Managerial Economics
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Lecture - 33
Theory of Production - I

We will introduce the third module today that is theory of production and cost, and we will start the first topic of our third module is on introducing the input output production. Generally what are the productions theory, and also how the production function differs in the case of a short run, and in case of a long run.

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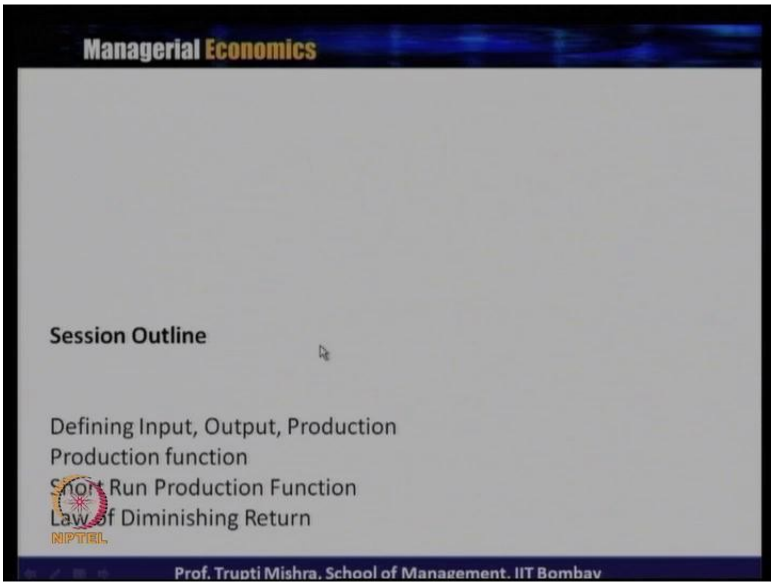

So, today's session outline will be mostly on defining input output production, then how we reached to the production function. Then we will talk about the short run production function, and in that context we will talk about the law of diminishing return, and we get few examples of law of diminishing returns, how it actually works in case of the real life.

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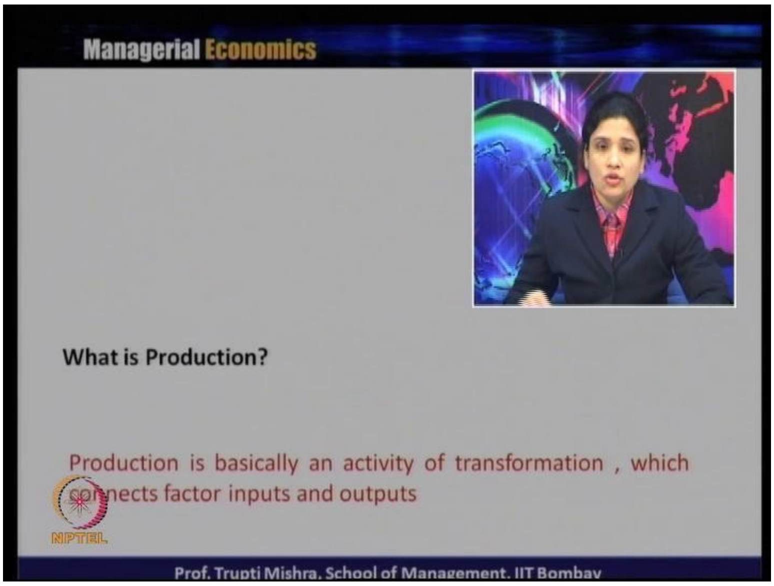

So, before getting into the details of production, let us understand, what is production? And if you define that production is basically an activity of transformation which connects factor input and output. It means, when the production is basically the activity which converts the inputs into the output. So, we can call it a process, we can call it a technique, we can call it a activity, and which transform the different kind of inputs into the outputs. So, production is the activity of transformation which connects the factor input into the output.

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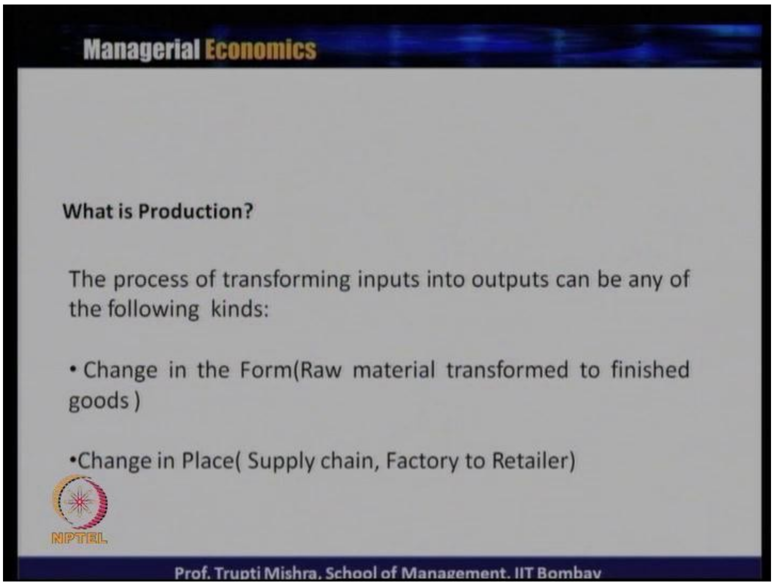

Now, this process, whether it is transforming input into the output, or the, may be the inter meditate product into the final product, this process of transformation is, the basically two kinds: one is, when there is a change in the form, and second one, when there is a change in the place. Let us see, what happens in case of change in the form. Raw material transform to finished goods. So, in this case, if you look at, there is a change in the form altogether the inputs get transformed into the finished goods.

But, the second category of change that is change in the place. So, here, we talk about the supply chain, the, how the output move from factory to the retailer. Because output generally get produced in the plants, output generally get produced in the factory, but that is, till the time it is not reaching to the retailer, it is not reaching to the market, at least for the individual consumption unit. So, in this case, the second form of transformation comes and which is also a part of the production activity, is the change in the place.

So, the process of transformation involves two kinds of changes: one, change in the form which leads the raw material into the final goods. And second one is, the change in the place which includes the part of production activity, because it moves goods and services to the retailer, to the, to the factory to the retailer. So, they make the products consumables. Till the time it is with factory, no access to market, the goods cannot be called as the finished goods or the good cannot be called as the final output, because it is not in a consumable form.

So, once it reaches to the retailer, it leads to consumable forms, and that is the reason, in this case, the change in the place is also one kind of production activity and this is considered as the activity of transformation. So, production is a activity of transformation, which is two type of changes, which involve two types of changes: one, change in the form, from moving from input to output, that is raw material to transformed to finished good; and second is, the change in place that is the supply chain, typically involve supply chain, that is the movement of the goods from factory to the retailer and this also add to the production activity because till the time it is not reaching to the retailer, it is not the consumable goods.

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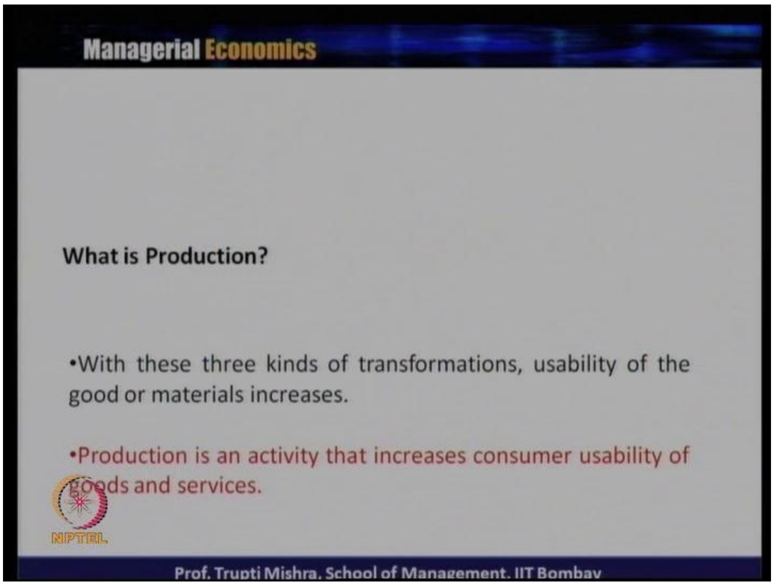

So, with this kind of transformation, whether transport, whether it is, may be the change in weather it is change in the place, whether it is change in the form, the usability of goods and materials increases. So, if you look at, like we are giving one example till the time it is not reaching to the retailer, the consumer is not getting access to the consumption of the goods. And that is the reason if you look at there is no usability of the goods till the time it is there with the factory, no access to market. So, this kind of transformation, usability of the goods and materials increases; and summarizing this, we can say production is an activity that increases the consumers usability of goods and services.

So, whether it is in the change, till the time is in the raw material form, consumer cannot consume it; till the time it is lying in the factory in the plant, consumer cannot consume it. So, with the change in the transformation, with the activity what is called production, through this, through the transformation activity that increases the consumer usability of the goods and services, and that is the reason, production is also one kind of activity that increases the consumer usability of goods and services.

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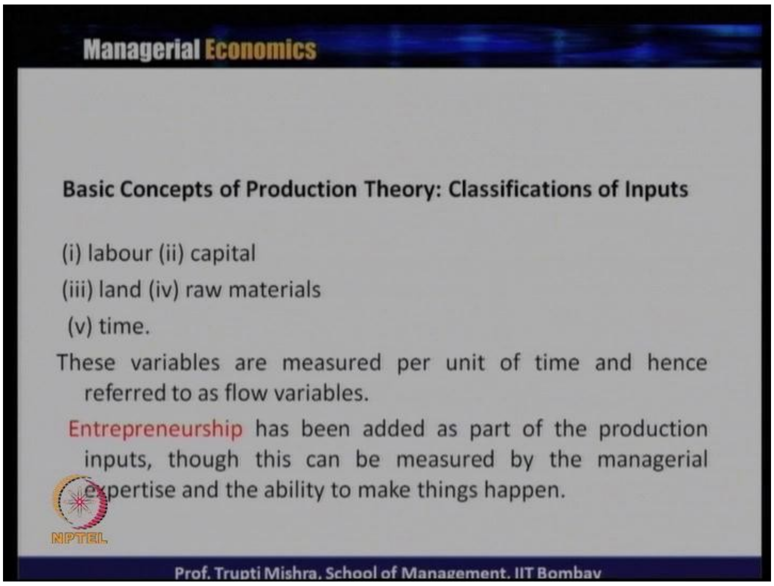

Now, we will introduce some basic concepts of production theory and we will start with the classification of inputs. Now, what are inputs? Inputs, generally what are the raw materials, what are the different kind of inputs getting used in the production process and which helps in the converting the input into the output. So, generally if you look at the age old definition say that there are four kind of factor production, or four kind of inputs like land, labour, capital and entrepreneurship. But if you look at, time is also one of the important factor which is considered as the part of input. So, one is labour, two is capital, three is land, four is raw material, and so there is one more addition of inputs over here, that is time.

All these variables are measured per unit of time and hence refer as the flow variable. Since there is a time dimension to land, since there is a time dimension to labour, since there is a time dimension to capital, since there is a time dimension to the raw materials, since there is a time dimension to the time factor as well, all these are flow variables; none of these are known as the stock variable. Stock variable is one, where, in the entire time line the inputs are remained fixed, but since it is changing with the time, in this case all these inputs are considered as the flow variable.

So, inputs are one, which helps the production process to get into the output or may this is the inputs in the production process. And apart from this five inputs, entrepreneurship is considered as the, one of the foremost inputs in the production process and that is not in the physical unit rather that is in the human unit. And it is a part of production and it can be measured by the managerial expertise and the ability to make things happen. So, if you have labour, if you have capital, if you have land, you have raw material, time, so the role of entrepreneurship comes here when they manage the, all these inputs, and they, when they measure the targets and when they reach the targets, using their managerial expertise and or may all these kind of input.

So, entrepreneurship is the guiding factor for all the inputs, to lead them into the desire form of the output. So, in this case we have listed six different kind of inputs land, labour, capital, then we have raw materials, then we have time, and finally, entrepreneurship is considered as the one of the input, at least in the modern form which generally with their expertise they lead to the desired form of the output.

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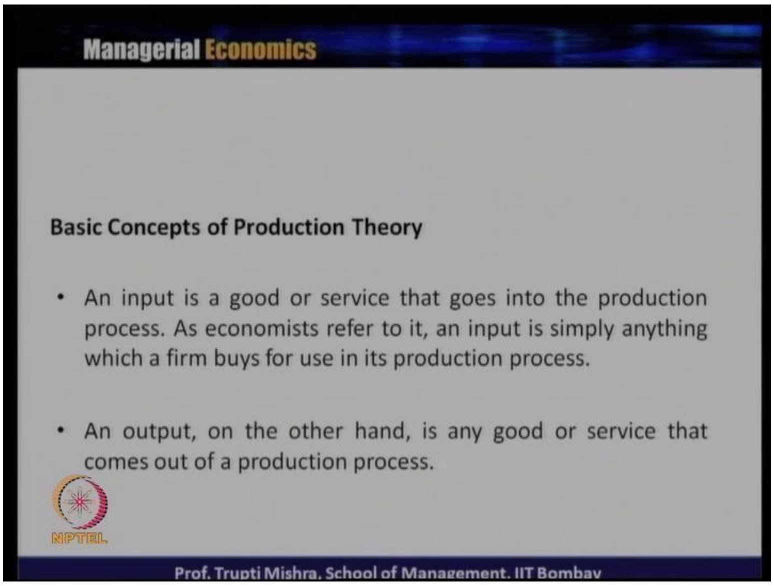

So, as defined, input is a goods or service that goes into the production process; and economists refer to, input is simply anything which a firm buys for the use in its production process. So, electricity unit is, one kind of input, may be the building is one kind of input, the man power equals to produce the output one kind of input, raw materials, the suppliers, they all considered as the input in the production process.

So, an input is simply anything which a firm buys for use in its production process, can be considered as the input. And what is output? Output is, on the other hand is any goods and services that comes out of the production process. So, input is always input in the production process and the outcome is generally known as the output. Generally the outcome is known as the output and output is any goods and services that comes out of production process that is generally known as output, and input is any goods and services that goes into the production process. So, in a typical economic jargon, we always say that anything which gets used in the production process is a part of input.

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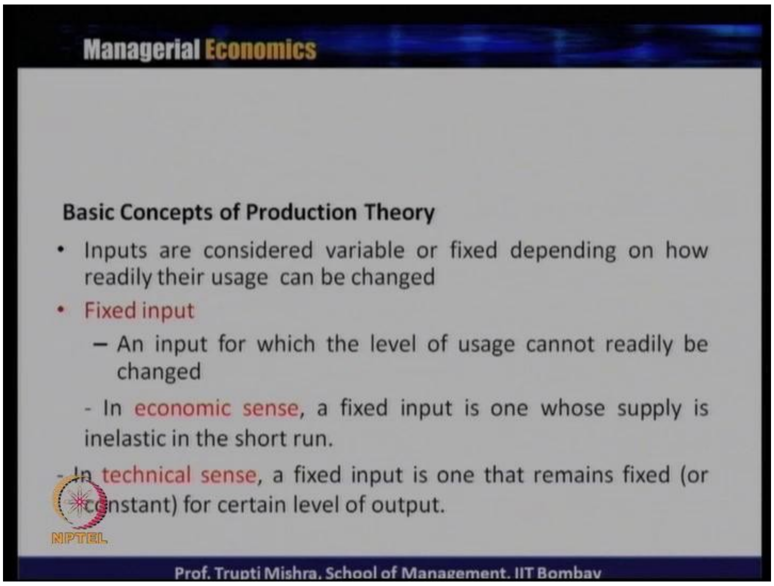

The inputs are considered as fixed or it is variable. So, how they are considered as the fixed or the variable, it depending on how readily their usage can be changed. If it can change immediately this is generally known as the variable input, but when there is a time factor associated with a change in the input, generally this is known as the fixed input. So, input can be categorized into the fixed input or the variable input; and whether they are variable or whether they are fixed, it depends on how readily the usage can be changed.

So, fixed input, an input for the level of usage cannot readily be changed. So, as we mentioned that there always a time required to change the level of input, and the level of usage when it cannot readily be changed this is called as the fixed input. And in typical economic jargon, a fixed input is one which supply is inelastic in the short run.

So, inelastic is what? Inelastic where it is less sensitivity, even if there are external factors still the variable does not change accordingly; they are generally rigid, they are rigid fixed in their changes and that is the reason, in case of fixed input the supply of fixed input is inelastic, it does not changes much in the short run. So, in technical sense, a fixed input is one that remain fixed or constant for a certain level of output. So, suppose you take the example, up to producing hundred units of output, if the input requirement for, suppose input required for the first category is 10 units, if that is not changing for 100 units then that is the part of the fixed input.

Or maybe, we can take the example, may be in more generic sense that to produce 100 units of output, if 10 units of electricity is required then electricity will be considered as the fixed input because it is not getting changed when there are 100 units of output. But if the electricity units getting changed, to produce 100 units of output at different level that is considered as the variable input. So, in economic sense fixed input is one which supply is inelastic in the short run, whereas in the technical sense, a fixed input is one that remain fixed or remain constant for certain level of output. So, with the different level of output, the input level is not getting changed that is in the technical sense.

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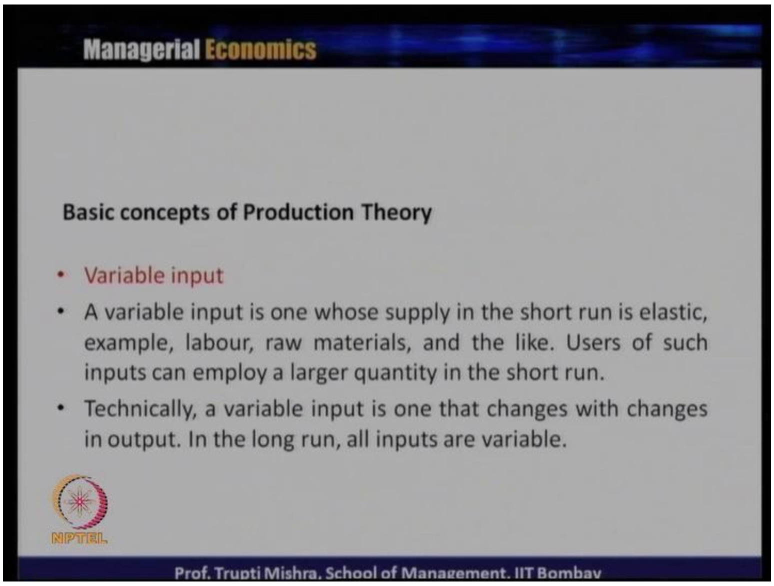

In contrast to this, we have variable input. Variable input is one whose supply in the short run is elastic, like it get changes, the level of input changes, on the basis of the change in external factor. So, typically we take the example of labour, we take the example of raw materials and the like, and user of such input can employ a larger quantity in the short run. Right. So if the input gets changes, accordingly the output changes; if the variable input is 1, when it changes like suppose, to produce a typical output, you require only 10 units of labour, right.

But if there is a time factor associated with it, and if you want to produce the output in half day, you can very well change the unit of labour associated with production of the output. And how it gets changes, because you can just, may be develop whatever the labour unit is getting used; and that is the reason, these inputs are considered as the variable inputs because it can readily change or usability of the goods or the usability of the inputs readily, change readily there is a variation over here. So, variable input is one whose supply in the short run is elastic, typical example we take labour, raw materials and typically inputs in that category. And user of such inputs can employ a large quantity in the short run.

Now technically, what is a variable input? A variable input is one that changes with the time in the output; in the long run typically all the inputs are variable. So, technically what is a variable input? If you are consider the same level of, same example what we took for the fixed input to produce 100 units of output, only there is a requirement of 10 unit of electricity. But once there is a increase in the output, once the production unit whatever is getting produced, if that is getting changed, immediately there is a change in the electricity unit also. And that is the reason, in this case also we can consider electricity as the variable input because once the output is getting changed, accordingly the input is also getting changed, and that is the reason this is considered as the variable input.

In the long run, all the inputs are variable, because long run is sufficiently long time period, where it is difficult to increase the output by changing only the few inputs, not all the inputs. So, we will discuss about the short run and long run may be in the next slide. For the time being, let us have the understanding that in the short run, few inputs are fixed, and few inputs are variable. But in the long run all the inputs are variable because long run is sufficiently a long time period where output cannot be increased by changing only few of the inputs, rather they have to change all the inputs.
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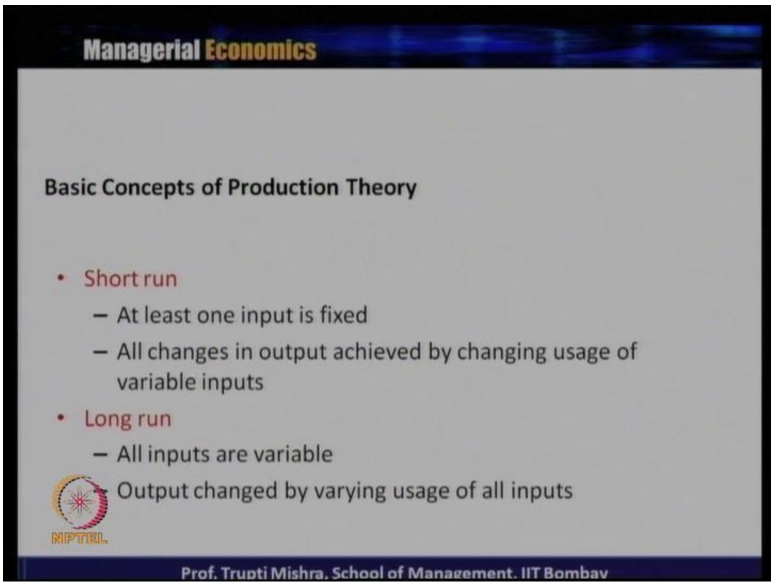

So, as we discuss, now we will see one of the important concept here in case of production theory is the, short run production and the long run production. Now, what is short run, what is long run; in case of short run, the time period is little bit, may be less than the time period, what is associated with the long run. But in case of short run at least there is one input is fixed, all changes in output achieve by changing usage of the variable inputs. And in case of long run, all inputs are variable, output change by varying usage of all inputs. So, in case of short run, there is one pre condition that at least one input has to be fixed, at least one input is fixed, all changes in output achieved by changing usage of variable inputs; long run, all inputs are variable, output change by varying usage of all the inputs.

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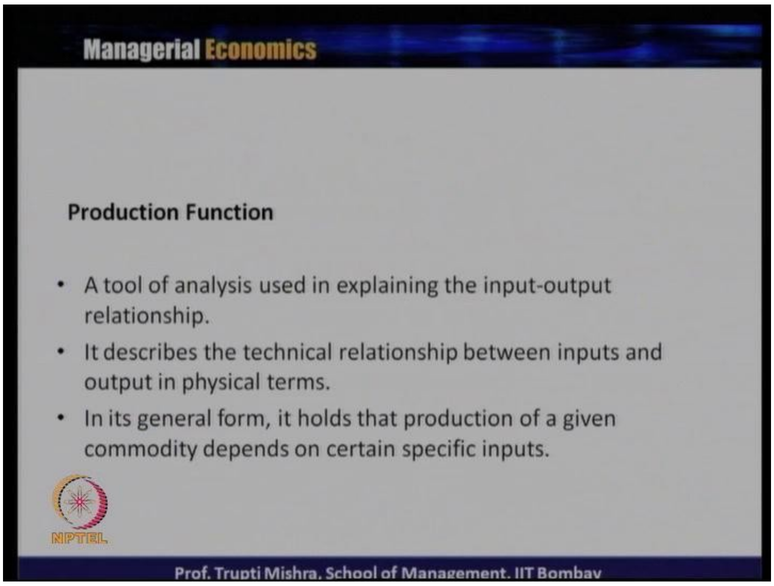

Now, we will see, what is the production function? So, till now we know that production is an activity, production is a technique, which connect the factor inputs into the factor outputs or which transform the input into the output. Now we will see, what is a production function? It is a tool of analysis used in explaining the input output relationship. Or maybe it describes a technical relationship between inputs and outputs in physical terms. In its general form, it holds production of a given commodity depends up on certain specific inputs. So, this is basically a technical relationship between input and output in physical term. And in its general form, it holds production of a given commodity, depends on certain specific input; it gets combination of the inputs which produce the certain level of output and how the inputs and outputs they are related.

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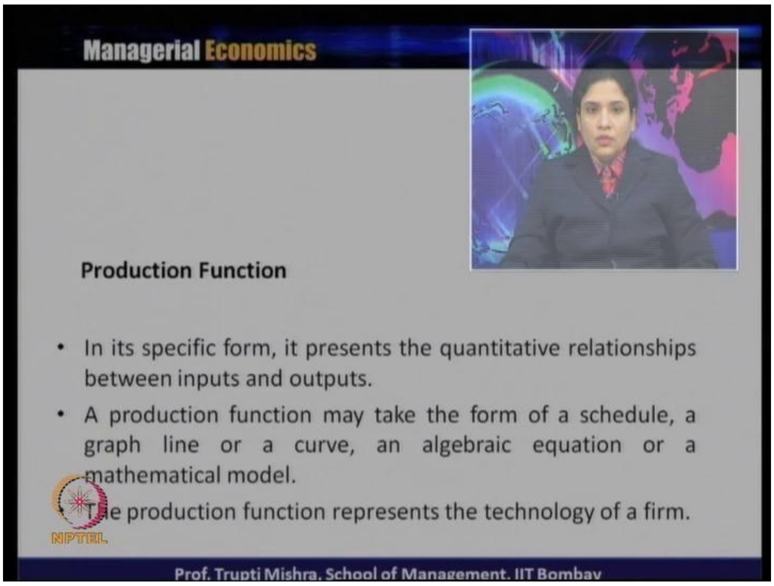

So, in its specific form it presents a quantitative relationships between the inputs and outputs; and it may take a form of a schedule, it may take a form of a graph line or a curve or an algebraic equation or a mathematical model. So, the relationship between the production, there is a relationship between input and output that is represented in the form of a production function, may take a form of a schedule, it can take a graph line, it can take a form of a curve, it can take a form of an algebraic equation or it can take a form of a mathematical model. The production function represents the, generally the technology of the firm because we are explaining this as the technique which connects factor input into the output. So, in that sense the production function represents the technology of a firm.

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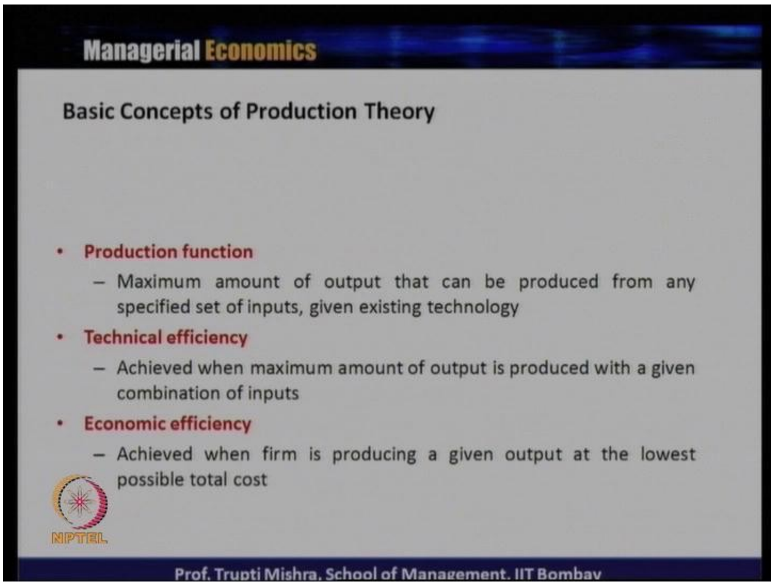

So, as mentioned production function is, it gives us the input combination to produce a certain level of output. Production function is the maximum amount of output that can be produced from any specified set of inputs, given the existing technology. So, it is the maximum amount of output that can be produced with a given set of technology and the specified set of input. What is the maximum output that can be produced? Generally, the production function explain this, if it is typically connecting the factor input into the output.

We get two type of efficiency, when you talk about the maximum amount of output; one, technical efficiency, second is the economic efficiency. Technical efficiency is achieved when maximum amount of output is produced with a given combinations of inputs. And economic efficiency is achieved when firm is producing a given output at the lowest possible, total cost. So, first one in case of technical efficiency, it is achieved when the maximum amount of output is produced with a given combination of inputs.

And, second it is, firm is producing a given output at the lowest possible total cost. So, if you look at the two level of efficiency, in the first case, combination of input is given and in the second case, the level of output is fixed; the first case the challenge is to maximize the output, in case of technical efficiency, with a given set of input and in the second case, the challenge is to minimize the input to produce a given level of output.

So, first is the optimization problem which relates to the maximization of the output, and second optimization problem relates to minimization of the input. So, if you look at the entire production also, entire production theory, it focuses on two optimization problem, one is maximization of output, and second one is minimization of input, and in both the cases the producer is getting the benefit, one in term of increase output and second in term of decreased input.

So, in case of technical efficiency, the optimization problem is to maximization of output to the given combination of input; and in case of economic, economic efficiency, the challenge is to, minimization of input or the, minimization of the total cost to produce a given level of output.

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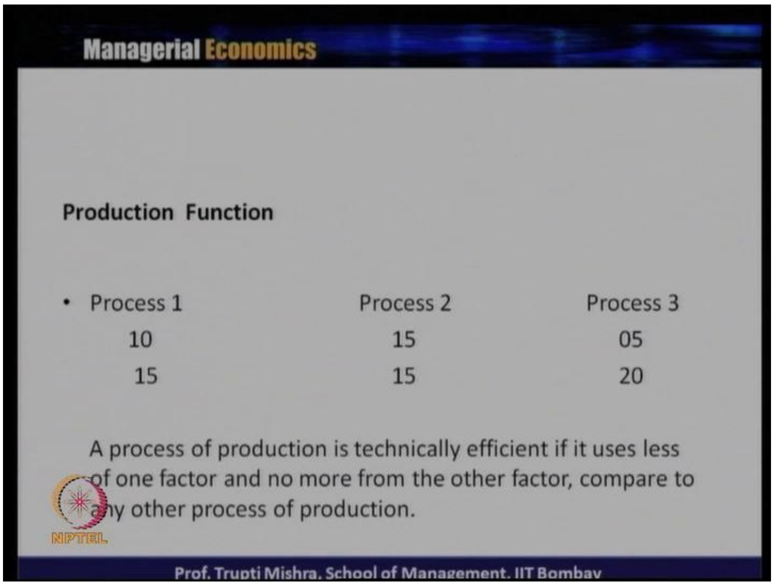

If you take the example, we have the, information about three kind of process: process 1, process 2, and process 3, suppose the first row talks about the input combination one, that is suppose capital; and the second row talks about the input combination two that is labour. So, in case of process one, to produce the output, the firm is using the 10 unit of capital and 15 unit of labour, process 2 is 15 unit of capital, 15 unit of labour, process three is 5 unit capital and 20 unit of labour.

A process of production is technically efficient, if it uses less of one factor and no more from other factor compared to any other process of production. Now, among these 3 processes, process 1, process 2, process 3, which are using different input combination, we need to find out which one is technically efficient. What is technically efficient? Maximization of output with a given combination of input; and how to find out the technically efficient here, if it is less of one factor and no more from other factor compared to any other process of production.

So, now let us look at process one, process three. Even if process three is using less of capital, it is using more of labour. So, process three is ruled out in case of technically efficient. If it is between process one and process two, even if, it is using more of, even if it is the same amount of labour, it is using less of capital so between process 1 and process 2, always process 1 is more technically efficient as compared to process 2. However, if you look at process 1, process 2, process 3, among these 3 processes, nothing gets clearly emerging out as a technical efficient because even if they are using less of one, they are using more of the other input, and in that way closely or clearly we will not find any technically efficient process.

However if you compare between process 2 and process 3, process 3 is ruled out, process 2 is ruled out, but if you compare between process 1 and process 2, and this process 1 is emerging as the more technically efficient process as compared to process 2.

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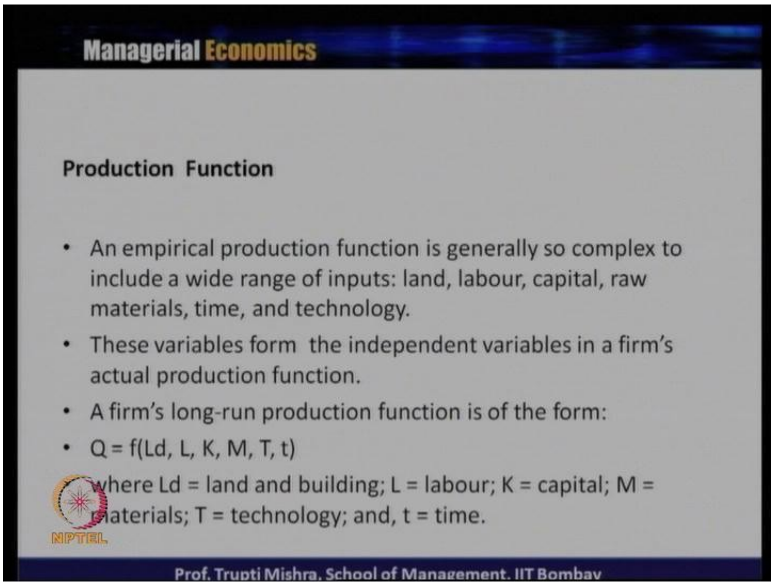

Then, we will see, how this production function is leading to a empirical production function; and how we convert this production function the theoretical production function into a empirical production function. Generally it is complex, because it includes wide range of inputs, starting from land to the technology like land, labour, capital, raw materials, time, technology, and sometime this is also the entrepreneurship. These variables form the independent variable in the firms actual production function.

All the inputs, they are the independent variable, and what is the dependent variable over here? The dependent variable here is the output. So, if firms long run is of the form that is Q is equal to function of Ld, L, K, M, T and small, where Ld is the land and building that is being used in the production process; L is the labour; K is the capital; M is the materials that is the raw materials; T is the technology; and small t is the time. So, Q output that is a function of the different input that is land and building, labour, capital, materials, technology and t is the time.

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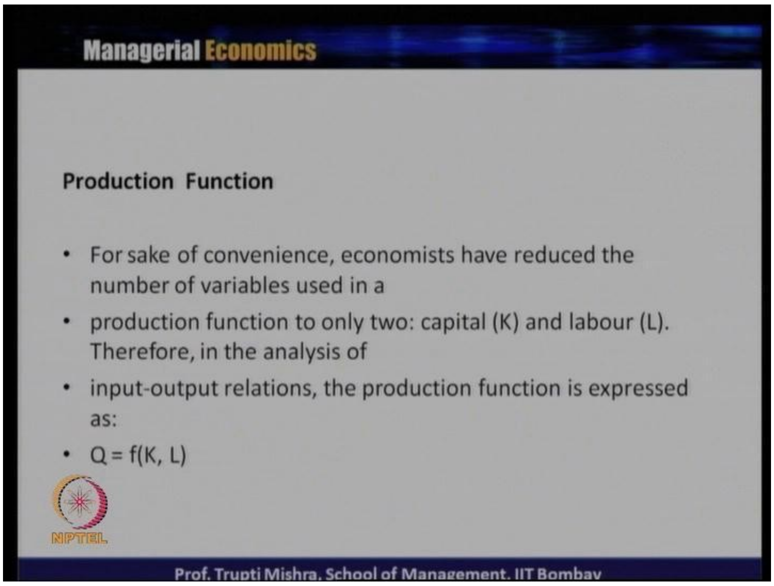

For the sake of convenience, economists have reduced the number of variable used in a production function to only two; that is capital and labour. Therefore, the analysis of input output relations the production function is expressed as the Q which is the function of capital and labour. For understanding, may be to making it simply to understand the other concept related to the production theory, generally economist they use the production function which is a combination of two inputs that is capital and labour.

And considering this the production function, the empirical production function is Q which is the function of just only capital and labour, and this is strictly used only for labour and capital making the other concept simple. There is no other reasoning that why capital and labour are only considered as the production process.

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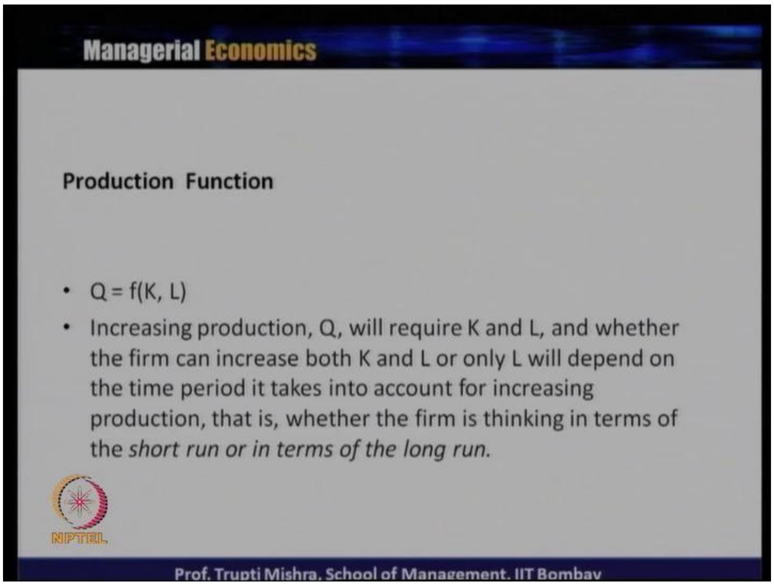

Now given production function Q which is a function of capital and labor, here Q is the dependent variable, K and L is the independent variable. So, at any point of time, in order to increase the production Q, there is a requirement of changing the K and L. Either the firm can increase both capital and labour, or only labour; depend on the time period which taken into account for increasing the production.

So, if you know, in case of short run, at least one input has to be fixed, given that scenario if it is the short run, generally the increase in the Q will be only with the help of labour because capital is considered as fixed because that is inelastic in the short run.

Whereas in case of long run, whenever there is a need to increase the Q, both the capital and labour gets changed; and that is the reason, in case of long run, both the capital level will be increased, in order to increase the Q. But in case of short run, in order to increase the Q, the labour will also, only the labour has to change because capital remain fixed in the short run. So, Q considers to be a dependent variable whenever the change is required, it has to be changed with the help of capital and the labour.

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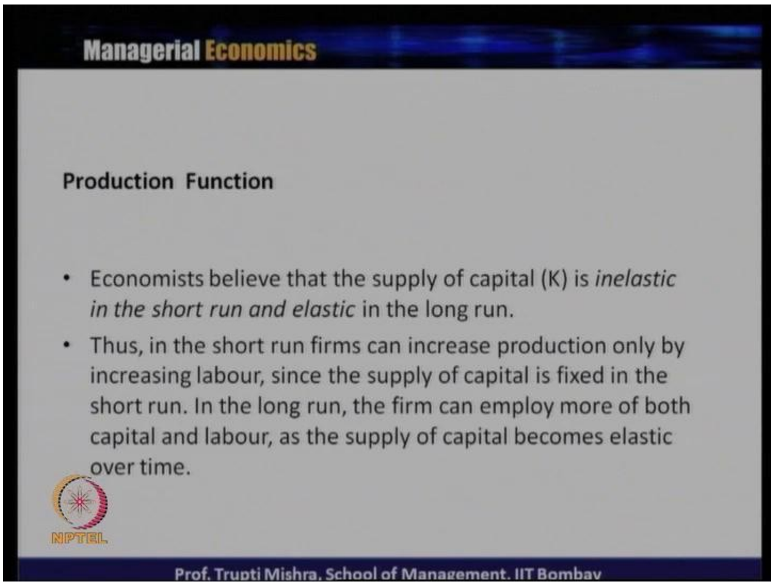

Next, there is a popular belief or the economists believe that the supply of capital K is inelastic in the short run and elastic in the long run. So, that is the reason, in the short run firm can increase production only by changing the labour or increasing the labour, since the supply of capital is fixed in the short run. But in case of long run, the firm can employ more of both the capital and labour, as the supply of capital becomes elastic over time.

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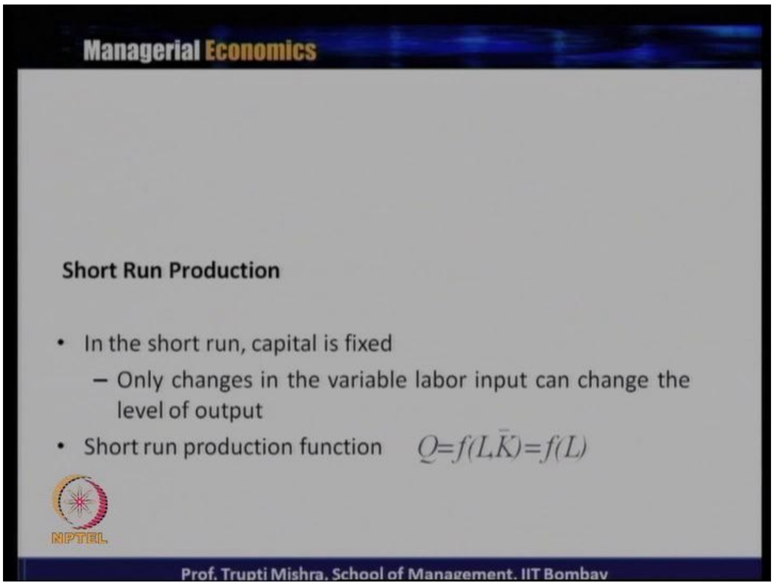

Then we will move to the short run where the capital is considered as the fixed, only changes in the variable labour input can change the level of output. And how the short run production empirically now, Q is a function of labour and capital, and capital remain fixed if you again simplify Q is just a function of labour, because initially whatever the capital is being fixed that is being fixed, whenever there is a need to change in the Q that has to be changed with the help of labour. So, in the short run the capital is fixed, only changes in the variable level input can change the level of output, and in case of short run empirical production function Q is a function of labour.

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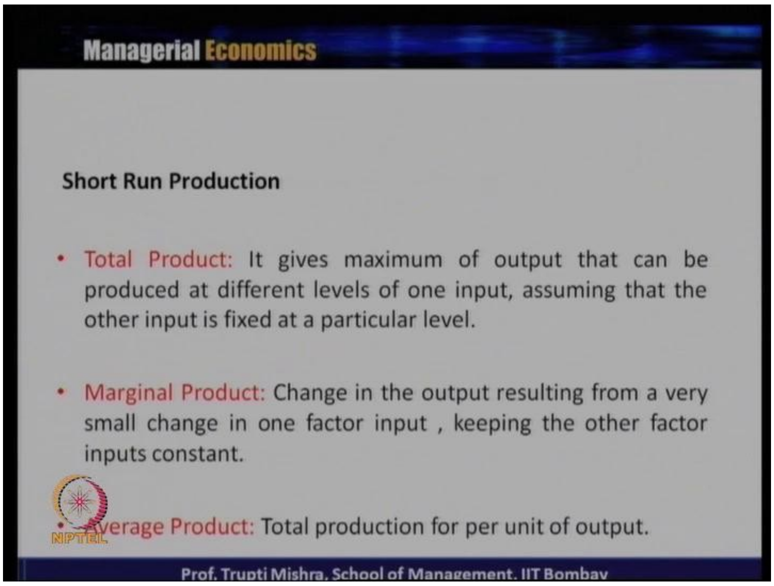

There are three concept associated with the production analysis. Whether it is a short run, whether it is a long run; one is total product, second one is the marginal product and the third one is the average product. Now, what is total product? It gives maximum of output that can be produced at different level of one input, assuming that the other input is fixed at a particular level. So, suppose capital is fixed at a level, whenever you change the labour input, the total product increases in the short run also in the long run when you change the capital and labour.

But in the specific case of short run, this is the maximum of output that can be produced at different level of one input assuming that the other input is fixed at a particular level. What is marginal product? Change in the output resulting from a very small change in the one factor input, keeping the other factor input, constant; average product that is the total production for per unit of output.

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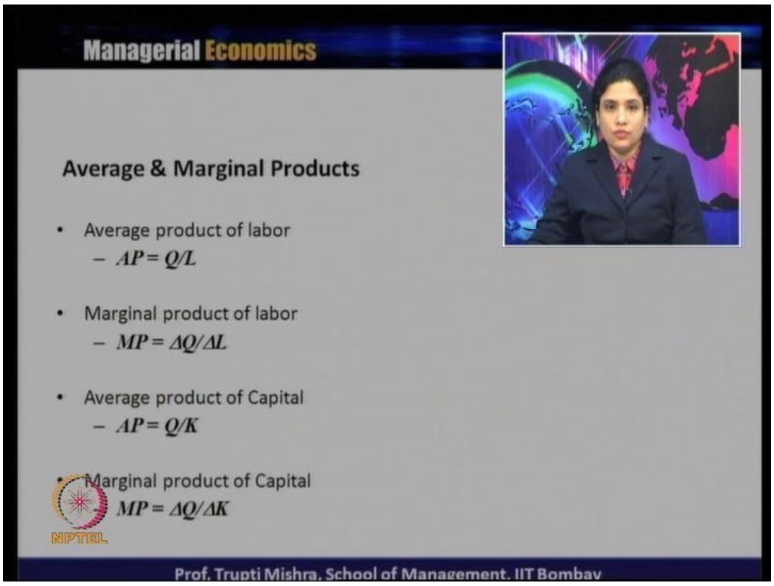

Now how to find out this average and the marginal product, average product of labour AP is total Q that is Q is the total product, total output, divided by the labour. Marginal product of labour is change in the Q with respect to change in the L, whenever there is a change in the labour unit, how much unit of output gets changes because of that. Similarly, average product of the capital total output divided by the K that is Q is the total product divided by the number of capital unit that will give us the average product. Marginal product of the capital is the change in Q with respect to change in the K. That is change in the output whenever there is in the change in capital unit.

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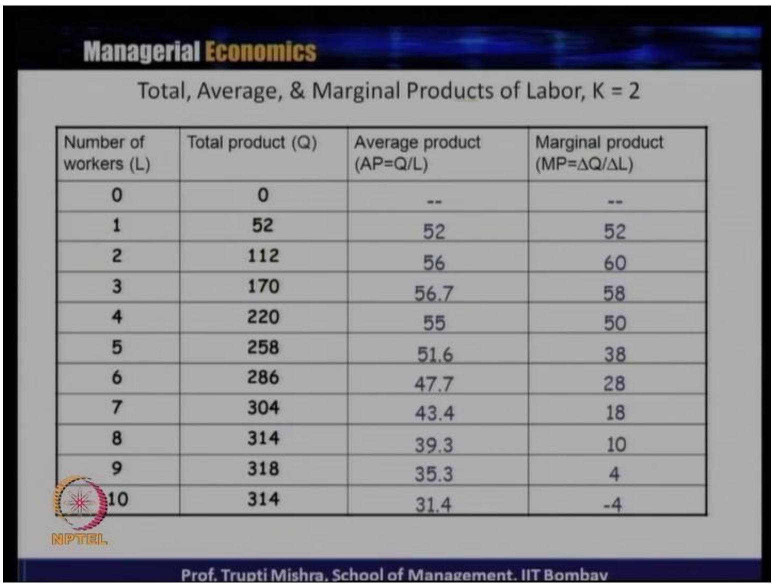

Total, Average, & Marginal Products of Labor, K = 2

Number of workers (L)	Total product (Q)	Average product (AP=Q/L)	Marginal product (MP=ΔQ/ΔL)
0	0	--	--
1	52	52	52
2	112	56	60
3	170	56.7	58
4	220	55	50
5	258	51.6	38
6	286	47.7	28
7	304	43.4	18
8	314	39.3	10
9	318	35.3	4
10	314	31.4	-4

So, this is just a hypothetical example of the total average and marginal product of the labour when K is equal to 2. So, in the first column, if you look at, this is the number of workers considering this is the short run case, only labour is variable, capital is fixed at 2, total product changes whenever there is a change in the labour unit and if you look at, it is going on increasing up to 9 th unit and after that even if there is a change in the labour still there is no change in the total product. We will explain the logic behind it, why even if there is change in the input, why it is not leading to change in the output.

Average product is nothing but the total product divided by the unit of the labour; and marginal product is again it is the change in the Q with respect to change in the labour. So, this is del Q with respect to del L. So, if you look at the difference between the first unit and second unit, by changing, by just increasing 1 unit of labour the product increases by, may be 52 in the first case, and again 60 in the second case. So, this is the additional change in the product when there is a use of one more level that gives us the marginal product. This is typically in the case of the short run when capital is fixed and the output is getting changed only with the help of the labour.