COST BENEFIT ANALYSIS OF THE INTRODUCTION OF HEAT TOLERANT BEAN VARIETIES IN ATLÁNTIDA, HONDURAS

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Rising ambient air temperatures, migration, and deforestation threaten the sustainability of hillside agriculture in Atlántida, Honduras. Currently, farmers avoid climatic constraints to common bean (*Phaseolus vulgaris* L.) production by planting at distinct altitudes during different seasons. However, this practice may become less effective due to climatic change. Farmers in ten villages in Atlántida, five at a lower altitude and five at a higher altitude, were interviewed to determine their knowledge and experience with climatic change, bean production and to collect data for a cost benefit analysis. Differences in bean production and yield between the low altitude and high altitude villages were attributed mainly to climatic constraints, due to differences in elevation. In this study, a cost/benefit analysis was conducted to determine if the development and introduction of heat tolerant bean varieties could help to alleviate heat-related constraints on bean production.

The ex ante cost benefit analysis was carried out using data collected from the farmer survey and additional data collected from the Department of Agriculture of Honduras. Migration rates, farm level bean and corn prices, and production area data were obtained from secondary data (e.g., national statistics/census data). Other data, such as expansion of bean production area and adoption rates were estimated from data collected through the farmer survey of 99 farmers in 10 villages. On the assumption that a heat tolerant variety would be released in 2010, the estimated cost of six years of plant breeding research was factored into the six years preceding 2010. Estimates for the projected annual adoption rates for the 10-year period following release are based on logistic adoption curves. The final estimates of the value of incremental production due to increased bean production was discounted for different scenarios which reflect reductions in corn production (i.e., to plant more area in beans, farmers would have to reduce their corn area). Increasing climatic temperatures are expected to decrease yields over the long term, 50 to 100 years. However, because of minimal effects of warming over the 10-year projection period for this study (about 0.2° C), this effect was not included in the cost/benefit analysis (data not shown). It was assumed that adoption rates would be similar to those of recently released varieties, thus a 33% maximum adoption rate was used. It was assumed that yield would increase more in Primera (20%) than in the Postrera (10%), because of the greater yield advantage of the new variety during the warmer Primera season. It was estimated that it takes six years and costs roughly $60,000 USD to develop a new common bean variety in Honduras. Furthermore, for the purpose of the farmer survey, it was estimated that this investment in breeding for heat tolerance would increase bean yield by approximately 260 kg per hectare in areas subjected to high temperature stress, i.e. seasonal temperatures averaging above 30° C during the day or 20° C at night.

Surveyed farmers were asked if and how they would change their production system if a new bean variety yielded 260 kg per hectare more than their current variety. The farmers reported that they would increase their bean production area during the Primera season by 68% on average. Farmers in lower elevation villages projected that they would increase their bean growing area by 81% versus 61% in high altitude villages. In addition, few farmers (less than

5%) said that they would acquire new properties for planting the improved bean variety. In order to determine access, acceptance, and use of improved varieties, farmers were asked about their use of common bean germplasm. Almost all of the surveyed farmers in Atlántida grew beans of the small red market class, however, approximately 7% also planted black beans. Approximately 48% of the farmers had heard of one or more of the improved varieties that had been released by the Zamorano Bean Program, and 34% had tested one of the improved varieties through association with a non-governmental organization (NGO) or on their own. Of the improved varieties that have been released by Zamorano, farmers regularly planted only two varieties, 'Tio Canela 75' (Rosas et al., 1997) and 'Dorado'. Farmers in four out of the 10 villages had no knowledge of any of the improved varieties, and 67% of the farmers planted only landraces.

Given the assumptions of population growth, yield increases, production area increases, and adoption rates, we estimated the potential increase in bean yield due to the introduction of a heat tolerant variety in Atlántida. The opportunity cost scenarios used net returns per hectare of maize as the opportunity cost, with various assumptions regarding the proportion of maize area reduction for every additional hectare of common bean (i.e., 1.0 ha allocated to beans results in a 1.0, 0.5, or a 0.25 ha reduction in the maize area). With the introduction of a heat-tolerant variety in 2010, 3,244 to 3,338 additional metric tons of beans could be produced between 2011 and 2020 in Atlántida, with an estimated net present value between $388,000 and $720,000 USD depending on the opportunity cost assumption (Table 1). The rate of return for the investment in a heat tolerant variety in Atlántida, discounting plant breeding costs, is therefore between 28 and 38%. The greater willingness of farmers at low altitudes to increase their bean production area, indicates a potential to shift bean production from the fragile higher altitude areas to lower zones during the Primera season.

Table 1. Net present value in USD of projected additional bean production, during the years 2011 to 2020, due to the introduction of a heat tolerant variety in Postrera and Primera in Atlántida, Honduras, given a range of opportunity costs to maize production[1]. Projected scenarios based on responses from farmers in high & low altitude villages in Atlántida.

Scenario	*Incremental production (Metric Tons)*	*Net present value OC= 0*[2]	*Net present value OC= 1/4*	*Net present value OC= 1/2*	*Net present value OC= 1/1*
High Altitude	3,244	$697,561	$627,162	$556,762	$415,962
Rate of Return		38%	36%	34%	29%
Low Altitude	3,338	$719,575	$636,636	$553,698	$387,821
Rate of Return		38%	36%	34%	28%

[1]Estimates calculated from historic maize yield averages and farm level prices.
[2]Opportunity costs (OC) of increased bean production on maize production. Ratio indicates proportion of maize area reduced for every hectare of bean area increase.

References

Rosas, J.C., O.I. Varela, and J.S. Beaver. 1997. Registration of 'Tío Canela 75' small red bean (race Mesoamerica). Crop Sci. 37:1391.