Video Script: Economic Surplus Model

How can we know what the future benefits would be that arise from investing into a specific type of banana research? In the cost-benefit video we have explained how the amount of benefits in monetary terms as well as the timing when benefits arise are used to compute our two indicators NPV and IRR. So, quantifying the benefits that result from banana research investments through modelling the effects of technology adoption is the core of this priority assessment exercise. In the previous sections we explained that adopting a new technology, such as a higher yielding variety or a new crop management regime, affects the yield and/or costs at the farm-level. We also discussed how to quantify the effect using the counterfactual as baseline for comparison. In this video we are using "delta" to symbolize the difference between the situation 'with' and 'without' the technology. If the new technology is adopted at a larger scale, it will not only lead to changes on the individual farm, but also results in changes to the total quantity produced and/or the price of bananas in a country. If such a price change occurs, it impacts not only banana producers adopting the technology, but ALL producers as well as the consumers who are benefiting from lower prices.

We expect that our new banana technology will have an impact on economic welfare. Economists use the term "economic welfare" to describe how well a society is doing in economic terms. In particular, economic welfare refers to the utility gained by an individual or a group of persons through, in our case, producing and consuming bananas. In order to quantify and disaggregate the effect of a new technology on economic welfare, we can apply an economic surplus model. Economic Surplus Modelling is a well-established, relatively simple and flexible approach and is thus often the preferred choice for assessing research impacts.

In a nutshell, the surplus model predicts how banana producers and consumers in an economy will respond to the introduction of a new innovation and how this will affect the price and quantity produced. Thereby, the future situation without research (the counterfactual) is compared to the future scenario with research and the resulting difference being the economic benefit of the new innovation. The model furthermore helps assess which shares of total benefits will be realized by producers and consumers, respectively. Let's have a brief look how this model is set up.

The basic components of the surplus model are a supply and demand curve which indicate how much banana producers are willing to provide and consumers are willing to purchase at a given price. We assume that both curves are linear and that supply will increase while demand will decrease with increasing price. The point where the two graphs intersect is where demand equals supply, and is called the 'market equilibrium', with an equilibrium price and quantity traded.

Looking at the graph however, we see, that some consumers would be willing to pay more than the price as indicated by the arrows in the graph. The little picture story of a woman purchasing bananas at the market illustrates this. Arriving at the market she is prepared to spend US$ 2.00 for a kilo of bananas. The sales price is only US$ 1.60, which is why she buys the bananas, and is happy about the good deal. The difference between what she was willing to pay and what she actually paid is perceived as a benefit, or money saved, and is called consumer surplus. The total aggregated consumer surplus

that is realized for a certain good in an economy can be estimated as the area below the demand curve and above the equilibrium price. As evident from the picture story, the surplus is not tangible but will lead to larger satisfaction and possibly higher spending in other areas.

Similarly, some producers - the more efficient ones - would be willing to sell below the equilibrium price. Again, this is illustrated by the arrows in our supply-demand graph. When a farmer goes to the market to sell his produce, he will have a certain price in mind that he would need to receive in order to pay for all of his inputs, including compensation for his time. In our little picture story, the man hopes to get $0.90 per kilo for his bananas and is being offered $1.30 per kilo. Of course, he immediately accepts the deal. The difference of $0.40 per kilo is perceived by the farmer as additional benefit. We call this benefit the producer surplus. The aggregated producer surplus can be depicted as the area below the equilibrium price and above the supply curve as illustrated in the graph.

Adding up consumer and producer surplus gives us the total economic surplus - which is also called economic welfare. The economic welfare, in our case, is the total benefit from production and consumption of bananas to a country's society.

Now that we have a basic understanding of how to quantify economic surplus, let's take a closer look at how we can assess the impact of an investment in banana research on economic welfare using this model.

So, what exactly happens to economic welfare if a new technology is released and adopted? For instance, think about the new, higher yielding variety of a major banana cultivar. If yield increases when adopting the new variety and if this yield increase out-weights any increases in production costs, the unit cost of production decreases. This means that our farmer can supply bananas at a lower price and if the technology is widely adopted, the supply curve will shift. Such a shift will result in a new market equilibrium associated with a lower price and a larger quantity traded.

Let's recall our definition of consumer and producer surplus and apply it to the new equilibrium situation. The consumer surplus is represented by this orange-coloured area below the demand curve and above the new equilibrium price. The producer surplus is defined as this blue-coloured area above the new supply curve and below the new equilibrium price. Both areas together show the total economic surplus resulting from the supply shift, which was induced by the introduction of the new variety. This new area is larger than the respective area based on the original supply curve, indicating an increase in economic surplus. This shaded area in the graph represents the increase in economic surplus. This increase in economic surplus equals the gross annual benefit of our research investment. The extent to which this benefit is shared among consumers and producers is dependent on the slope of the demand and supply curves.

For simplicity and in line with standard practice, we assumed linear supply and demand curves and parallel shifts of the supply curve in our economic surplus model. In addition, we conducted our estimation of benefits with the assumption of a closed economy. This means that in our model there is no interaction with the banana sector of other countries and no exports leave the country or imports are brought in.

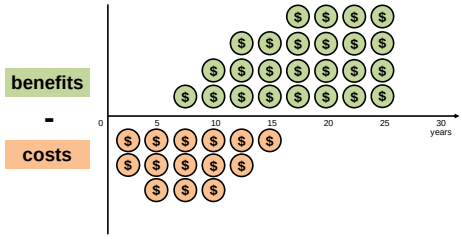
The economic surplus model considers the different levels of adoption over time and results in a benefit stream of consumer and producer surplus for each year of the assessment period. We now only need to multiply the benefits with the probability of success. The probability of success is an estimate of how likely it is that our research investment will successfully generate a new technology. Including this risk component is necessary, since the effort to develop, for example, a new, higher yielding variety with other characteristics similar to the original variety, might fail. In the final step, we can compare these risk-adjusted benefits to the costs necessary to develop and disseminate the technology as discussed in the section on cost-benefit-analysis. The results can tell us if investing in a particular research option is economically viable and how different alternative research investments compare based on standard economic indicators such as the Net Present Value and Internal Rate of Return.

Now that we demonstrated how to estimate the benefits of adopting a new technology, such as a higher yielding banana variety, by applying an economic surplus model, we can take the next step and compute the costs that arise when developing and disseminating the innovation.

Economic Surplus Model

1

Cost and benefit streams over time



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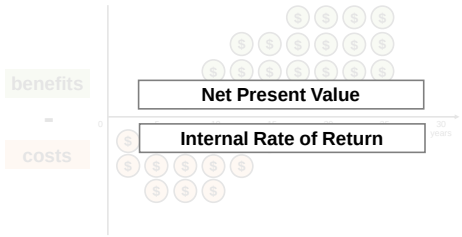
Cost and benefit streams over time



3

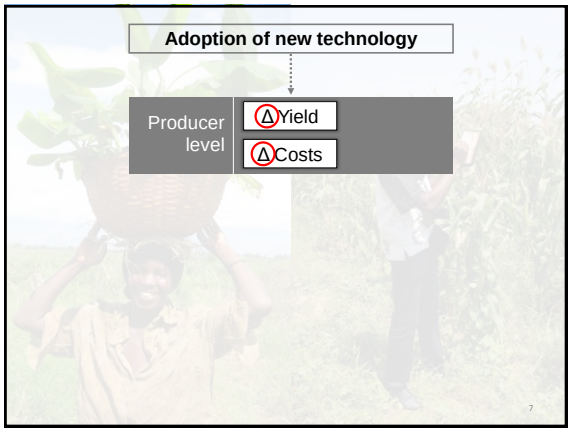
Quantifying the benefits that arise from banana research investments through modelling the effects of technology adoption is the **core** of this priority assessment exercise

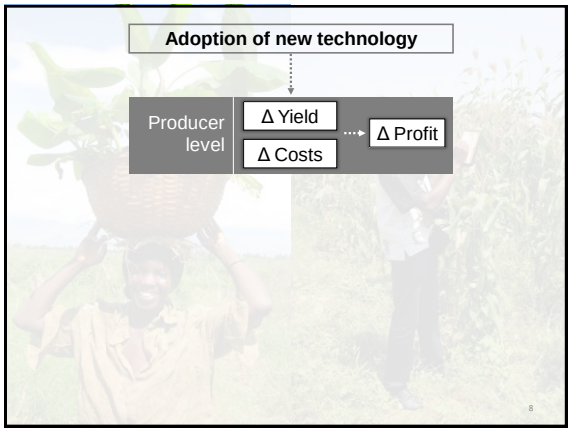
4

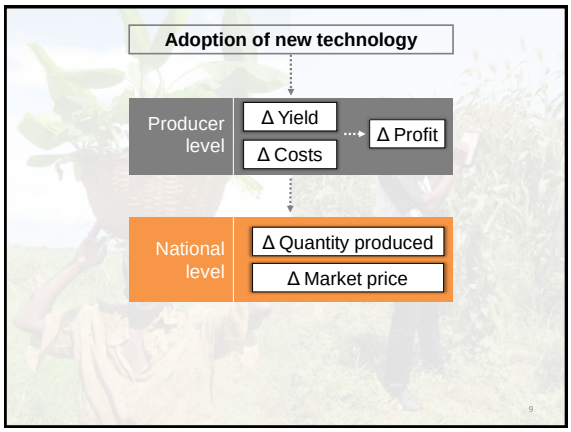
Adoption of new technology

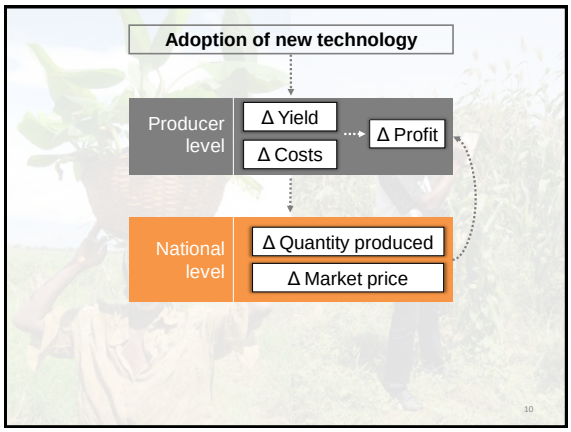
Producer level		Changes
	Δ Yield	⇅
	Δ Costs	

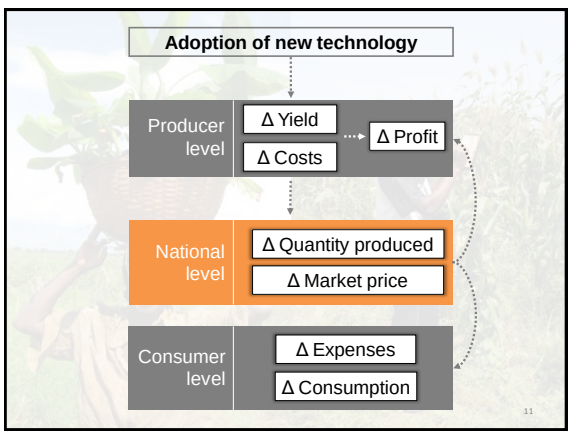
6


Adoption of new technology
Producer level
Δ Yield
Δ Costs


Adoption of new technology
Producer level
Δ Yield
Δ Costs
Δ Profit


Adoption of new technology
Producer level
Δ Yield
Δ Costs
Δ Profit
National level
Δ Quantity produced
Δ Market price


Adoption of new technology
Producer level
Δ Yield
Δ Costs
Δ Profit
National level
Δ Quantity produced
Δ Market price

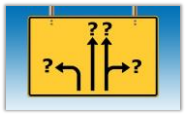

Adoption of new technology
Producer level
Δ Yield
Δ Costs
Δ Profit
National level
Δ Quantity produced
Δ Market price
Consumer level
Δ Expenses
Δ Consumption


Economic welfare
… describes how well a society is doing in economic terms

Economic Surplus Model

… predicts how producers and consumers will respond to the innovation

… predicts effect on price and quantity produced



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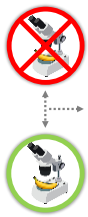
Economic Surplus Model

… predicts how producers and consumers will respond to the innovation

… predicts effect on price and quantity produced



Economic benefit of the innovation

14

Economic Surplus Model

… predicts how producers and consumers will respond to the innovation

… predicts effect on price and quantity produced

… helps assess shares of total benefits realized by consumers vs. producers

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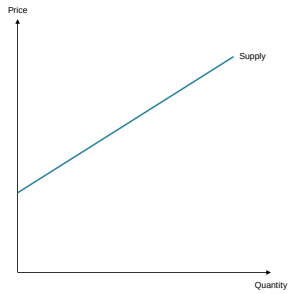

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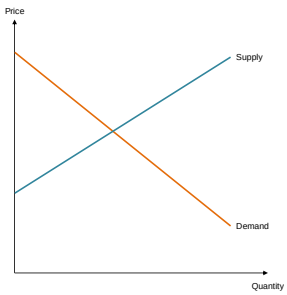

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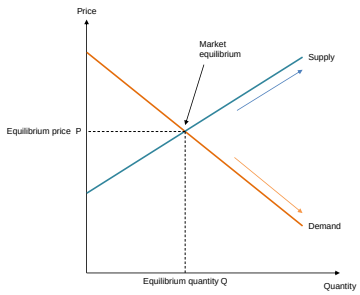

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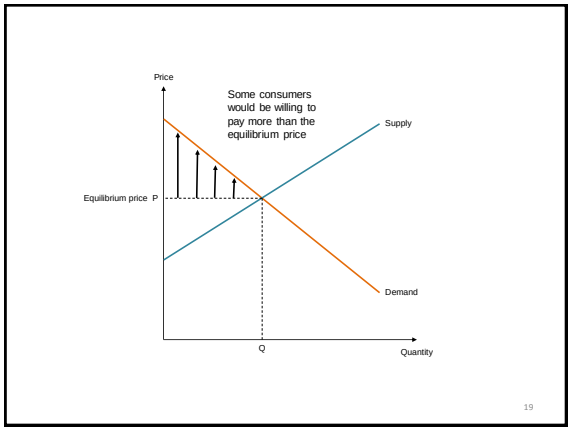
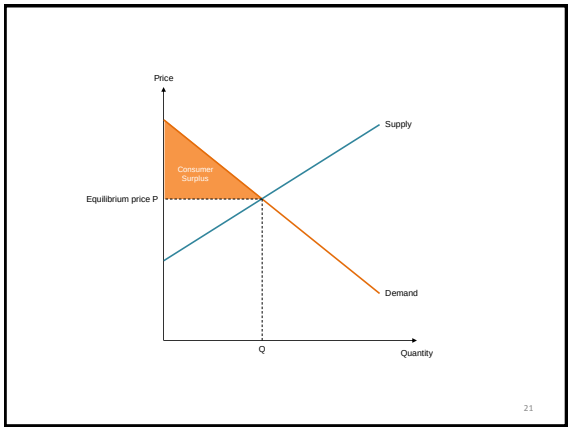
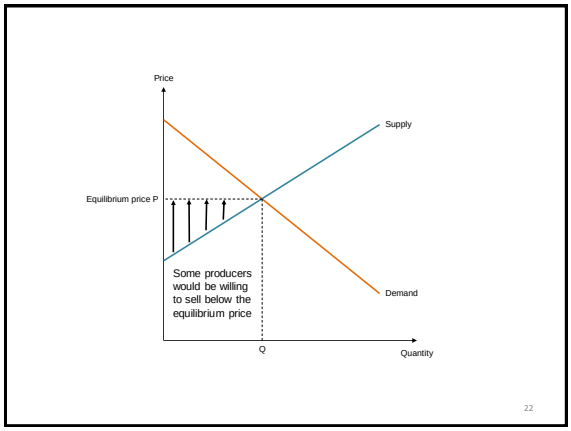
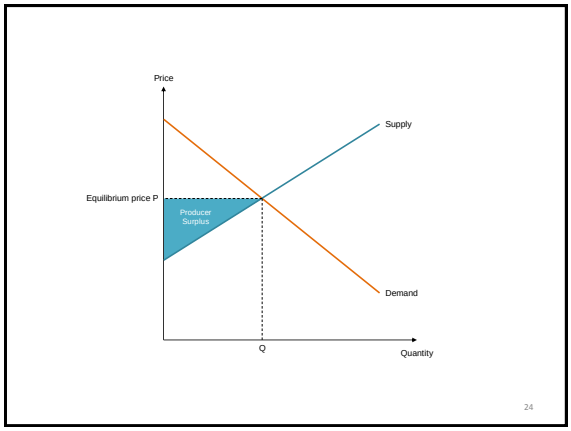

Price
Some consumers would be willing to pay more than the equilibrium price
Supply
Equilibrium price P
Demand
Q
Quantity
19

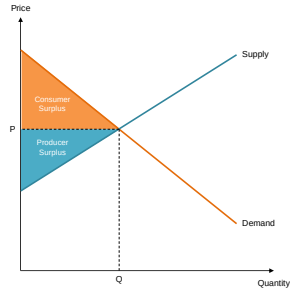

I would pay $2 for a kilo of these bananas
What a good deal!
These are $1.60 per kilo
Great, I will take these, please!
Difference: $0.40 /kg
Consumer Surplus
20


Price
Supply
Consumer Surplus
Equilibrium price P
Demand
Q
Quantity
21


Price
Supply
Equilibrium price P
Some producers would be willing to sell below the equilibrium price
Demand
Q
Quantity
22


I would sell my bananas for $0.90 per kilo!
I will buy your bananas for $1.30 per kilo!
Deal!
Difference: $0.40/kg
Producer Surplus
23


Price
Supply
Equilibrium price P
Producer Surplus
Demand
Q
Quantity
24



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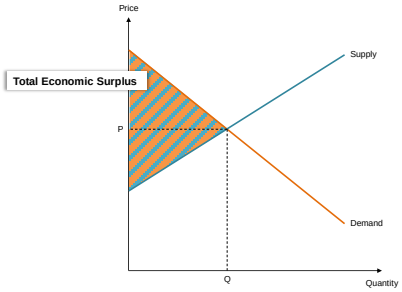

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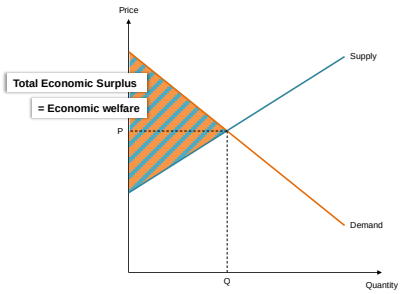

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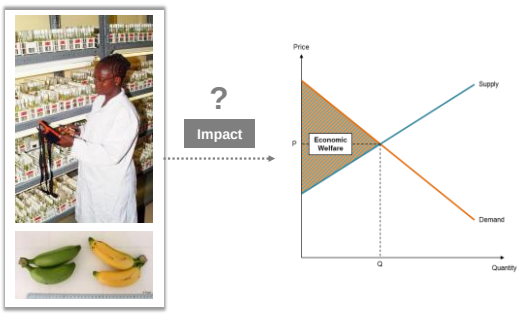

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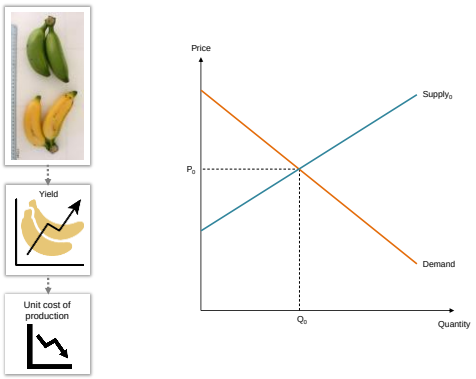
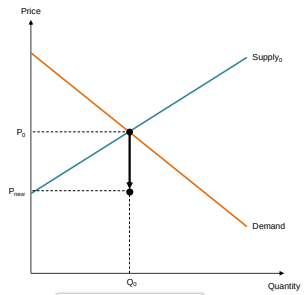


30

What happens to economic welfare if a new technology is released and adopted?



Supply of the **same quantity** at a **lower price** since unit cost of production decreases

31

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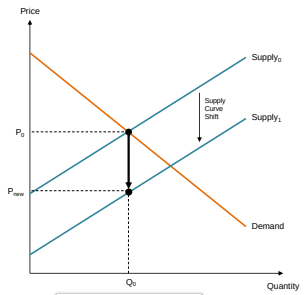

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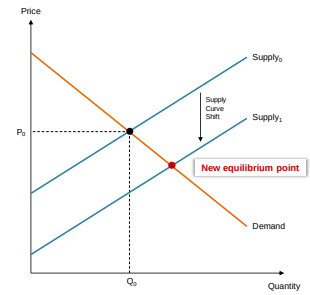

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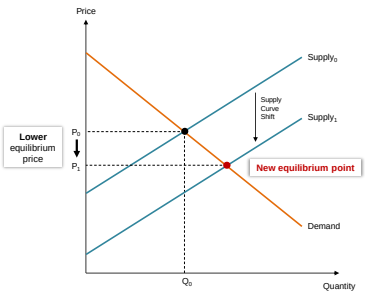

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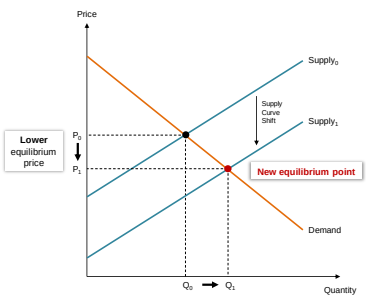

Increased equilibrium quantity

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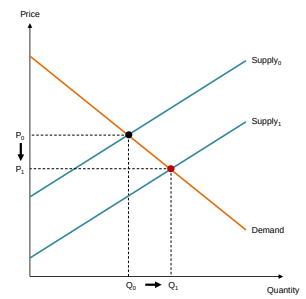

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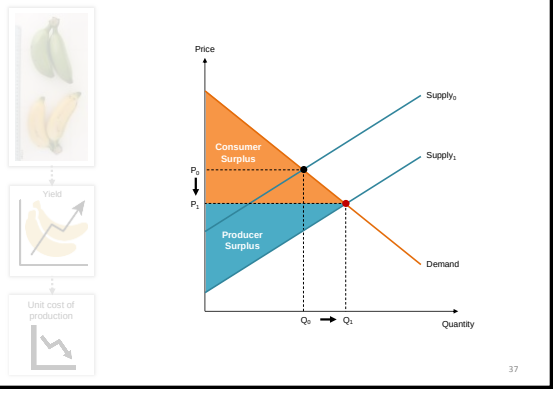

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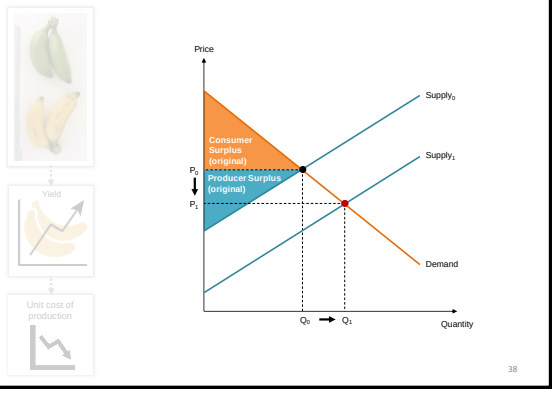

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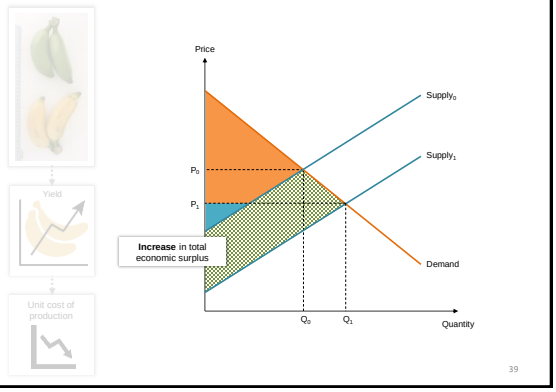

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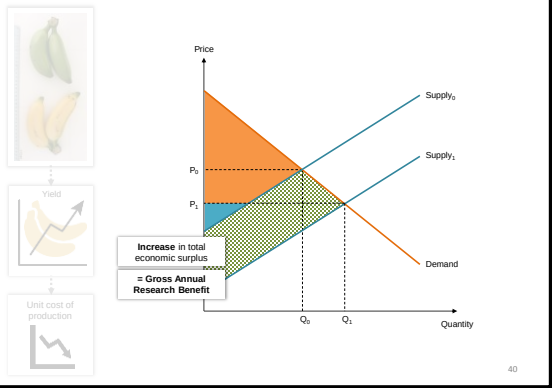

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For simplicity and in line with standard practice …

We use **linear** demand and supply curves

41

For simplicity and in line with standard practice …

We use **linear** demand and supply curves

We assume a **parallel shift** of the supply curve

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We conducted our estimation of benefits for a **closed economy**

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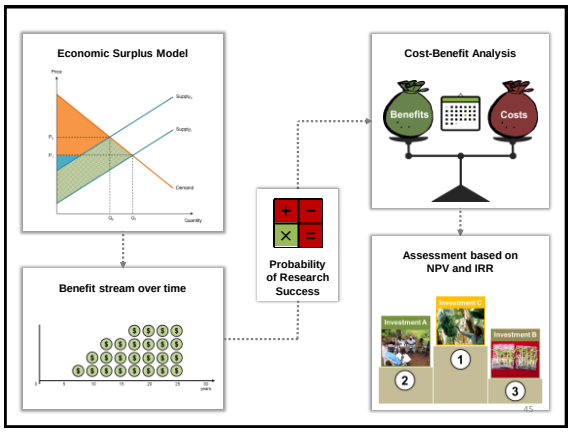

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Production and Narration (November 2016):
Diemuth Pernsl, Lars Scheerer, Veronica Mulligan, Charles Staver

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CGIAR

RESEARCH PROGRAM ON
Roots, Tubers and Bananas

A broad alliance of research-for-development stakeholders & partners

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