INTERNATIONAL FOOD
POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty

Supported by the CGIAR

IFPRI Discussion Paper 00744

December 2007

Benefit-Cost Analysis of Uganda's Clonal Coffee Replanting Program

An Ex-Ante Analysis

Samuel Benin
and
Liangzhi You

Development Strategy and Governance Division
and
Environment and Production Technology Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI) was established in 1975. IFPRI is one of 15 agricultural research centers that receive principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research.

FINANCIAL CONTRIBUTORS AND PARTNERS

IFPRI's research, capacity strengthening, and communications work is made possible by its financial contributors and partners. IFPRI gratefully acknowledges generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

INTERNATIONAL FOOD
POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty

Supported by the CGIAR

IFPRI Discussion Paper 00744

December 2007

Benefit-Cost Analysis of Uganda's Clonal Coffee Replanting Program

An Ex-Ante Analysis

Samuel Benin
and
Liangzhi You

Development Strategy and Governance Division
and
Environment and Production Technology Division

PUBLISHED BY

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

www.ifpri.org

Notices:

[1] Effective January 2007, the Discussion Paper series within each division and the Director General's Office of IFPRI were merged into one IFPRI-wide Discussion Paper series. The new series begins with number 00689, reflecting the prior publication of 688 discussion papers within the dispersed series. The earlier series are available on IFPRI's website at www.ifpri.org/pubs/otherpubs.htm#dp.

[2] IFPRI Discussion Papers contain preliminary material and research results. They have not been subject to formal external reviews managed by IFPRI's Publications Review Committee, but have been reviewed by at least one internal and/or external researcher. They are circulated in order to stimulate discussion and critical comment.

Contents

Acknowledgments v
Abstract vi
1. Introduction 1
2. Coffee-Wilt Disease and the Replanting Program in Uganda 4
3. Conceptual Framework and Empirical Approach 7
4. Dream Model Simulation and Results 14
5. Conclusions and Implications 20
Appendix: Supplementary Tables 22
References 25

List of Tables

1. Number of clonal Robusta coffee seedlings distributed in Uganda 10
2. Costs of UCDA research and development (R&D) on coffee in Uganda 11
3. Estimated R&D cost for clonal-coffee-replanting program in Uganda by district 12
4. Comparison of farm production costs and returns for growing clonal versus traditional Robusta coffee in Uganda 13
5. Baseline data for DREAM model simulations 14
6. DREAM sensitivity analysis results 18

A.1. Amount and value of Uganda's coffee exports, 1964/65 to 2003/04 22
A.2. Number of Robusta coffee seedlings distributed in Uganda by district 23
A.3. Benefit–cost analysis of the clonal-coffee-replanting program in Uganda by district 24

List of Figures

1. International coffee prices and unit value of Uganda's coffee exports, 1976–2004 1
2. Uganda's coffee exports by volume and value, 1976–2004 2
3. Coffee output and coffee areas affected by coffee-wilt disease in Uganda, by district 4
4. Number of coffee seedlings distributed free to farmers in Uganda, 1993/94–2003/04. 6
5. Supply–demand model of economic surplus due to productivity increase 7
6. Economic analysis of the clonal-coffee-replanting program in Uganda 16
7. Share of coffee export prices received by farmers, and export prices and prices received by farmers as share of retail prices in importing countries in the EU 17
8. Amount and share of Uganda's coffee production that is consumed domestically 19

ACKNOWLEDGMENTS

USAID–Uganda Mission provided financial support for this research through the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program, which is implemented by the International Food Policy Research Institute (see www.foodnet.cgiar.org/SCRIP for details). Data management support was provided by Rhona Walusimbi, Fred Mutenyo, and Miriam Kyotalimye. All errors are the responsibility of the authors. Kindly send comments to s.benin@cgiar.org.

ABSTRACT

The Ugandan coffee industry is facing some serious challenges, including low international prices in the international coffee market, aging coffee trees and declining productivity, and, more recently, the appearance of coffee-wilt disease, which have all contributed to the decline in both the quantity and value of coffee exports.

The government of Uganda, through the Uganda Coffee Development Authority (UCDA), in 1993/94 started a coffee-replanting program to both replace coffee trees that were old or affected by coffee-wilt and expand coffee production into other suitable areas in northern and eastern Uganda. This program seems to be helping to both combat the industry's problems and reverse the declining trends. However, the UCDA announced in 2004 that it was withdrawing from the replanting program in the 2004/05 season (it had supported nursery operators and purchased and distributed free seedlings to farmers), so the program's achievements may not last.

This paper estimates the economic returns (benefit–cost ratio) of the coffee-replanting program, particularly replanting with clonal varieties, and analyzes the welfare implications of the decision to withdraw. We find that the internal rate of return (IRR) and benefit–cost ratio are very high, about 50 percent and 3.7 respectively, suggesting that the replanting program in Uganda is very beneficial to the livelihoods of coffee farmers, the coffee sub-sector, and the economy as a whole. The largest benefits occur in the central region, where the bulk of coffee is grown, followed by the eastern and western regions. The largest return on investment occurs in the eastern region, followed by the central and western regions. Sensitivity analyses show that the results (that is, the net benefits) are robust with respect to the assumptions made, including demand and supply elasticities and level of domestic consumption. Although the results are sensitive to farm production costs and coffee yields, the program still improves welfare. Taken all together, the results suggest that if the government withdraws from the replanting program without putting place adequate alternative measures to ensure the program's sustainability, welfare will be severely reduced in coffee-growing areas.

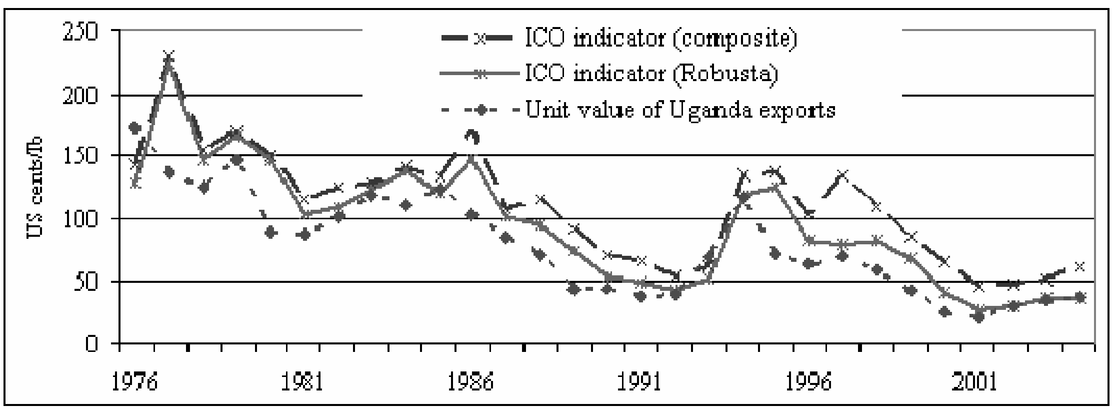
Keywords: clonal coffee, benefit-cost analysis, IRR, DREAM, Uganda

1. INTRODUCTION

Coffee plays an important role in the economy and livelihoods of Uganda's rural population. The coffee industry consists of low input-intensity smallholders with an average plot size of 0.2 hectares (UNHS 2002), providing the main source of income for an estimated 0.3–0.5 million households distributed over two-thirds of the country. However, over 2 million people are estimated to derive coffee-related incomes by living and working on coffee farms and other support and downstream activities, including processing, input supply, trading, and transport (Ssemwanga 2004; UCTF 2005). About 40 percent of Uganda's total export earnings are derived from coffee exports.

The Ugandan coffee industry is facing some serious challenges. International coffee prices have been on the decline for many years, but have been rising for the last five years (see Figure 1). More recently, the industry has been hit by coffee-wilt disease (CWD).

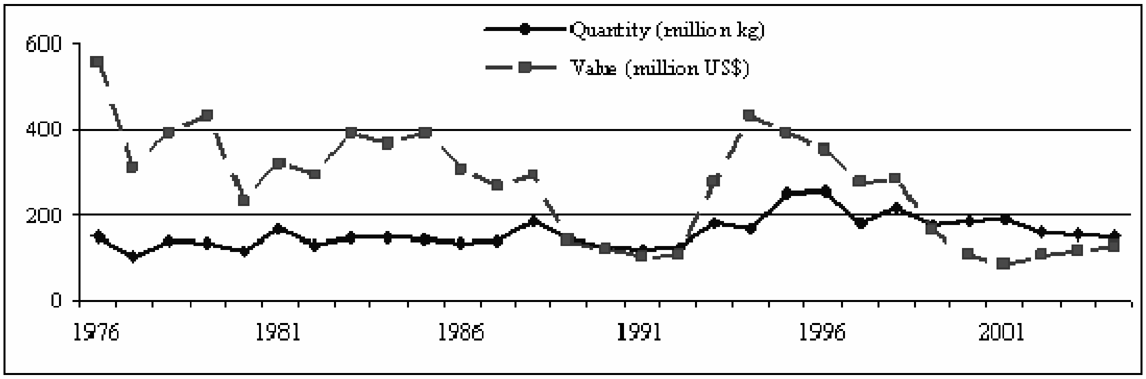
Figure 1. International coffee prices and unit value of Uganda's coffee exports, 1976–2004



Sources: ICO indicators (ICO 2006); Unit value of Uganda exports is total value of exports divided by total quantity of exports (UCDA annual reports).

Aging coffee trees are another problem, because they are less productive. It is estimated that about 120 million (44.5 percent) of Uganda's Robusta coffee trees have been destroyed by CWD (a loss of about 78,000 metric tons (mt) of coffee per year) and more than 70 percent of the remaining trees are more than 40 years old (UCTF 2005). Together, these problems threaten the long-term viability of the industry. In the last five years, between the 1998/99 and 2003/04 seasons, the quantity and value of coffee exports declined by an average of 6.6 percent and 12.6 percent per year, respectively, although the value of coffee exports has been increasing since 2001 (see Figure 2). Coffee used to be the leading earner of foreign exchange until recently when it was overtaken by other export commodities.

Figure 2. Uganda's coffee exports by volume and value, 1976–2004



Source: UCDA annual reports (see Appendix Table A.1).

To help combat the industry's problems and reverse the declining trends in productivity, production and revenues, the Government of Uganda, through the Uganda Coffee Development Authority (UCDA), has been implementing a coffee-replanting program to replace old coffee trees and those affected by CWD. The program also expands coffee-growing into other suitable areas in northern and eastern Uganda. The program began during the 1993/94 coffee season, and from then up until the 2003/04 season the UCDA purchased and distributed to poor farmers on average 12.5 million Robusta and Arabica coffee seedlings per year (UCTF 2005). About 20 percent of the Robusta seedlings distributed are clonal varieties (UCDA, personal communication), which are higher yielding and resistant to CWD. Although the recommended farm management and production practices associated with growing the clonal varieties are much more costly compared with growing the traditional varieties, clonal coffee is potentially much more profitable because of its much higher productivity.

The aim of this study is to estimate the economic returns (benefit–cost ratio) of the coffee-replanting program, particularly the replanting with clonal varieties, using the Dynamic Research EvAluation for Management (DREAM) model (Alston et al. 1995; Wood et al. 2000). This study is inspired by two different factors. First, a study by You and Bolwig (2003) that analyzed the welfare benefits of alternative coffee-growth scenarios in Uganda concluded that strategies that seek to improve the quality and productivity of coffee can lead to large increases in annual export earnings and significant welfare improvements in Uganda. Although they say that the implementation of both productivity- and quality-enhancing strategies would require a higher level of organization in the industry (horizontally among small producers, and vertically among producers, traders, roasters and consumers), they do not analyze the costs associated with the alternative strategies, and so cannot describe the cost effectiveness of different interventions. The second factor is the government's withdrawal from the replanting program. In a UCDA notice of May 2004 given to all District Coffee Coordinators and nursery operators, the UCDA announced that the government will no longer buy coffee seedlings from nursery operators and distribute them free to farmers, and that farmers therefore have to buy their own seedlings, which will also depend on the ability of the nursery operators to supply them (UCTF 2005). According to the Uganda Coffee Trade Federation many of the private nursery operators had not been paid by the government and had abandoned their nurseries, potentially affecting the sustainability of the replanting program, the coffee sub-sector, and the economy as a whole (UCTF 2005) The UCDA's decision to withdraw from the replanting program may be temporary, depending on an evaluation of the program being commissioned by UCDA, The economic returns of the program will be an important factor in the government's final decision to withdraw from or continue with the program, so it is important to know what they are. Furthermore, analyzing the distribution of the benefits of the program to various stakeholders (including farmers, roasters, processors, exporters, and the government) could suggest other potential sources of financing for the program, which seems to be a critical issue.

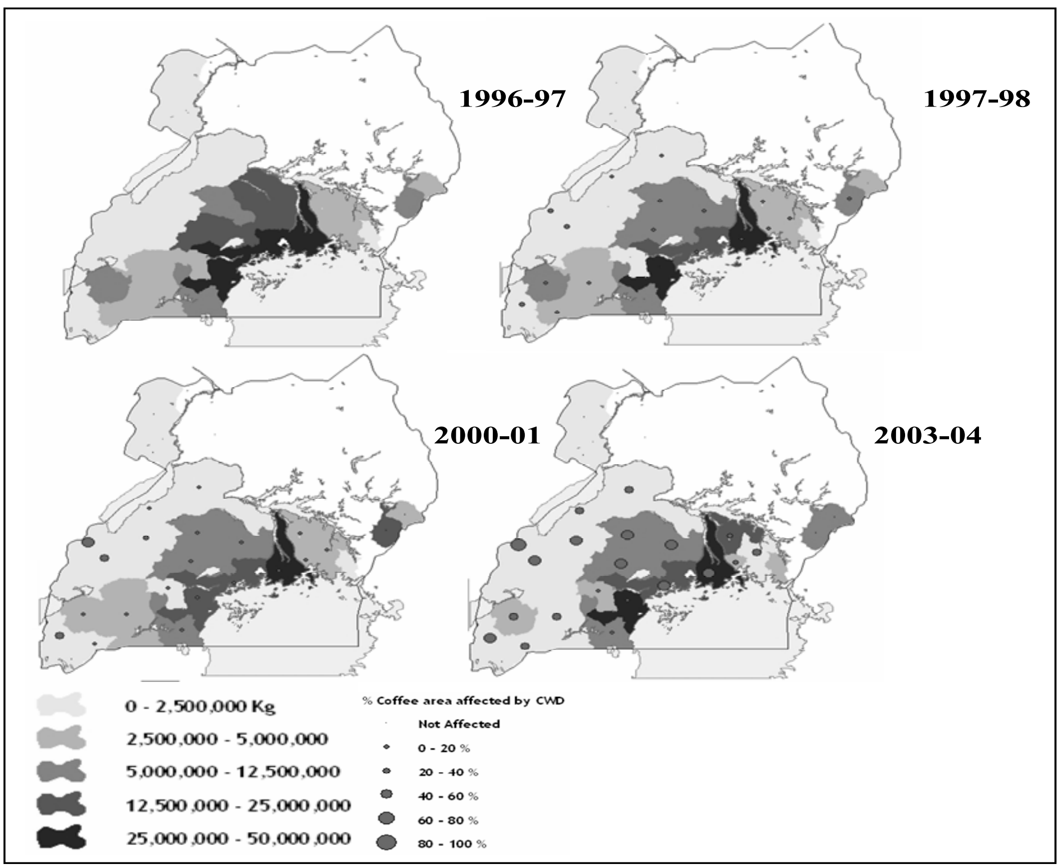
This paper will look first at coffee-wilt disease and the replanting program (Section 2), followed by an explanation of the conceptual framework and empirical approach that we used to assess the economic returns to the program (Section 3). The results, including sensitivity analysis, are presented in Section 4, followed by conclusions and implications in Section 5.

2. COFFEE-WILT DISEASE AND THE REPLANTING PROGRAM IN UGANDA

Coffee-wilt disease (or *Tracheomycosis*), like other wilt diseases, is caused by a fungus that blocks water and nutrients from traveling from the roots to other parts of the plant, causing wilting and, eventually, death. The disease was first reported in the Central African Republic in 1927, then spread to Cote D'Ivoire, Liberia and Cameroon between 1944 and 1950, the Democratic Republic of Congo between 1998 and the early 1990s, and thereafter to Uganda (Baffes 2006).

There have been several attempts to estimate the level of CWD infection at the farm, national, and regional (East Africa) levels, and these studies are ongoing (see for example COMPETE/EC 2001; CORNET 2003; Ssemwanga 2004). The study by CORNET (2003) shows that about 90 percent of the farms surveyed in Uganda (1,374 in total) were infested with CWD. Furthermore, the disease was observed in all 15 districts surveyed, affecting 44.5 percent of the trees (ranging from 3.5 to 60.9 percent). Figure 3 shows the progression of the disease at the district level in Uganda since the 1996/97 coffee season. Within a few years, not only has the disease spread to many producing areas, but also the incidence of infection has increased rapidly.

Figure 3. Coffee output and coffee areas affected by coffee-wilt disease in Uganda, by district



Source: Farrow (2006)

Interestingly, the disease is not evenly distributed in terms of the type of coffee affected in the East Africa region. In the CORNET (2003) study, for example, the disease was found to occur only on Robusta coffee in Uganda and Tanzania, and only on Arabica coffee in Ethiopia. The disease was not found on Arabica coffee in Uganda, Tanzania or Rwanda, nor on Robusta coffee in Ethiopia. It is not clear why these anomalies occur. Altitude may be an influencing factor. In Uganda, for example, Arabica is grown at higher altitudes than Robusta. In Tanzania, however, the disease was observed only on Robusta coffee, even where Arabica and Robusta coffee farms or trees were growing adjacent to each other (CORNET 2003).

According to UCTF, all the traditional Robusta-growing areas in Uganda have been affected by the disease, and it is estimated that about 120 million Robusta coffee trees have died due to the disease (UCTF 2005). This represents about 44.5 percent of the total Robusta coffee trees and a loss in foreign exchange of at least US$59.63 million per year.[1] The CORNET study also estimated the impact of the disease in Uganda on yield loss to be in excess of 350 kilograms/ha per year and an economic loss of US$231.6 per ha per year of coffee exported.[2] These figures point to substantial potential impacts of CWD on livelihoods in Uganda, as Robusta coffee accounts for 85–90 percent of total coffee production. In 2003/04, for example, it accounted for about 79 percent and 71 percent of total quantity and value of coffee exported, respectively (UCTF 2005). The development of wilt-resistant varieties is critical for the survival of the coffee industry, as well as for improving and sustaining the livelihoods of many people who depend on the coffee sub-sector. This is true not only for Uganda, but also for other countries affected by the disease, as the CORNET study shows.

Research and development in Uganda to improve coffee production, including the selection and breeding work on Robusta coffee that resulted in the clonal varieties, dates back more than 100 years in research facilities, but it was not until the 1980s that clonal coffee was introduced at the farm level (Sserunkuuma 1999). The Ugandan Coffee Research Institute (CORI), under the National Agricultural Research System, is responsible for carrying out research on coffee, in particular developing wilt-resistant Robusta varieties. Research is also underway to develop wilt-resistant Arabica varieties for planting in lowland areas, which traditionally grow Robusta coffee, with one variety popularly known as *Tuza* now being tested in Bushenyi, Rukungiri and Ibanda districts (New Vision 2007). Arabica is resistant to CWD in Uganda, and it also fetches a higher price than Robusta.

During the 1993/94 coffee season, the government of Uganda, under the UCDA, embarked on a replanting program. They bought coffee seedlings and distributed them free to farmers. The program had

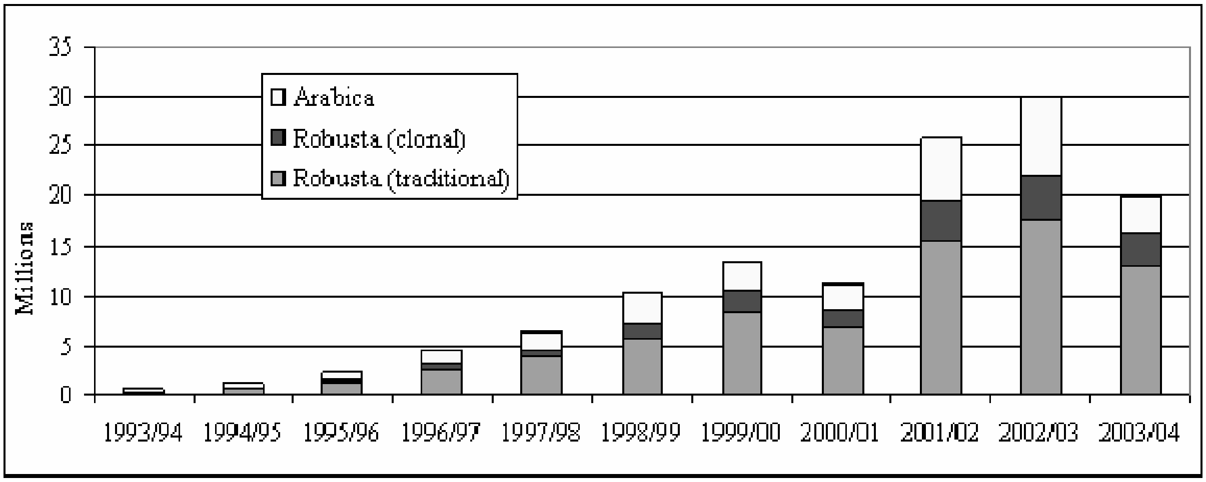
---

[1] The loss in foreign exchange was calculated by multiplying the estimated loss of 1.3 million 60-kilogram bags per year (UCTF 2005) by the average value of exports earned in 2003/04 of US$45.87 per 60-kilogram bag (UCTF 2005).

[2] Comparable calculations for the case of Ethiopia put the yield loss at 276 kilograms/ha per year and economic loss at US$275.3 per ha per year of coffee exported (CORNET, 2003).

three objectives: (1) replace old coffee trees and those affected by the disease; (2) introduce coffee growing to new areas in northern and eastern Uganda; and (3) increase Arabica production to 20 percent by 2006 (UCTF 2005). Between the 1993/94 and 2003/04 seasons, UCDA purchased and distributed a 125 million coffee seedlings to coffee farmers (see Figure 4).

Figure 4. Number of coffee seedlings distributed free to farmers in Uganda, 1993/94–2003/04.



Source of original data: UCTF (2005)
Note: The number of clonal Robusta coffee seedlings is estimated as 20 percent of the total Robusta seedlings, based on personal communication with a UCDA official.

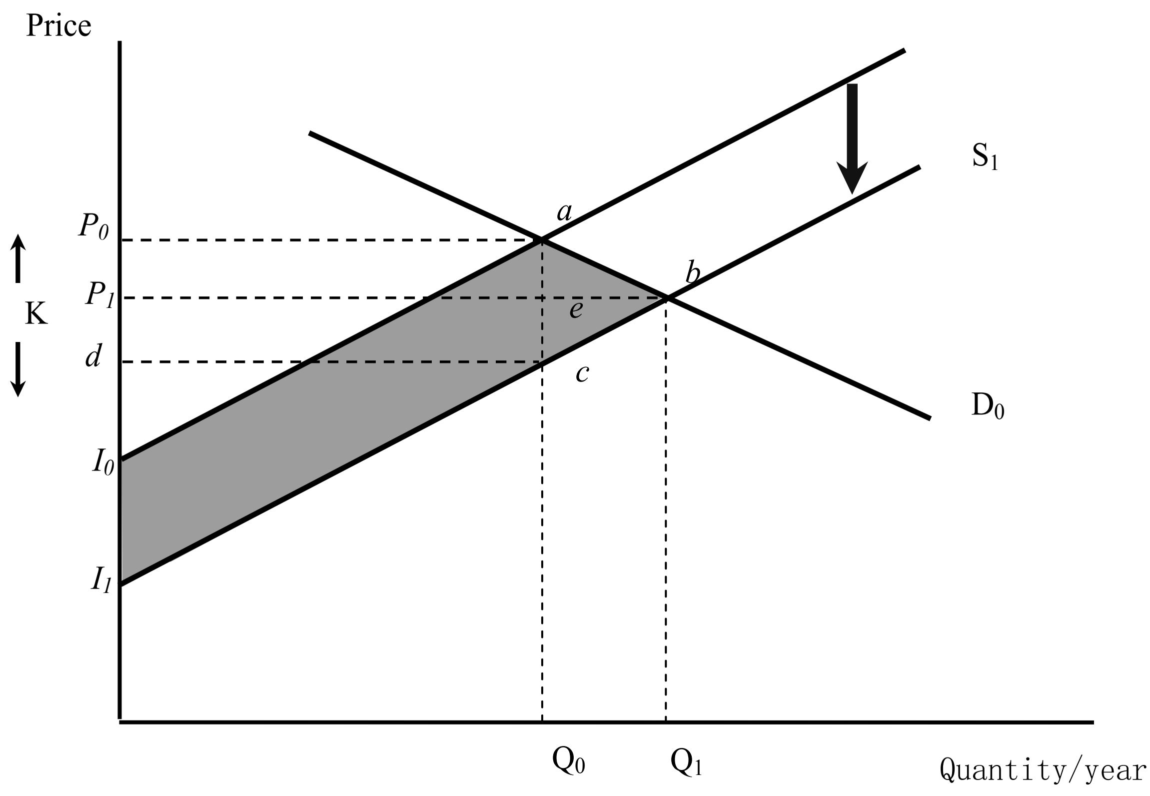
About 25 percent of the seedlings distributed to farmers are Arabica. Of the remaining 75 percent of Robusta seedlings, about 20 percent are the CWD-resistant clonal type, and the other 80 percent (60 percent overall) are traditional Robusta. Not surprisingly, some of the newly planted coffee trees have also been attacked by the disease (Baffes 2006; UCTF 2005). The production of high-quality seedlings by nurseries and proper farm management practices by farmers – with help from support services such as extension agents – are critical for ensuring high survival rates of the seedlings. A UCDA official put the seedling survival rate at 80 percent, which is higher than the 50–60 percent rate quoted by Baffes (2006). Nevertheless, with a less than 100 percent survival rate of the newly planted seedlings, and the need to replace the 120 million trees destroyed by CWD plus the remaining stock of trees that are very old (40 years of age and above), it is feared that the distribution so far of 125 million trees falls short of what is needed to get the sub-sector back to its pre-CWD production and export-performance level. Given the introduction of the CWD-resistant and higher yielding clonal type, however, this fear need not necessarily materialize. In the next section, we present a conceptual and empirical approach to assessing the benefit–cost ratio of the clonal-coffee-replanting program.

3. CONCEPTUAL FRAMEWORK AND EMPIRICAL APPROACH

3.1. Conceptual Framework

The conceptual framework for analyzing the impact of the replanting with clonal Robusta coffee varieties is based on the economic surplus approach due to the change in productivity, as depicted in the supply–demand model in Figure 1. Let the curves D_0 and I_0S_0 represent the demand and initial supply functions, respectively. The corresponding initial equilibrium price and quantity are P_0 and Q_0. The effects of replanting with clonal varieties, which reduces the overall loss to CWD and improves productivity, can be expressed as a per unit reduction in production costs, K, and modeled as a parallel shift down in the supply function to I_1S_1. Assuming demand remains unchanged, this technology-induced supply shift leads to an increase in production and consumption from Q_0 to Q_1 (the change is measured by $\Delta Q = Q_1 – Q_0$). The market price drops from P_0 to P_1 ($\Delta P = P_0 – P_1$).

Figure 5. Supply–demand model of economic surplus due to productivity increase



Consumers are better off because of the reduced output price and increased consumption. Producers are also better off if the positive effect associated with the increase in production and decrease in per unit cost of production outweighs the negative effect associated with the decrease in output price.[3] The consumer surplus associated with the change is equal to area P_0abP_1, while the producer surplus is equal to area P_1abcd. The economic surplus is the sum of the consumer and producer surpluses, which is equal to the shaded area I_0abI_1. The change in the per unit cost of production multiplied by the initial quantity, $K \times Q_0$, is often used as an approximation for measuring the economic surplus. Thus, the size of the market, indexed by the initial quantity Q_0, as well as the size of the productivity gain, indexed by the change in the per unit cost of production, K, are critical factors in estimating the economic gain or loss from any productivity change.

3.2. Empirical Approach

The Dynamic Research EvAluation for Management (DREAM) model and computer program (Alston et al. 1995; Wood et al. 2000) was used to analyze and estimate the impact of the clonal-coffee-replanting program. Based on the economic surplus approach discussed earlier, DREAM is designed to measure economic returns to commodity-oriented research under a range of market conditions, allowing price and technology spillover effects among regions due to the adoption of productivity-enhancing technologies or practices in an innovating region. Supply and demand in each region are represented by linear equations, with market clearing enforced by a set of quantity and price identities. The DREAM model is a single-commodity model without explicit representation of cross-commodity substitution effects in production and consumption, and the commodity is treated as tradable between regions, although a spectrum of possibilities from free trade to self-sufficient (or no trade) can be represented. The market-clearing conditions are defined in terms of border prices, which may differ from the prices received by farmers (or paid by consumers) because of transportation, transactions, product transformation, and other costs that are incurred within regions between the farm and the border.

Alston and Wohlgenant (1990) showed that changes-in-benefits estimates from comparatively small equilibrium displacements of linear models provide a reasonable approximation of the same shifts with various other functional forms. Small shifts also have added virtues. The cross-commodity and general equilibrium effects are likely to be small and thus are effectively represented within the partial equilibrium DREAM model. In addition, the total research benefits will not depend significantly on the particular elasticity values used, although the distribution of those benefits between producers and consumers will.

---

[3] This outcome depends on the elasticity of demand, where the benefit to producers increases as the demand curve becomes flatter (or more elastic) and declines as the demand curve becomes steeper (or more inelastic).

Despite these simplifications, which make the DREAM model manageable, significant effort is needed to parameterize and use the model to simulate market outcomes under various scenarios (Alston et al. 2000; Wood et al. 2000). The primary parameterization of the model's supply and demand equations is based upon a set of demand and supply quantities, prices, and elasticities that were measured during a defined "base" period. DREAM allows for exogenous shifts in supply and demand, thereby allowing for a sequence of yearly equilibrium prices and quantities to be generated in "without research" scenarios. These "without research" outcomes can be compared with "with research" outcomes, which are obtained by simulating a sequence of supply curve shifts attributable to research. The research-induced supply shifts are defined based on some assumed pattern of adoption of the technology over time, up to 100 percent adoption in some future year. Finally, measures of producer and consumer surplus are computed and compared between the "with research" and "without research" scenarios, and these are discounted back to the base year to compute the present values of benefits. In cases where the costs of the research are known, DREAM will compute a net present value or internal rate of return (IRR).

3.2.1. DREAM Model Parameters

We have adapted the model just described to simulate a sequence of supply-curve shifts attributable to planting clonal Robusta coffee varieties, representing the "with research" scenario. Thus, one of the critical parameters in estimating the economic surplus of increased productivity (associated with planting clonal coffee) is the supply shift parameter, modeled as the change in the per unit cost of production, *K* (see Figure 5). Based on Alston et al. (1995), *K* can be estimated as follows:

$$K_{j,t} = \left[\frac{\Delta Y_j}{\varepsilon_j} - \frac{\Delta C_j}{1 + \Delta Y_j} \right] p_j * A_{j,t} * P_{j,0} \qquad \ldots\ldots\ldots\ldots\ldots 1$$

where $K_{j,t}$ is the supply shift parameter in each region or defined production and consumption unit area (which is the district in this study); ΔY_j is the yield change due to the clonal variety (new technology); ΔC_j is the change in farm production cost due to the clonal variety; ε_j is the elasticity of supply of the commodity; p_j is the probability of success of the clonal variety; $A_{j,t}$ is the adoption rate of the clonal variety in each district; and $P_{j,0}$ is the producer price of the commodity at the initial time.

3.2.2. Clonal Coffee Research and Development Costs, Yields, and Returns

We were unable to obtain district-level data for clonal varieties alone. However, communication with a UCDA official revealed that about 20 percent of the Robusta seedlings given to farmers are clonal varieties. This percentage, compared to the total number of Robusta seedlings distributed by district (see Appendix Table A.2), was used to estimate the number of clonal seedlings distributed to each district. Table 1 shows that nearly 18 million clonal seedlings were distributed to farmers between 1996/97 and 2003/04.

Table 1. Number of clonal Robusta coffee seedlings distributed in Uganda ('000s)

Region	District	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Northern	Adjumani								
	Arua				1	1			
	Apac				39	14	33	34	27
	Gulu				33	26	60	63	50
	Kitgum				28	5	12	13	10
	Lira				38	34	78	81	64
	Subtotal				138	81	183	191	151
Eastern	Jinja*	24	38	60	59	20	46	49	38
	Kamuli*	24	37	59	179	23	53	55	43
	Iganga*	10	16	26	191	79	180	188	149
	Bugiri*					17	39	40	32
	Busia				15	19	43	45	36
	Pallisa				19	3	6	6	5
	Tororo				17	22	50	52	41
	Teso					10	24	25	20
	Subtotal	58	91	145	479	193	440	460	364
Central	Mpigi*	62	97	154	165	235	537	561	444
	Luwero*	32	49	79	139	123	280	293	232
	Nakasongola*	0	0	0	0	17	38	40	31
	Mukono*	72	112	178	176	159	363	379	300
	Kalangala*	11	17	26	17	3	6	7	5
	Masaka*	78	122	194	218	126	288	301	238
	Sembabule*				55	34	77	81	64
	Rakai*	76	118	189	63	66	150	157	124
	Kampala								
	Subtotal	330	514	820	833	762	1,740	1,818	1,438
Western	Mbarara*	7	10	17	81	57	131	137	108
	Bushenyi*	43	66	106	87	85	194	203	160
	Ntugamo*	18	28	44	35	45	103	108	85
	Rukungiri*	18	28	45	52	23	52	54	43
	Kanungu					3	8	8	6
	Mubende*	40	62	99	131	294	672	702	555
	Kiboga*	9	14	22	71	20	46	48	38
	Kabarole*	34	52	83	75	58	133	139	110
	Bundibugyo	1	2	4	9	10	22	23	18
	Kibaale*	16	25	40	33	18	41	43	34
	Hoima	14	22	35	47	31	71	74	58
	Kasese								
	Masindi*	4	7	11	27	16	36	38	30
	Subtotal	203	316	505	649	661	1,508	1,576	1,246
Uganda	Total	592	922	1,470	2,099	1,696	3,872	4,044	3,199

Source of original data: UCDA Annual Reports (see Appendix Table A.1)
Notes: These estimates are based on personal communication with a UCDA official, who said that the number of clonal Robusta seedlings distributed is about 20 percent of the total number of Robusta seedlings distributed to each district. Districts marked with an asterisk (*) are the traditional Robusta coffee-growing districts. Teso includes Kapchorwa, Katakwi and Kumi districts.

As Table 2 shows, UCDA spent about 687 million shillings (USh) per year between 1996/97 and 2003/04 on coffee research and development (R&D), which translates into about USh45 per coffee seedling distributed to farmers within the same period.[4] R&D costs specific only to the clonal variety were not available, which is not surprising given the difficulty in undertaking such a disaggregation. Nevertheless, the R&D costs per coffee seedling distributed seems low, compared to the cost to farmers of purchasing a Robusta clone, which is about USh500 (Sserunkuuma 1999) compared to only USh250 for a traditional Robusta seedling (COMPETE/EC 2001).

Table 2. Costs of UCDA research and development (R&D) on coffee in Uganda

	1996/97	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**2001/02**	**2002/03**	**2003/04**
Nursery funding (million USh)	517.1	200.9	198.3	86.4	5.6	2.2	53.6	0.0
Research activities (million USh)	46.0	18.7	13.2	3.9	0.0	0.0	4.4	1.8
Tracheomycosis (million USh)	7.3	4.0	620.8	704.7				
District coffee coordinators (million USh)	173.2	199.7	204.9	218.4	205.6	150.2	141.3	43.3
TV and radio programs (million USh)	51.7	40.1	54.9	17.2				
Replanting program (million USh)					39.4	20.9	14.3	6.6
Training, seminars and library (million USh)	320.7	425.5	109.7	100.3	16.0	3.2	27.8	5.0
Coffee promotion (million USh)	5.9		74.8	65.0	66.6	30.7	0.8	
Monitoring and evaluation (million USh)					6.6	27.8	13.6	27.3
Miscellaneous (million USh)	78.2	22.2						
Total R&D cost (million USh)	1,200.2	911.2	1,276.7	1,195.7	339.9	235.0	255.8	84.1
Total R&D cost ('000s US$)	1,122.0	763.1	890.9	757.9	188.5	134.9	143.1	45.0
Total operating cost ('000s US$)	3,705.6	2,997.8	2,940.8	2,140.8	1,587.8	1,411.6	1,445.6	1,588.7
Share of R&D in total operating cost (%)	30.3	25.5	30.3	35.4	11.9	9.6	9.9	2.8

Source: UCDA Annual Reports
Tracheomycosis is coffee-wilt disease. Annual average exchange rates (USh to 1US$) are 1,070 (1996/97), 1,194 (1997/98), 1,433 (1998/99), 1,578 (1999/2000), 1,803 (2000/01), 1,743 (2001/02), 1,787 (2002/03) and 1,867 (2003/04) (OANDA 2006).

While we were trying to disaggregate the total R&D costs attributed to clonal coffee, we learned from a UCDA official that about 20 percent of the Robusta coffee seedlings distributed to farmers were of the clonal-coffee type. This did not seem enough information for our purposes, given that the costs of a particular type of coffee are not necessarily proportional to simply the number of seedlings of that type that were distributed. Instead of trying to estimate the exact percentage of the total cost that was spent on clonal-coffee R&D, we chose to use the total R&D cost for all coffee (see Table 2) as the cost for just the clonal-coffee-replanting program, as we felt it was safer to assume the higher cost. This means that the R&D costs per clonal seedling distributed were 23 US cents on average between 1996/97 and 2003/04 (which is US$ 4.045 million, the total R&D costs for the period, divided by 17.894 million trees, the total

[4] This was calculated by dividing the cumulative research and development cost between 1996/97 and 2003/04 (see Table 2) by the cumulative number of coffee seedlings distributed to farmers within the same period (about 121 million) (see Figure 1).

number of clonal seedlings for the period). We also needed the costs to be disaggregated by district, which is even more difficult to estimate. Here, we did the disaggregation by simply multiplying the average cost per seedling in a particular year by the number of clonal seedlings distributed to each district in that same year. Table 3 shows the estimated cost by district.

Table 3. Estimated R&D cost for clonal-coffee-replanting program in Uganda by district ('000s US$)

Region	District	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
Northern	Adjumani								
	Arua					0.7	0.5	0.5	00.2
	Apac				15.2	1.8	1.2	1.3	0.4
	Gulu				12.8	3.2	2.3	2.5	0.8
	Kitgum				11.1	0.7	0.5	0.5	0.2
	Lira				15.0	4.1	2.9	3.2	1.0
	Subtotal				54.0	10.4	7.4	8.0	2.5
Eastern	Jinja	50.0	34.0	39.7	23.1	2.5	1.8	1.9	0.6
	Kamuli	49.2	33.5	39.1	70.2	2.8	2.0	2.1	0.7
	Iganga	21.6	14.7	17.2	75.0	5.6	4.0	4.3	1.3
	Bugiri					2.1	1.5	1.6	0.5
	Busia				5.9	2.3	1.6	1.8	0.5
	Pallisa				7.4	4.3	3.0	3.3	1.0
	Tororo				6.6	2.6	1.9	2.0	0.6
	Teso				0.0	1.3	0.9	1.0	0.3
	Subtotal	120.8	82.2	96.0	188.2	23.4	16.6	18.0	5.6
Central	Mpigi	128.5	87.4	102.1	64.7	27.7	21.1	20.0	6.8
	Luwero	65.4	44.4	51.9	54.5	14.9	10.6	11.4	3.6
	Nakasongola					2.0	1.4	1.5	0.5
	Mukono	148.2	100.8	117.7	69.1	19.3	13.5	14.5	4.3
	Kalangala	22.0	15.0	17.5	6.8	0.3	0.2	0.3	0.1
	Masaka	161.7	110.0	128.4	85.4	15.3	10.9	11.8	3.7
	Sembabule				21.6	4.1	2.9	3.2	1.0
	Rakai	157.2	106.9	124.9	24.8	8.0	5.7	6.1	1.9
	Kampala								
	Subtotal	683.0	464.5	542.3	326.9	91.7	66.3	68.9	21.8
Western	Mbarara	13.7	9.3	10.9	31.8	7.0	4.9	5.4	1.7
	Bushenyi	88.1	59.9	70.0	34.2	10.3	7.3	7.9	2.5
	Ntugamo	36.6	24.9	29.1	13.6	5.5	3.9	4.2	1.3
	Rukungiri	37.2	25.3	29.6	20.3	2.8	2.0	2.1	0.7
	Kanungu					0.4	0.3	0.3	0.1
	Mubende	82.2	55.9	65.3	51.6	35.7	25.3	27.4	8.6
	Kiboga	18.4	12.5	14.6	27.9	2.4	1.7	1.9	0.6
	Kabarole	69.3	47.1	55.0	29.5	7.1	5.0	5.4	1.7
	Bundibugyo	3.1	2.1	2.5	3.5	1.2	0.8	0.9	0.3
	Kibaale	33.3	22.6	26.4	13.1	2.2	1.6	1.7	0.5
	Hoima	28.9	19.6	22.9	18.6	3.8	2.7	2.9	0.9
	Kasese								
	Masindi	9.2	6.3	7.3	10.5	1.9	1.4	1.5	0.5
	Subtotal	318.2	216.4	252.6	188.7	62.9	44.6	48.3	15.1
Uganda	**Total**	**1,122.0**	**763.1**	**890.9**	**757.9**	**188.5**	**134.9**	**143.1**	**45.0**

Table 4 summarizes the farm production costs and returns associated with growing traditional Robusta coffee versus the clonal type. Although total farm management and production costs are between two and three times higher for growing clonal coffee (e.g. USh1,018/ha in 2002/03) than for growing traditional Robusta coffee (USh420/ha), growing clonal coffee is much more profitable (see Table 4). Average yield is three to four times higher, so the unit cost of production is lower by more than 30 percent (e.g. USh255/kilogram for the clonal type, compared to USh420/kilogram for traditional Robusta in 2002/03). In addition, the clonal coffee tree starts producing berries earlier, during its second year after establishment compared to years 4 to 5 for traditional Robusta, and peaks in the third and fourth years, at a level which could be maintained for several decades (about 40 years).

Table 4. Comparison of farm production costs and returns for growing clonal versus traditional Robusta coffee in Uganda

	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Clonal variety							
Labor/maintenance cost ('000s USh/ha)	290	360	490	630	360	480	648
Amortized cost ('000s USh/ha) [1]	50	50	50	50	50	50	50
Depreciation of equipment ('000s USh/ha)	100	100	100	125	100	100	120
Non-labor input cost ('000s USh/ha)	190	190	135	100	100	120	200
Total cost ('000s USh/ha)	630	700	775	905	610	750	1,018
Yield (kg/ha)	3,000	3,300	3,300	3,600	4,000	4,400	4,000
Unit cost (USh/kg)	210	212	235	251	153	170	255
Farm-gate price (USh/kg)	600	650	600	425	270	280	530
Gross margin (USh/kg)	390	438	365	174	118	110	276
Gross margin ('000s USh/ha)	1,170	1,445	1,205	625	470	482	1,102
Traditional variety							
Labor/maintenance cost ('000s USh/ha)	150	216	225	350	150	180	270
Amortized cost ('000s USh/ha) [1]	0	0	0	0	0	0	0
Depreciation of equipment ('000s USh/ha)	75	75	75	50	50	60	75
Non-labor input cost ('000s USh/ha)	70	70	75	50	50	60	75
Total cost ('000s USh/ha)	295	361	375	450	250	300	420
Yield (kg/ha)	1,200	1,100	1,100	1,200	1,000	1,200	1,000
Unit cost (USh/kg)	246	328	341	375	250	250	420
Farm-gate price (USh/kg)	600	650	600	425	270	280	530
Gross margin (USh/kg)	354	322	259	50	20	30	110
Gross margin ('000s USh/ha)	425	354	285	60	20	36	110

Source: UCDA annual reports

[1] Amortization cost is the establishment cost spread over the optimal productive life (about 40 years) of a coffee plot (*shamba*). The cost of establishing a hectare of clonal coffee is about USh2 million, which includes the cost of planting material (about USh500 per clone), and the opportunity cost of land, etc. The value of the traditional variety is zero, and is used as the benchmark.

Annual average exchange rates (USh to the US$) for coffee years (October to September) are 1,070 (1996/97), 1,194 (1997/98), 1,433 (1998/99), 1,578 (1999/2000), 1,803 (2000/01), 1,743 (2001/02), 1,787 (2002/03) and 1,867 (2003/04) (OANDA 2006).

4. DREAM MODEL SIMULATION AND RESULTS

4.1. Baseline Simulation and Results

We estimate the impact (benefit–cost ratio) of the clonal Robusta coffee replanting program using the actual data for 1998/99 and 1999/2000 to set up the baseline scenario. Our simulation period is 16 years, from 2000 to 2015. We assume that clonal coffee production peaks at 4,000 kilograms/ha after four years (2004). The peak productivity will be maintained for the rest of simulation period since the peak productivity of clonal trees would be maintained for almost 40 years (Section 3). These assumptions and the data in Table 3 are used to estimate the change in production costs (ΔC_j) and yield (ΔY_j) due to the clonal variety, as shown in equation 1. Regarding the probability of success (p_j), we used the 80 percent seedling survival rate estimated by UCDA. The adoption rate ($A_{j,t}$) used is the share of clonal coffee production in total coffee production, which ranges from 2 percent in Gulu district to 10 percent in Kabale district. Based on these parameters and assuming a supply elasticity of 0.4[5], the supply shift parameter (K_j) in equation 1 was estimated for each district, ranging from $1.77\times P_0$ in Gulu to $2.16\times P_0$ in Kabale, which are associated with the low and high ends of $A_{j,t}$, respectively. Table 5 shows details of other parameters and the market conditions used.

Table 5. Baseline data for DREAM model simulations

Region/District	Supply (t)	Domestic demand (t)	Region/District	Supply (t)	Domestic demand (t)
Central	100,508	2,550	*Northern*	420	870
Nakasongola	1,227	3	Arua		107
Luwero	10,901	28	Adjumani		74
Mukono	32,143	309	Moyo		0
Mpigi	20,781	1,050	Nebbi		138
Kampala	0	708	Gulu	120	226
Sembabule	2,394	37	Kitgum	80	240
Masaka	25,180	264	Apac	150	30
Kalangala	1,684	22	Lira	70	0
Rakai	6,198	128	Kotido		0
Western	41,339	1,088	Moroto		53
Masindi	1,637	7			
Hoima	2,804	76	*Eastern*	16,418	592
Kabale		5	Katakwi		2
Bundibugyo	428	82	Soroti		303
Kiboga	6,198	93	Kumi		30

[5] Lewin et al. (2003) estimated the world Robusta price elasticity of supply at 0.20, with a three-year lag from time of planting to harvesting of the first crop – excluding Brazil and Vietnam. Townsend (1999) reports much higher estimates of supply elasticities of 0.64 in the short run and 1.48 in the long run for Kenyan smallholder coffee farmers during 1947–1964. We conservatively assume the supply elasticity for Uganda to be 0.40, the midpoint between Lewin et al.'s and Townsend's short-run estimate. Later, we perform sensitivity analysis.

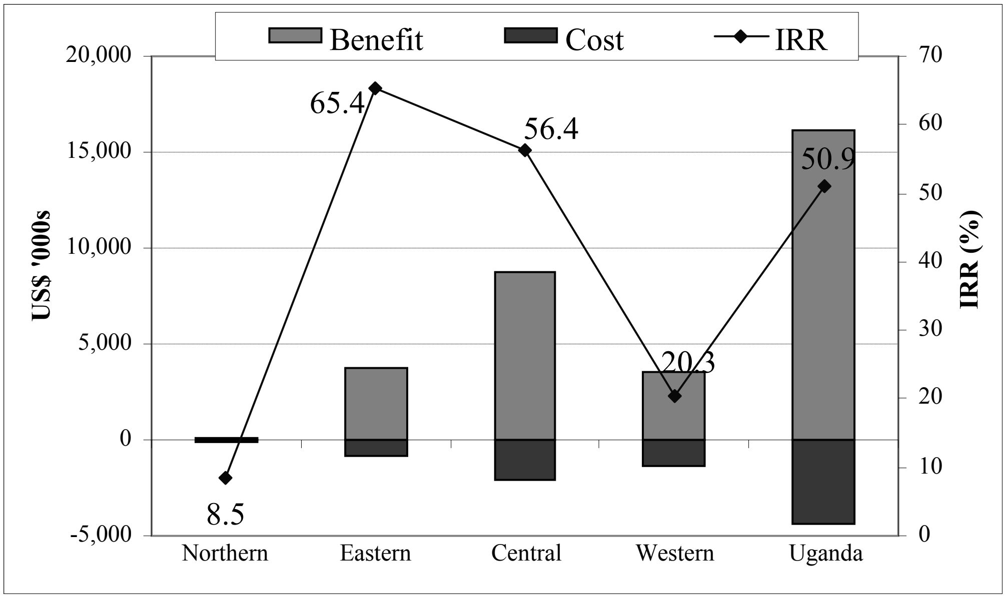
Table 5. Continued

Region/District	Supply (t)	Domestic demand (t)	Region/District	Supply (t)	Domestic demand (t)
Mubende	13,392	193	Mbale		56
Kabarole	1,559	191	Kapchorwa		18
Kasese		220	Kamuli	4,630	0
Bushenyi	4,624	119	Pallisa	200	34
Ntungamo	2,687	43	Busia	80	16
Mbarara	3,348	48	Tororo	100	59
Rukungiri	1,671	6	Jinja	3,363	12
Kisoro		0	Bugiri		34
Kibaale	2,992	3	Iganga	8,045	27
			Uganda total	158,685	5,099
			Rest of world	2,360,453	2,514,039
			World total	2,519,138	2,519,138

Sources of data: UCDA annual reports; ICO website
Notes: District demand data is based on the domestic consumption of coffee as a function of the share of the population of the district in the total population, and a zero means less than 1t. Other parameters include for Uganda: supply elasticity=0.4, demand elasticity=0.2, income elasticity=0.57, and demand growth rate=2 percent per year; and ROW: supply elasticity=0.3, demand elasticity=0.2, income elasticity=0.7, and demand growth rate=1.36 percent per year.

Figure 6 shows the baseline results of the Uganda coffee-replanting program associated with the clonal coffee varieties; assuming a starting world market coffee price of US$610 per ton and a real discount rate of 3 percent per year. The national internal rate of return (IRR) of 50 percent and benefit–cost ratio of 3.7 are very high, suggesting that the program in Uganda with its associated R&D and the purchase and distribution of clonal coffee varieties to Uganda's farmers for planting is very beneficial to the coffee sub-sector and the economy as a whole (see Appendix Table A.3 for details). Recall that the R&D costs used in the analysis are for the entire coffee sub-sector, and not just clonal coffee development, which means that the real anticipated returns are much higher. The largest benefits occur in the central region, where the bulk of coffee is grown, followed by the eastern and western regions. However, the largest return on investment occurs in the eastern region (IRR=65.4 percent) as a whole, followed by the central and western regions. At the district level, the largest return on investment occurs in Kiboga (western region), Mukono (central region), and Kamuli (eastern region) in that order. Together, these suggest that if the government withdraws from the replanting program without ensuring that there are adequate measures in place to ensure its sustainability, welfare is very likely to suffer.

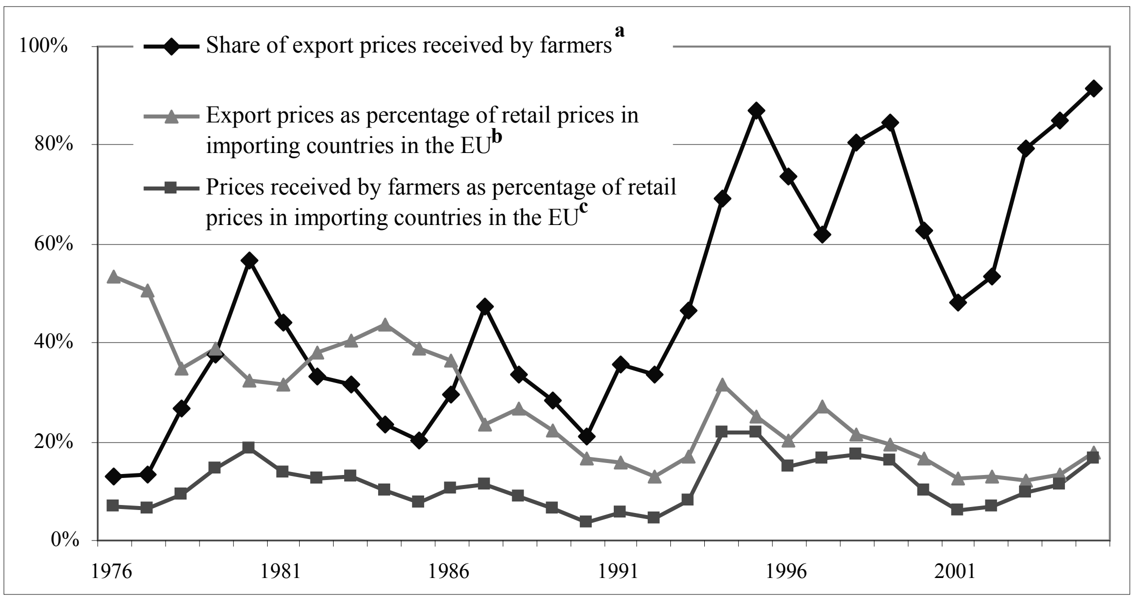
Figure 6. Economic analysis of the clonal-coffee-replanting program in Uganda (baseline scenario)



Although growing clonal Robusta coffee is very profitable at the farm level compared to growing traditional Robusta (as we explained earlier), the incentives for farmers to take up and continue using this new technology is affected by several key factors. First is the high cost of establishment, which is estimated at about USh2 million per hectare, with the cost of one clonal seedling being about USh500. Although farmers are aware of the earlier maturity, larger berries, and higher yields associated with the clonal type, there is concern about its ability to withstand both harsh weather conditions (for example prolonged drought and scorching sunshine) and periods of neglect (Sserunkuuma 1999). With the outbreak of CWD, one would have expected widespread adoption by farmers of the clonal type. However, as Sserunkuuma (1999) points out, many farmers are instead suspicious of the government because of the coincidence between the introduction of the new variety and the outbreak of CWD. This suggests that there is a need to educate farmers about the outbreak and economic importance of the disease, as well as about the new technology. This education campaign should be complemented with the availability of high-quality planting materials and the provision of other services (especially extension and credit) to stop and reverse the devastating impact of the disease as well as address the declining productivity of the old trees.

Although members of UCTF have appealed to the government to continue the replanting program (UCTF 2005), the industry needs to get involved to address the source(s) of financing the program, as there are many other groups besides coffee farmers that benefit immensely from coffee production and exports. As Figure 7 shows, between 1976 and 2005 about US$114.6 million per year (or US$0.55 per dollar of coffee exported per year) accrued to transporters, roasters, processors, exporters, and other sector stakeholders.[6] Ever since the early 1990s, when the share of export prices paid to coffee farmers began to improve, about US$62.4 million per year (or US$0.30 per dollar of coffee exported per year) has accrued to non-coffee-farmers. (The data on the shares that accrued to each of the different stakeholders were not available.) These accruals far outweigh the US$10.8 million per year that COMPETE/EC (2001) estimated it would cost to replant 70 percent of Uganda's total coffee stock within five years. Improving efficiency between the farm gate and the border could also lead to cost savings that could be invested in the replanting program and support services.

Figure 7. Share of coffee export prices received by farmers, and export prices and prices received by farmers as share of retail prices in importing countries in the EU



Source: ICO 2006
Notes: [a] is annual average price paid to Ugandan growers divided by annual average ICO composite price index; [b] is annual average ICO composite price index divided by annual average retail price in importing countries in the EU (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and UK); [c] is annual average price paid to Ugandan growers divided by annual average retail price in importing countries in the EU.

Given the enormous benefits of the program, in addition to the dramatic increase in the share of coffee export prices received by coffee farmers following liberalization in the early 1990s (see Figure 7), it seems that farmers themselves should be able to buy their own seedlings. Although we have no information about farmers' reaction to this, whether or not the actual returns associated with planting clonal varieties realized by farmers are as profitable as suggested in Table 4 will be important. We discuss

[6] These are calculated as one minus the share of coffee-export prices received by farmers, multiplied by the total value of coffee exports. See Figure 7 and Annex 1 for data used and sources.

this further in the next section on sensitivity of the results to higher coffee production costs and lower coffee yields, which better reflects the situation on the ground.

We have no information on the sources of funds for the program to assess whether and to what extent any of the different stakeholders benefiting financially from the replanting program are stepping up to keep the program going. But Figure 7 also highlights the importance of improving value addition so that farmers themselves, and the coffee sub-sector more broadly, can capture more of the final value of coffee exports, which would increase the financial base for potentially supporting the replanting program. Since 1976, the coffee sub-sector in Uganda has received only about a quarter of the final value of the coffee exports (see figure 7). Although the modest share has declined by about 1 percent per year since 1976, there has an increasing trend since 2001.

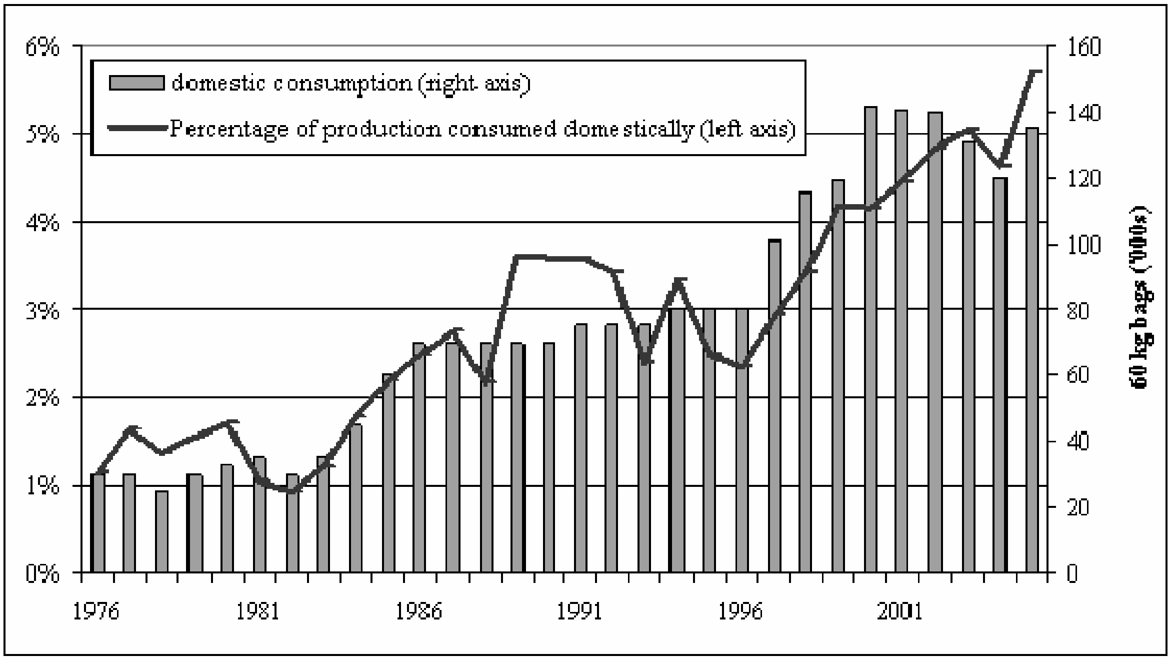
4.2. Sensitivity Analysis

The sensitivity of the baseline outcomes to key parameter values or assumptions suggests that the results (that is, the benefits) are robust with respect to demand and supply elasticities (Table 5), which is expected (see discussion under Section 3.2 on the empirical approach). Increasing the domestic consumption of coffee by up to 100 percent has a positive but not a significant effect on the benefits and return on investment, as domestic consumption of coffee is too low to begin with (see Figure 8) for it to have a substantial multiplier effect. In general, however, increasing domestic consumption does raise the value of coffee and, consequently, the amount accruing to producers and others. It also creates employment through increased agro-industrial processing.

Table 6. DREAM sensitivity analysis results

Parameter			**% change in IRR**				
Description	Base-run value	% change	Region				Uganda
			Northern	Eastern	Central	Western	
Supply elasticity	0.4	–50	–0.10	–0.06	0.00	–0.19	–0.11
		150	0.20	0.10	0.13	0.05	0.12
Demand elasticity	–0.2	–50	–0.04	0.00	0.00	–0.03	0.00
		150	0.00	0.01	0.05	0.04	0.00
R&D and farm production costs	Varies by district	50	–32.53	–33.95	–34.08	–35.17	–34.20
		100	–58.09	–50.93	–51.12	–51.94	–51.29
Coffee yields	Varies by district	–20	–21.24	–20.37	–20.45	–21.10	–19.05
		–50	–52.84	–50.93	–51.80	–49.11	–51.29
Domestic consumption	Varies by district	50	0.00	0.02	0.00	0.01	0.01
		100	0.03	0.03	0.02	0.04	0.02

Figure 8. Amount and share of Uganda's coffee production that is consumed domestically



Source: ICO 2006.

The results are sensitive to R&D costs, farm production costs, and yields, which is also unsurprising. The overall program is still beneficial as the resulting IRRs are still high. A reduction in clonal coffee yield leads to a proportional reduction in the IRR, with the effect being greater in the northern region, while an increase in R&D and production costs reduces benefits and IRR substantially, although the percentage reduction in IRR is less than the percentage increase in costs.[7] Information on actual farm yields of clonal Robusta coffee in Uganda varies. For example, UCDA data shows a five-year (1996 to 2000) average yield of 1,540 kilograms/ha, although the yield in 1999/00 was about 2,250 kilograms/ha (COMPETE 2001). Juma et al. (1994) report average yields of about 1,100 kilograms/ha without the use chemical fertilizers and 2,000–3,500kilograms/ha with chemical fertilizers, highlighting the importance of promoting uptake of complementary technologies and improved management practices. These yield figures suggest that the sensitivity analysis associated with a 50 percent drop in the baseline yield value of 3,000–4,000 kilograms/ha is very reasonable.

[7] Sensitivity analysis associated with an increase in yields or reduction in costs have not been carried out as they are welfare improving. Note that sensitivity analysis could also be done for other parameters or assumptions, for example regarding adoption rate of clonal varieties or regarding parameters of the rest of the world.

5. CONCLUSIONS AND IMPLICATIONS

The Ugandan coffee industry, which plays an important role in the economy and livelihoods of the rural population in Uganda, is facing some serious challenges, including low and volatile international coffee prices, old coffee trees and declining productivity and, more recently, coffee-wilt disease. Together these problems contributed to the decline in quantity and value of coffee exports by an average of about 6.6 percent and 12.6 percent per year, respectively, between 1998/99 and 2003/04.

The implementation of a coffee-replanting program to replace old and disease-affected coffee trees, and to expand coffee production into other suitable areas in the northern and eastern parts of Uganda, seems to be helping to both combat the existing problems and reverse the declining trends. However, with the withdrawal of the Uganda Coffee Development Authority, who supported nursery operators and purchased and distributed seedlings free to farmers, the achievements of the replanting program may not last.

This paper estimated the economic returns (benefit–cost ratio) of the coffee-replanting program, particularly replanting with clonal varieties, to analyze the welfare implications of the decision by the government to withdraw from the program. We find that the overall internal rate of return of 50 percent and the benefit–cost ratio of 3.7 are very high, suggesting that the Ugandan replanting program is very beneficial to the coffee sub-sector and the economy as a whole. The largest benefits occur in the central region, where the bulk of coffee is grown, followed by the eastern and western regions. The largest return on investment occurs in the eastern region, followed by the central and western regions. Sensitivity analysis shows that the results (that is, the benefits) are robust with respect to several of the assumptions, including demand and supply elasticities, and domestic consumption. Although the results are sensitive to farm production costs and coffee yields, the program is still beneficial as its IRRs are still high. For example, a reduction in clonal coffee yield leads to a proportional reduction in the IRR. With an increase in costs, however, the percentage reduction in IRR is less than the percentage increase in costs. Together, these suggest that if the government withdraws from the replanting program without putting in place adequate measures to ensure its sustainability, welfare is very likely to be reduced.

Many groups in the Ugandan coffee industry besides coffee farmers benefit immensely from coffee production and exports, such as transporters, roasters, processors, and exporters, so the question of who should step in to finance the program is important. Between 1976 and 2005, for example, about US$114.6 million per year (or US$0.55 per dollar of coffee exported per year) accrued to these other groups, as the share of export prices received by farmers was low. Ever since the early 1990s, when the share of export prices paid to coffee farmers began to improve, the amount accruing to non-coffee-farmers was still high – about US$62.4 million per year (or US$0.30 per dollar of coffee exported per year). These accruals far outweigh the US$10.8 million per year that one of the donor programs estimates it will cost to replant 70 percent of Uganda's total coffee-tree population within five years (COMPETE/EC 2001). The various actors in the coffee industry need to get together to evaluate the situation carefully and act accordingly.

This study contributes to understanding the government's role in both promoting economic growth and poverty reduction and improving food and nutrition security through investment in agricultural R&D and subsidies. The findings are consistent with those of several other studies that found that spending in agricultural research and extension yields some of the largest returns on investment and lift the most people out of poverty, compared to spending in other sectors of the economy. The cost of disinvesting from the agricultural sector, as experienced during the structural adjustment era, cannot be ignored, especially in the face of stagnant or declining private investment in the sector due largely to declining international prices of major agricultural export commodities and rising input costs, especially those of chemical fertilizers.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1. Amount and value of Uganda's coffee exports, 1964/65 to 2003/04

Season	Number (60kg bags)	Value (US$)	Unit value (US$/kg)	Season	Number (60kg bags)	Value (US$)	Unit value (US$/kg)
1964/65	2,158,736	76,820,312	0.59	1984/85	2,500,031	367,591,092	2.45
1965/66	2,855,621	106,126,982	0.62	1985/86	2,392,198	390,362,568	2.72
1966/67	2,637,862	146,548,850	0.93	1986/87	2,280,206	308,594,658	2.26
1967/68	2,967,825	139,078,017	0.78	1987/88	2,318,341	263,239,573	1.89
1968/69	2,670,201	162,473,613	1.01	1988/89	3,114,396	294,867,882	1.58
1969/70	3,193,638	185,874,447	0.97	1989/90	2,364,751	139,566,731	0.98
1970/71	3,032,609	130,818,018	0.72	1990/91	2,085,004	121,343,113	0.97
1971/72	3,139,559	145,469,659	0.77	1991/92	2,030,829	101,442,768	0.83
1972/73	3,677,100	175,549,153	0.80	1992/93	2,088,642	108,873,991	0.87
1973/74	3,283,183	228,518,975	1.16	1993/94	3,005,205	273,658,850	1.52
1974/75	2,861,399	175,337,140	1.02	1994/95	2,792,753	432,651,034	2.58
1975/76	2,431,524	245,222,753	1.68	1995/96	4,148,803	388,916,157	1.56
1976/77	2,449,737	558,512,578	3.80	1996/97	4,237,114	355,126,641	1.40
1977/78	1,742,575	312,097,360	2.99	1997/98	3,032,338	276,476,134	1.52
1978/79	2,353,031	389,108,354	2.76	1998/99	3,647,989	282,995,511	1.29
1979/80	2,219,802	433,471,715	3.25	1999/2000	2,917,257	164,763,789	0.94
1980/81	1,973,458	230,463,637	1.95	2000/01	3,074,773	104,776,424	0.57
1981/82	2,785,647	322,030,310	1.93	2001/02	3,146,381	83,936,951	0.44
1982/83	2,194,888	295,259,322	2.24	2002/03	2,663,888	104,787,094	0.66
1983/84	2,519,024	392,677,096	2.60	2003/04	2,523,042	115,722,011	0.76

Source: UCDA Annual Reports

Table A.2. Number of Robusta coffee seedlings distributed in Uganda by district ('000s)

Region/District	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	Total
Western	591	920	1,467	1,972	2,236	5,103	5,331	4,217	33,318
Mubende*	199	309	494	657	1,472	3,359	3,509	2,776	12,774
Kiboga*	45	69	111	356	100	228	239	189	1,335
Kabarole*	168	261	416	376	94	214	224	177	1,930
Kyenjojo					111	253	264	209	837
Kamwenge					87	198	207	164	655
Bundibugyo	7	12	19	45	48	110	115	91	446
Kibaale*	80	125	200	167	90	206	215	170	1,255
Hoima	70	109	173	237	155	353	369	292	1,758
Masindi*	22	35	55	134	79	181	189	150	845
Mbarara*	33	52	83	405	287	656	686	542	2,744
Bushenyi*	213	332	529	435	425	969	1,013	801	4,717
Ntungamo*	88	138	220	173	226	515	538	425	2,323
Rukungiri*	90	140	224	258	113	259	271	214	1,569
Kanungu					17	39	41	32	129
Eastern	292	455	726	2,397	964	2,200	2,299	1,818	11,151
Jinja*	121	188	300	295	102	232	243	192	1,674
Kamuli*	119	185	296	894	115	263	275	217	2,363
Iganga*	52	81	130	955	232	529	553	437	2,969
Bugiri*				0	85	193	202	160	639
Busia				75	94	215	225	178	786
Mayuge				0	163	372	388	307	1,230
Pallisa				95	13	30	31	25	193
Tororo				84	108	248	259	205	903
Teso					52	119	124	98	393
Central	1,651	2,572	4,102	4,164	3,812	8,701	9,089	7,190	41,281
Mpigi*	311	484	772	825	597	1,363	1,424	1,127	6,902
Luwero*	158	246	393	695	614	1,402	1,464	1,158	6,129
Wakiso					579	1,322	1,381	1,092	4,374
Nakasongola*					83	190	198	157	627
Kayunga					134	305	319	252	1,009
Mukono*	358	558	890	880	661	1,509	1,576	1,247	7,679
Kalangala*	53	83	132	86	14	32	33	26	459
Masaka*	391	609	971	1,088	631	1,441	1,505	1,191	7,827
Sembabule*		0	0	275	170	387	404	320	1,555
Rakai*	380	592	944	317	329	751	785	621	4,718
Northern				688	446	1,018	1,064	841	4,057
Apac				194	72	165	172	136	739
Gulu				163	132	300	314	248	1,157
Kitgum				141	27	62	65	51	347
Lira				190	170	388	405	320	1,473
Pader					16	36	38	30	120
Yumbe					29	67	70	55	222
Total	**2,958**	**4,609**	**7,350**	**10,493**	**8,525**	**19,461**	**20,330**	**16,081**	**89,807**

Source of original data: UCDA Annual Reports
Notes: Districts marked with an asterisk (*) are the traditional Robusta coffee-growing districts. For the 1996/97, 1997/98, 2000/01, 2001/02, and 2003/04 years, average shares for the other years were used to estimate district distribution. 'Teso' includes Kapchorwa, Katakwi and Kumi districts.

Table A.3. Benefit–cost analysis of the clonal-coffee-replanting program in Uganda by district

Region	District	Benefit (B) ('000s US$)	Cost (B) ('000s US$)	B–C ('000s US$)	B/C (ratio)	IRR (%)
Northern	Arua	0.2	1.6	–1.3	0.16	
	Adjumani					
	Moyo					
	Nebbi	0.3	0.0	0.3		
	Gulu	31.8	22.1	9.7	1.43	11.4
	Kitgum	21.3	14.2	7.1	1.50	11.7
	Apac	36.2	20.2	16.0	1.79	16.2
	Lira	17.3	26.8	–9.5	0.64	–4.5
	Kotido	0.0	0.0	0.0		
	Moroto	0.1	0.0	0.1		
	Subtotal	***107.2***	***84.9***	***22.4***	***1.26***	***8.5***
Eastern	Katakwi					
	Soroti	0.8		0.8		
	Kumi					
	Mbale					
	Kapchorwa					
	Kamuli	1,075.3	193.5	881.8	5.55	79.7
	Pallisa	24.7	8.7	15.9	2.81	47.6
	Busia	9.8	13.0	–3.2	0.75	–4.0
	Tororo	12.6	12.6	0.0	0.99	4.2
	Jinja	811.6	144.6	666.9	5.61	68.4
	Bugiri	0.0	4.7	–4.6	0.01	
	Iganga	1,826.4	408.1	1,417.7	4.46	59.9
	Subtotal	***3,761.2***	***785.2***	***2,975.3***	***4.79***	***65.4***
Central	Nakasongola	–4.0	4.4	–8.4	–0.89	
	Luwero	1,036.7	239.6	797.0	4.32	61.3
	Mukono	2,947.5	456.8	2,490.6	6.45	82.9
	Mpigi	1,840.9	431.5	1,409.4	4.26	60.3
	Kampala	1.6		1.6		
	Sembabule	132.5	31.7	100.7	4.17	
	Masaka	2,230.0	494.3	1,735.6	4.51	59.1
	Kalangala	117.3	58.3	59.0	2.01	22.0
	Rakai	449.0	403.8	45.2	1.11	6.0
	Subtotal	***8,751.5***	***2,120.4***	***6,630.7***	***4.13***	***56.4***
Western	Masindi	131.3	36.3	94.9	3.61	52.2
	Hoima	222.0	93.8	128.1	2.36	29.2
	Kabale					
	Bundibugyo	28.3	12.5	15.8	2.26	32.5
	Kiboga	541.6	77.2	464.3	7.01	106.1
	Mubende	1,158.0	319.4	838.5	3.62	57.0
	Kabarole	136.9	202.8	–65.8	0.67	–4.6
	Kasese	0.5		0.5		
	Bushenyi	422.8	260.2	162.6	1.62	16.2
	Ntungamo	252.9	110.0	142.8	2.29	27.5
	Mbarara	297.6	80.3	217.2	3.70	67.0
	Rukungiri	135.2	112.8	22.4	1.19	7.9
	Kisoro					
	Kibaale	214.9	94.8	120.1	2.26	26.8
	Subtotal	***3,542.0***	***1,400.1***	***2,141.4***	***2.53***	***20.3***
UGANDA	**TOTAL**	**16,161.9**	**4,390.6**	**11,769.8**	**3.68**	**50.9**

REFERENCES

Alston, J. M., G. W. Norton, and P. G. Pardey. 1995. *Science Under Scarcity: Principles and Practices for Agricultural Research Evaluation and Priority Setting.* Wallingford, U.K.: CAB International.

Alston, J. M., and Wohlgenant, W. K. 1990. Measuring research benefits using linear elasticity equilibrium displacement models. In *The returns of the Australian wool industry from investment in R&D,* Rural and Resource Economics Report No. 10, ed. J. D. Mullen and J. M. Alston. Sydney, Australia: New South Wales Department of Agriculture and Fisheries.

Baffes, J. 2006. Restructuring Uganda's coffee industry: Why going back to basics matters. *Development Policy Review* 24(4): 413–436.

COMPETE (Competitive Private Enterprise and Trade Expansion) and EC (European Commission). 2001. The path forward in Uganda's coffee sector. Report prepared for the Presidential Conference on Export Competitiveness. EC, Kampala, Uganda.

CORNET (Coffee Research Network). 2003. Surveys to assess the extent and impact of coffee wilt disease in East and Central Africa. CAB International, Nairobi, Kenya.

Farrow, A. 2006. Uganda coffee maps. www.dgroups.org/groups/cta/Coffee-Alliance/index.cfm?op=main&cat_id=16925

ICO (International Coffee Organization). 2006. www.ico.org/historical.asp

Juma, C., Magambo, J. M. and Monteith, H. 1994. Tissue culture for coffee: The case of Uganda. *Biotechnology and Development Monitor* 20: 19–20.

Lewin, B., D. Giovannucci and P. Varangis. 2003. Coffee market: New paradigms in global supply and demand. Agricultural and Rural Development Internal Report. The World Bank, Washington, D.C.

New Vision. 2007. Uganda: Wilt resistant coffee developed. Kampala, Uganda. http://allafrica.com/stories/200704040215.html.

OANDA Corporation. 2006. FXHistory: Historical currency exchange rates. www.oanda.com/convert/fxhistory.

Ssemwanga Consulting Ltd. 2004. Production mapping and capacity survey in five coffee growing districts of Uganda. Strengthening the Competitiveness of Private Enterprise (SCOPE), Kampala, Uganda.

Sserunkuuma, D. 1999. Agricultural technology, economic viability and poverty alleviation in Uganda. The Eastern and Central Africa Programme for Agricultural Policy Analysis (ECAPAPA), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Entebbe, Uganda.

Townsend, R. F. 1999. *Agricultural incentives in Sub-Saharan Africa: Policy challenges*. World Bank Technical Paper No.444.Washington, D.C.: The World Bank.

UCDA (Uganda Coffee Development Authority). (Various years) *Annual Report*.Kampala, Uganda.

UCTF (Uganda Coffee Trade Federation). 2005. The coffee yearbook: 2004/05. Kampala, Uganda.

Wood, S., L. You and W. Baitx. 2001. Dynamic Research Evaluation for Management (*DREAM*). International Food Policy Research Institute, Washington, DC.

You, L. and S. Bolwig. 2003. *Alternative growth scenarios for Ugandan coffee to 2020*. Environment and Production Technology Division Discussion Paper 98.Washington, D.C.: International Food Policy Research Institute.

RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to www.ifpri.org/pubs/pubs.htm#dp.
All discussion papers can be downloaded for free.

743. *The impact of CAFTA on poverty, distribution, and growth in El Salvador*. Samuel Morley, Eduardo Nakasone and Valeria Piñeiro, 2007.

742. *Impact of contract farming on income: Linking small farmers, packers, and supermarkets in China*. Sachiko Miyata, Nicholas Minot, and Dinghuan Hu, 2007.

741. *Spatial coordination in public good allocation:Nonparametric evidence from decentralized Indonesia*. Futoshi Yamauchi, Shyamal Chowdhury, and Reno Dewina, 2007.

740. *Genetically modified food and international trade: The case of India, Bangladesh, Indonesia, and the Philippines*. Guillaume Gruère, Antoine Bouët, and Simon Mevel, 2007.

739. *Income growth and gender bias in childhood mortality in developing countries*. Mike Ueyama, 2007.

738. *Seed provision and dryland crops in the semiarid regions of eastern Kenya*. Latha Nagarajan, Patrick Audi, Richard Jones, and Melinda Smale, 2007.

737. F*ood safety requirements in African green bean exports and their impact on small farmers,* Julius Juma Okello. Clare Narrod, and Devesh Roy, 2007.

736. *Strengthening agricultural education and training in Sub-Saharan Africa from an innovation systems perspective: Case studies of Ethiopia and Mozambique*. Kristin Davis, Javier Ekboir, Wendmsyamregne Mekasha, Cosmas M.O. Ochieng, David J. Spielman, and Elias Zerfu, 2007.

735. *Gobernabilidad de los sistemas de innovación en Bolivia: Lecciones para las políticas de innovación agrícola.* Frank Hartwich, Anastasia Alexaki, and René Baptista, 2007.

734. *A typology for vulnerability and agriculture in Sub-Saharan Africa*. Xiaobo Zhang, Marc Rockmore, and Jordan Chamberlin, 2007.

733. *Impact of soil conservation on crop production in the Northern Ethiopian Highlands*. Menale Kassie, John Pender, Mahmud Yesuf, Gunnar Kohlin, Randy Bluffstone, and Elias Mulugeta, 2007.

732. *Innovation systems governance in Bolivia: Lessons for agricultural innovation policies*. Frank Hartwich, Anastasia Alexaki, and René Baptista, 2007.

731. *The human right to food as a U.S. nutrition concern, 1976-2006.* Ellen Messer and Marc Cohen, 2007.

730. *Measuring and accounting for community capabilities in Kordofan, Sudan.* Khalid El Harizi and Heather Klemick, 2007.

729. *How to make agricultural extension demand-driven?: The case of India's agricultural extension policy.* Regina Birner and Jock Anderson, 2007.

728. *Urbanization, educational expansion, and expenditures inequality in Indonesia in 1996, 1999, and 2002*. Takahiro Akita and Sachiko Miyata, 2007.

727. *Diversification in Indian agriculture towards high-value crops: The role of smallholders*. P. S. Birthal, P. K. Joshi, Devesh Roy, and Amit Thorat

726. *Farmer preferences for milpa diversity and genetically modified maize in Mexico: A latent class approach*. Ekin Birol, Eric Rayn Villalba, Melinda Smale, 2007.

725. G*enerating plausible crop distribution and performance maps for Sub-Saharan Africa using a spatially disaggregated data fusion and optimization approach*. Liangzhi You, Stanley Wood, and Ulrike Wood-Sichra, 2007.

724. *Assessing the impact of the national agricultural advisory services (NAADS) in the Uganda rural livelihoods.* Samuel Benin, Ephraim Nkonya, Geresom Okecho, John Pender, Silim Nahdy, Samuel Mugarura, Edward Kato, and Godfrey Kayobyo, 2007.

723. *Rural Investments to Accelerate Growth and Poverty Reduction in Kenya*. James Thurlow, Jane Kiringai, and Madhur Gautam, 2007.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ADDIS ABABA

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

IFPRI NEW DELHI

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org