

Numerical Exercise 3: Economics of Technical Change and Input Use

Name: Answer Key

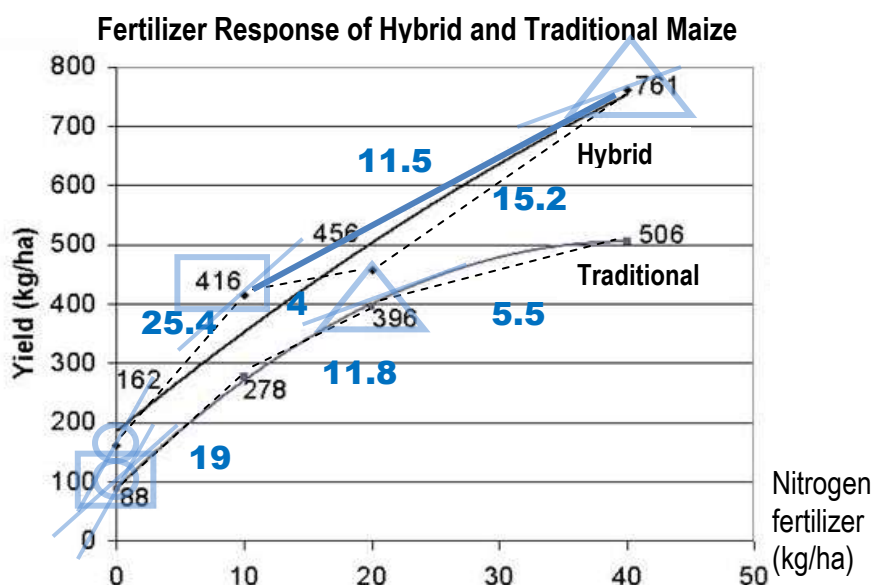
Thanks to your Purdue education, you’ve just been hired by Yara, a Norwegian company that is the world’s largest manufacturer of agricultural fertilizers. Your first task for them is to help explain why African farmers use so little fertilizer, in hopes that the company can do something to increase sales and help African farmers increase crop yields.

Luckily, from AGECE 340 you know how to look at the problem from the farmer’s point of view, and consider what is most profitable for them in terms of their production possibilities and relative price ratios. From AGECE 340 you also know how to do a good literature review, and using Google Scholar you come across a paper that offers this chart using data from Malawi, a small country in Eastern Africa.

Notice that each point on the chart refers to the level of maize (=corn) yield achieved at each of four levels of fertilizer use (0, 10, 20 and 40), measured in kilograms per hectare (kg/ha).

Notice also that the author of this paper has drawn smooth lines through her actual observations. For your purposes it is preferable to work with the underlying points, so you decide to ignore her smoothed lines and focus on the dashed lines that go straight from one actual observation to the next.

To complete your analysis, you could enter the data into a spreadsheet, but all of the calculations requested below are easily done using scratch paper and a hand calculator.



Source: Andrea S. Anderson (2002), "The Effect of Cash Cropping, Credit, and Household Composition on Food Security in Southern Malawi", *African Studies Quarterly* 6 (1&2): article 7.

- (1) First, **compute the slope of each dashed segment** of the farmer’s input response curve, and write that slope near each segment **using blue ink**.
- (2) Next, recall that farmers will choose the type of seed (hybrid or traditional) and level of fertilizer (0, 10, 20 and 40 kg/ha) to obtain the highest profit, as shown by a line whose slope is the relevant price ratio. Notice that the hybrid seed with 20 kg/ha would never be chosen, so you **draw the line when farmers jump from 10 to 40 kg/ha, and write its slope above that segment**.
- (3) Now show the points offering the highest profits, using each of the two kinds of seed, using a **pencil** to draw **circles** around the points chosen when fertilizer costs 30 times the price of maize, **squares** around the points chosen when that price ratio falls to 20, and **triangles** around those chosen when the price of fertilizer falls to 10 times the price of maize. At each of these points, also **sketch the highest available profit line**, with an appropriate slope. (This profit line should not be very long. It should be just long enough to show its slope.)

Please turn the page to answer the remaining questions.

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(4) To begin your numerical analysis, if farmers have both types of seed available, please fill in the following table:

<i>Price ratio of fertilizer to maize:</i>	<u>30</u>	<u>20</u>	<u>10</u>
Type of seed chosen (H or T)	<u>H</u>	<u>H</u>	<u>H</u>
Level of fertilizer use (in kg/ha)	<u>0</u>	<u>10</u>	<u>40</u>
Level of maize yield (in kg/ha)	<u>162</u>	<u>416</u>	<u>761</u>

(5) Recall that the traditional seed is obtained when farmers simply choose the best plants in each field and save their seeds from one year to the next, whereas hybrid seed requires scientific breeding to develop the inbred lines and crosses, as well as a commercial system for seed production and distribution so that farmers can buy fresh seed every year. In Malawi today, there is not enough hybrid seed for all farmers to use it, so many farmers must use traditional seeds. Now fill in the table for those farmers who cannot use hybrids, and compare that with the results above to show the change that you expect when hybrids become available:

<i>Price ratio of fertilizer to maize:</i>	<u>30</u>	<u>20</u>	<u>10</u>
<i>Using traditional seed only</i>			
Level of fertilizer use (in kg/ha)	<u>0</u>	<u>0</u>	<u>20</u>
Level of maize yield (in kg/ha)	<u>88</u>	<u>88</u>	<u>396</u>
<i>Change when hybrids become available</i>			
Change in fertilizer use (kg/ha)	<u>0</u>	<u>10</u>	<u>20</u>
Change in maize yield (kg/ha)	<u>74</u>	<u>328</u>	<u>365</u>

(6) Clearly, you cannot explain farmers' choices or predict changes without knowing the relative prices that farmers must pay or receive for fertilizer and maize. So, you take a vehicle and travel around the countryside, interviewing farmers around the country about the prices they pay or receive. Since fertilizer is needed at planting but the maize is received at harvest, you must also include the interest rate cost of borrowing money for fertilizer from planting to harvest. What you find is that for the most remote and risky farmers with high transport costs and high interest rates, the ratio of fertilizer cost to maize prices is around 30. For other farmers in more favorable locations the ratio is around 20, and for the few best-placed farmers it is around 10. Using this information, please fill in the following sentences, from Yara's point of view:

- (a) the price ratio at which availability of hybrid seeds is *most* important would be: 10 .
- (b) the price ratio at which availability of hybrid seeds is *least* important would be: 30 .

(7) Suddenly you realize you forgot the name of the Malawian currency. Does the type of money used in Malawi, if any, matter for this assignment? On the lines below, please write a single complete sentence explaining your answer.

The type of money used does not matter, because the currency units cancel and what actually determines farmers' choices is the relative price or barter exchange rate in terms of quantities, or the quantity of maize exchanged per unit of fertilizer.