**Video Script: Types of Benefits and the Counterfactual Concept**

We now understand how costs and benefits can be compared in a way that adjusts for the timing when they occur. Let's explore what types of benefits we expect from typical banana research investments and how we would go about quantifying and assigning a monetary value to them.

A large number of different benefits could arise from banana research, some of the most common ones being: higher yielding varieties, varieties resistant to biotic or abiotic constraints (for example resistant to a certain disease), improved pest or crop management practices, new types of inputs (such as clean planting material, more effective pesticides or fertilizer formulations), improved post-harvest and handling techniques, or banana varieties with improved fruit quality (either in areas of consumer preference such as taste, color or texture or improved nutritional quality or longer shelf-life).

Research can also lead to changes at the more aggregate regional or national level for example in the form of improved agricultural policies, quarantine regulations or diagnostic kits which will then ultimately trickle down to results at producer or consumer level.

When assessing the benefits of applied banana research, we have to answer three basic questions:

- What impact would arise at the producer and/or consumer level?
- Under which conditions and/or for which area is the intervention suitable?
- How widespread and fast would the uptake of the innovation be?

Basically, the answer to the first question gives us the benefits per unit (for example per hectare planted). The second question gives us the upper boundary of the area where we can expect benefits (also called the target domain). The third question addresses the adoption - that is the likely timing and extent of benefits occurring.

In this video, we will only focus on the first question, while we will define and explain the concepts of target domain and adoption in the two subsequent sections.

One fundamental concept that we will need for the quantification of benefits is the 'counterfactual' which is the economic term to describe 'what would have happened without our intervention'. This 'without scenario' or counterfactual constitutes the baseline for measuring changes. This means that when assessing the benefits of a specific banana research intervention, we are comparing a situation with the research investment against an alternative situation without the investment. We will work through two examples to show what the steps of quantifying benefits for our assessment are and to illustrate how comparison to the counterfactual works.

For our first example let's pick a research intervention that develops a new, higher yielding banana variety. The entry point for this intervention is at the producer level, since we expect farmers to switch from the varieties they are currently using to our new higher yielding variety. In order to quantify the farm-level effects of the research intervention, we need to pay attention to both the intended benefit (in our case the yield increase) as well as any other effects that may arise. For example, the planting material for our new higher yielding variety may be more expensive leading to an increase in the

production costs. The new variety may also require additional adaptation of the production practices such as the use of more, less or other inputs such as fertilizers, pesticides or labor. Also, we need to evaluate whether or not the final product is the same or if there are differences, for example, in the quality of the banana such as poorer taste, changes in color or the effort involved in peeling. This could result in a change in the price the farmer receives when selling her produce.

Luckily, since we construct both future 'with' and 'without' scenarios in a theoretical logical manner, we don't need to worry about the attribution. This means that we do not need to worry about the question whether or not observed changes such as higher yield are actually caused by and can be attributed to the intervention.

We do, however, need to be very careful when defining our counterfactual – that is deciding on the baseline against which we will assess changes. For example, there may already be an improved variety from past research that the national agricultural extension system is starting to promote. So, even in the absence of our research investment leading to a new high yielding variety, yield levels are likely to go up over the course of our assessment period. Thus, when quantifying the yield effect, we start with the farm-level yield expected from the new high yielding variety and then work out the difference to what we think yield levels would be without our investment while considering other on-going or likely changes or trends (such as previous or parallel breeding efforts).

The relevance of the counterfactual becomes even more obvious in our second example: improved quarantine measures that aim at preventing the spread of a devastating banana disease such as Fusarium tropical race 4. When the quarantine measures are adopted at the national level, we expect an impact for all banana farmers in the country. The farm-level benefit would be the difference between the yield without and with the disease. Thus, we are talking about avoided losses that the disease would cause if it spread. In our assessment model this can be handled as a yield increase.

When aggregating benefits, however, the assumption that all farmers will benefit would likely lead to a drastic overestimation of the total benefit of the intervention. Instead, the relevant question is what share of the total production area in the country would be affected by the disease over time without the intervention - which will likely only be a fraction of the total area susceptible to the disease. Only the difference of area affected without and with the new quarantine measure should be the multiplier for our avoided yield loss. Since both the 'with' and 'without' scenarios describe events that are in the future and somewhat hypothetical, we need to rely on our best estimate for the spread of the disease under both scenarios. This spread estimate could for example be based on existing epidemiological models or expert knowledge.

We have summarized adoptable innovations from banana research and the variables that can be used to model resulting benefits in this table:

| **Types of adoptable innovations** | **Variable(s) in model used to quantify benefits** |
|---|---|
| - Higher yielding varieties | Yield (increase), change in production costs |

| | |
|---|---|
| - Disease resistant variety | Yield (increase), change in production costs |
| - Improved agricultural practices | Yield (increase), change in production costs |
| - Varieties with improved quality | |
| o Improved taste | Price (premium) |
| o Longer shelf-life | Yield (increase) and/or Price (premium) |
| o Higher nutritional quality | Price (premium), disability-adjusted life years |
| - Improved plant quarantine systems | Yield (increase) → equal to avoided yield loss |
| - Improved policy or regulations | Change in production costs or prices |

In the column on the right we have indicated which variables in the model we would use to quantify the benefits. For example, a disease resistant variety can lead to higher yields, but may also result in increased production costs if the planting material of the improved variety is more expensive. If, however, the prior method to control the disease was the application of large amounts of chemical pesticides, switching to the resistant variety would not only increase yield but would also make the use of pesticides redundant therefore reducing overall production costs.

Conceptually, there are two more types of benefits which we at least want to mention: First, when the innovation is adopted, it could have external or non-tangible impacts such as positive or negative environmental, nutritional or health effects; and second, there are likely indirect effects from our research intervention such as changes in the price of banana due to a large increase in the total production amount. As for the second type, the indirect benefits, we will present in a separate video how some of these can be quantified with a so-called economic surplus model. With regard to the external or non-tangible effects, methodologies exist which help quantify and express these benefits in monetary terms. Since we did not apply such methods in our assessment due to the nature of the research options included, we will not explain those any further.

With this knowledge on how to quantify benefits, we will move on to address question number two and three, which are the construction of the target domain and the adoption profile.

## Types of benefits and the counterfactual concept

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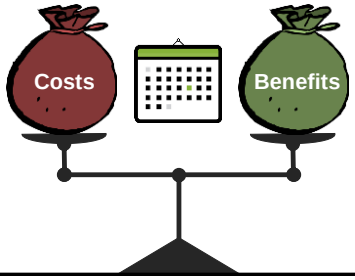


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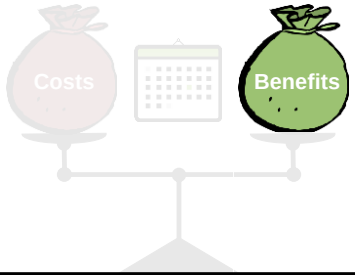


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**Benefits arising from banana research**

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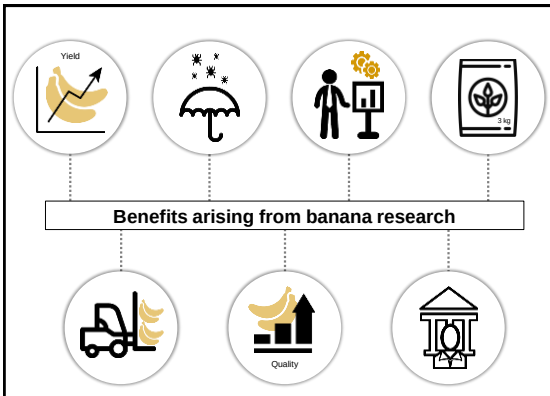


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**When assessing the benefits of applied banana research…**

1. What impact would arise at the producer and/or consumer level?
2. Under which conditions / for which area is the area suitable?
3. How widespread and fast would the uptake of the innovation be?

6

When assessing the benefits of applied banana research…

Benefits per unit

1 **What impact would arise at the producer and/or consumer level?**

2 Under which conditions / for which area is the area suitable?

3 How widespread and fast would the uptake of the innovation be?

7

When assessing the benefits of applied banana research…

Target domain

1 What impact would arise at the producer and/or consumer level?

2 **Under which conditions / for which area is the area suitable?**

3 How widespread and fast would the uptake of the innovation be?

8

When assessing the benefits of applied banana research…

1 What impact would arise at the producer and/or consumer level?

2 Under which conditions / for which area is the area suitable?

Adoption

3 **How widespread and fast would the uptake of the innovation be?**

9

When assessing the benefits of applied banana research…

1 **What impact would arise at the producer and/or consumer level?**

2 Under which conditions / for which area is the area suitable?

3 How widespread and fast would the uptake of the innovation be?

10

**Counterfactual**

11

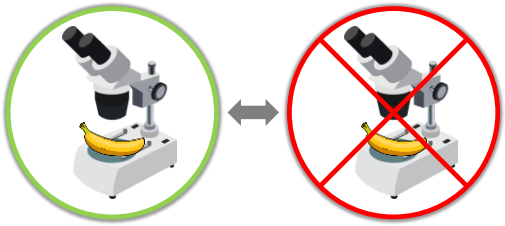
**Counterfactual**

**"What would have happened without our intervention?"**

**Baseline for measuring changes**

12

13



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**Example No.1**

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**Example No.1**


16

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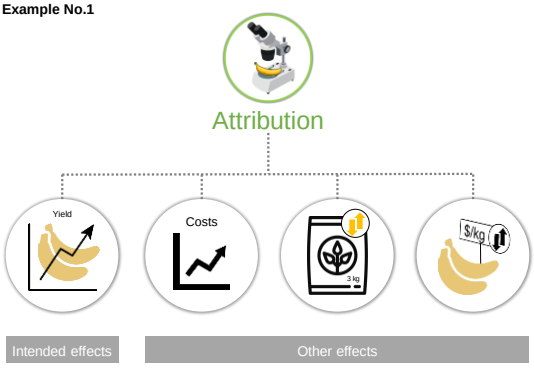


17

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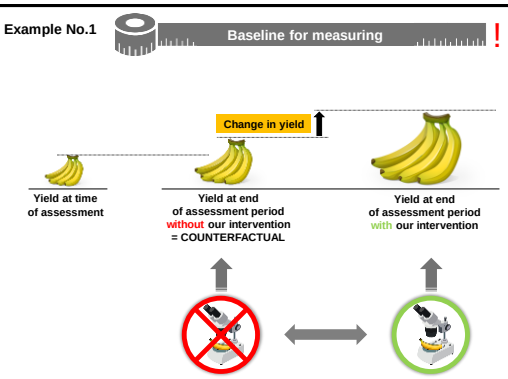
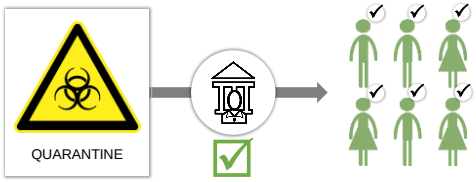



18

**Example No.2**




19

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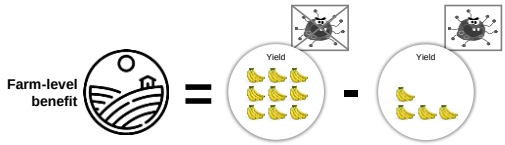



20

**Example No.2**



**"Avoided losses"**

21

**Example No.2**

**Who benefits?**

22

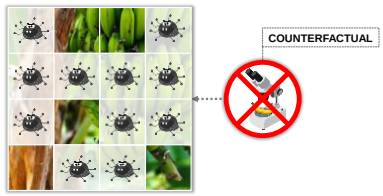
**Example No.2**

**Who benefits?**

**Overestimation**

23

**Example No.2**

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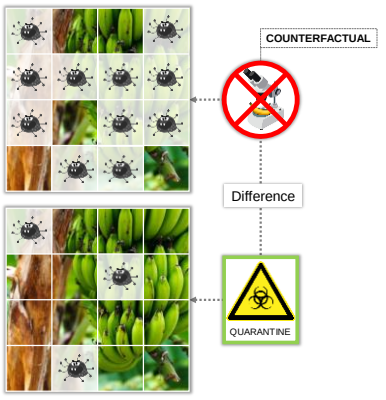


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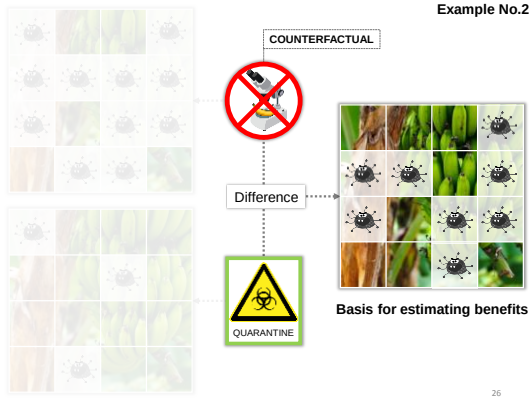


26

**Example No.2**


27

## Banana research: key benefits

| Types of benefits | Variable(s) in model reflecting changes |
|---|---|
| Higher yielding varieties | Yield (increase), change in production costs |
| Disease resistant variety | Yield (increase), change in production costs |
| Improved practices/input use | Yield (increase), change in production costs |
| Improved quality (taste) | Price (premium) |
| Improved quality (longer shelf-life) | Yield (increase) and/or price (premium) |
| Improved quality (higher nutritional quality) | Price (premium), disability-adjusted life years |
| Improved plant quarantine systems | Change in production costs, price |
| Improved policies or regulations | Change in production costs, price |

Source: own illustration

28

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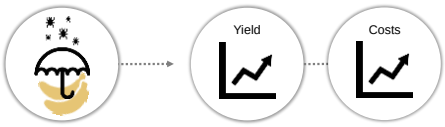


30

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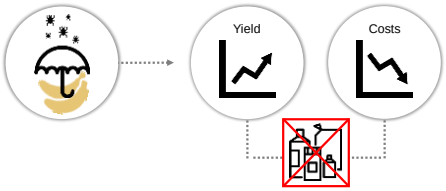


31

## Banana research: more types of benefits

External or non-tangible impacts


Indirect effects

32

## Banana research: more types of benefits



External or non-tangible impacts


Indirect effects

**Economic Surplus Model**

33

Target domain and adoption profile

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35