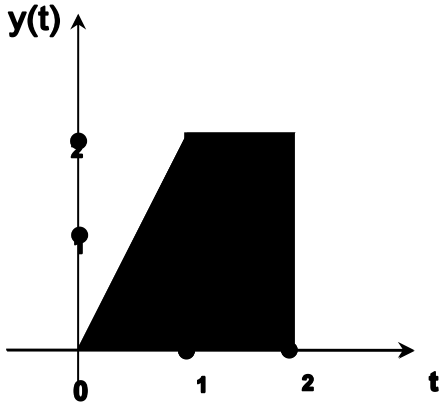

Figure-4

So, in the second case, the farm will receive 180 mln. produces products worth 60 million soums, compared to the first case. it is a lot of soums. So, it will be beneficial for the farmer to get all the allocated investment in the first year.

In conclusion, above, we have analyzed the impact of the amount of investment made to the enterprise or farm on the volume of their products using a mathematical model. Obviously, creating an alternative mathematical model that fully represents any real production process is one of the most complex issues. In most cases, a model created on the basis of certain conditions is sufficient to reveal and study the fundamental laws of the studied microeconomic process.

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