Economic Benefits of Mitigating Major Production Constraints Affecting Banana in Uganda: An Industry-Scale Analysis

Banana is the single most important staple crop in Uganda; contributing about 30 percent of total food consumption and 14 percent of total crop value. About 24 percent of all agricultural households are engaged in banana production.

Banana production faces severe constraints due especially to weevils, nematodes, black sigatoka, bacterial wilt and low soil fertility, with associated yield losses typically in the range of 30–60 percent (Table 1). Overall, low soil fertility and banana bacterial wilt (BBW) appear to pose the most damaging threats to banana productivity. BBW has recently spread alarmingly through much of central Uganda, with devastating effect.[1] Estimates of yield losses due to the above constraints are generally much greater in the extensive, low productivity areas than in the high productivity areas, reflecting the importance of both biophysical conditions that are less hospitable to pests and diseases and the greater use of improved cultural practices in the latter areas. With the exception of BBW whose impacts are both short-term and extreme, losses tend to grow over time. This brief summarizes the findings of a research project on the potential economic benefits of mitigating major production constraints in the banana sector of Uganda.

Table 1: Estimated yield losses due to priority banana production constraints in Uganda

	Typical Losses	
Constraint	% loss	Year [a]
Banana weevil	50-70	4th
Nematodes	40-60	4th
Black sigatoka	30-50	3rd
Bacterial wilt	80-100	1st
Low soil fertility	10-70	>3rd

Notes: a means year of plantation cycle in which losses typically become significant.
Sources: Compiled from various published sources, NARO surveys and expert consultation.

Methodology

IFPRI's Dynamic Research Evaluation for Management (DREAM)[2] model is used to assess the likely economic benefit of research and development (R&D) induced increases in banana productivity. An expert and stakeholder consultation group defined three broad scenario groups comprising a total of 14 individual technology scenarios (Table 2) for addressing the main banana constraints mentioned above. The three broad scenario groups were:

I. Adoption of current agronomic and cultural best practices (CBP), including cleaning of tools, crop sanitation, weevil trapping, weed control, use of clean planting materials, removal of male buds, pruning and de-suckering, and soil amendments
II. Generation and adoption of germplasm with resistance traits enhanced through conventional breeding practices (Conv)
III. Generation and adoption of transgenic materials with enhanced resistance traits (GM).

Table 2: Technology scenarios

Scenario Group		Technology Scenarios (1 to 14)
I	Increasing adoption of current best practices (CBP)	Improved best practices for management of weevils (1), nematodes (2), black sigatoka (3), and bacterial wilt (4); Use of combinations of inorganic and organic fertilizers and mulch to enhance plant nutrition (5)
II	Improved germplasm (conventional breeding) with improved practices (Conv)	conventional breeding: introduced hybrids from FHIA (6); Banana genotype with resistance to weevils (7), nematodes (8), black sigatoka (9) and bacterial wilt (10)
III	Improved germplasm (transgenic) with improved practices (GM)	GMO banana genotype with resistance to weevils (11), nematodes (12), black sigatoka (13) and bacterial wilt (14)

The expert and stakeholder consultations revealed that successful research outcomes for improved resistance to black sigatoka through conventional breeding and improved weevil resistance through transgenic approaches were the most likely (about 78 percent probability of success). Development of banana bacterial wilt resistance through conventional means was rated as the least likely to be successful (18 percent chance). Conventional approaches to banana breeding were perceived to take longer to be successful (15 years average time lag) than biotechnology-based approaches (12 years). Each of these three broad scenario groups corresponds to major science and technology development issues for the Ugandan banana sector, to questions on the generation and delivery of innovations by the National Agricultural Research

[1] See Benin, S., Abodi, A. and Wood, S. 2005. Assessing the impacts of banana bacterial wilt disease on banana productivity and livelihoods of farm households in Uganda. SCRIP Report, IFPRI, Kampala, Uganda.

[2] Alston, J.M., Norton, G.W. and Pardey, P.G. 1995. Science under scarcity: principles and practices for agricultural research evaluation and priority setting. CAB International (CABI), Wallingford, U.K; Wood, S., You, L. and Baitx, W. 2000. DREAM user manual 2000. IFPRI, Washington, D.C., USA

Organization (NARO) and National Agricultural Advisory Services (NAADS). Results associated with the first group of scenarios, of relevance to NAADS, will highlight the value of improved services to banana producers. The second and third scenario groups address germplasm improvement (conventional versus transgenic) and are largely targeted to NARO in terms of both generating information that might help build support for further banana-related R&D investments, as well as informing the targeting of those investments.

Estimation of the potential benefits is based on the economic surplus approach. Consumers benefit from enhanced productivity through decline in prices due to an increase in the supply of bananas resulting from increase in productivity, relative to the situation without the new technology. As a result of the decline in price, there can be negative benefits (losses) incurred by some producers. Producers who adopt innovations earlier or at a faster rate may derive greater benefits from lower unit production costs. Furthermore, some technologies are biased to deliver greater impacts in specific production conditions, so that producers elsewhere cannot fully utilize them.

Table 3: Potential economic benefits (US$ million) of alternative yield improving strategies for banana production in Uganda, 2005-2030

Scenario Number	Type	Constraint	Average Annual Gross Benefits
4	CBP	Bacterial Wilt	27-55
5	CBP	Soil Fertility	
14	GM	Bacterial Wilt	
6	CBP	FHIAs	
1	CBP	Weevils	8-14
2	CBP	Nematodes	
3	CBP	Black Sigatoka	
12	GM	Nematodes	
11	GM	Weevils	
13	GM	Black Sigatoka	3-7
7	Conv	Weevils	
10	Conv	Bacterial Wilt	
8	Conv	Nematodes	
9	Conv	Black Sigatoka	

Notes: CBP is current best practices; GM is genetic modification, Conv is conventional breeding. Each technology is defined by a unique set of R&D and adoption lag times, e.g. CBPs are available for adoption immediately in 2005, while conventional breeding approaches may involve up to 15 years before technologies become available for adoption

Simulation results

The simulation results for the 14 individual industry-scale scenarios, summarized in Table 3, suggest a wide range of potential benefits from constraint mitigation over the period 2005-2030. Average annual gross benefits of US$27–55 million are associated with investments that mitigate the effects of BBW through increased adoption of best practices or through biotechnology approaches and increased adoption of best practices associated with soil nutrient management or more-resistant banana varieties (FHIA). The lowest average annual gross benefits were associated with conventional breeding approaches, primarily because of the longer R&D lag times and lower expected constraint mitigation potential than with biotechnology-based approaches.

The high potential payoff to improved adoption of CBPs is intuitive, given the much reduced time lags. An intervention that can provide significant yield savings *now* is more attractive than those with payoffs 10–15 years into the future. In these simulations also, there is no offsetting R&D associated with existing CBPs. For example, the payoffs to a biotechnology-based solution to mitigating the effects of BBW are projected to be high since its R&D lag times are projected to be shorter than conventional breeding. While purely conventional approaches to crop improvement appear to offer lower potential benefits (although they still might remain economically attractive), this does not imply that conventional breeding is unnecessary, as transgenic approaches rely on many conventional improvement activities.

Implications

Conventional *only* approaches are less desirable, primarily because biotechnology appears to offer some unique solutions to the complex breeding issues surrounding banana sterility. The results suggest doing the easy things first. Better usage of knowledge already gained may have the highest payoffs and might also present the fewest implementation challenges. However, this strategy alone is insufficient. Also, it is challenging simply to maintain *existing* productivity levels as pests and diseases evolve, and new challenges are faced in consolidating past productivity gains. This fact alone drives the urgent need to maintain (and preferably expand) efforts mitigate constraints that are responsible for extremely large economic losses. Accelerating the emphasis on a combined biotechnology and conventionally-based strategy has several advantages, not least of which is time.

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