The Economic Impact of Peanut Research on Poverty Reduction: Resistance Strategies to Control Peanut Viruses in Uganda

By

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Abstract

Economic impacts of research that developed Rosette Virus-resistance peanut in Uganda are estimated. Changes in economic surplus are calculated and combined with household data to assess changes in poverty rates and effects on livelihoods of the poor. The poverty rate may decline up to 1.5 percent as a result of the research.

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Introduction

Rural households in Sub-Saharan Africa depend largely on agriculture, and peanuts are an important crop in many areas. Peanuts are often the principal source of digestible protein, cooking oil and vitamins in African countries, with women taking the lead in growing and managing the crop. Peanut productivity has a significant bearing on the economic and nutritional well being of a large segment of the population in several countries. Unfortunately, peanut production is affected by the prevalence of various viruses and diseases, the most common being Groundnut Rosette disease, a viral infection first reported in Tanganyika (now Tanzania) as early as 1907 (Gibbons). The International Crop Research Institute for Semi-Arid Tropics (ICRISAT) reports that Groundnut Rosette disease has been and continues to be responsible for devastating losses to peanut production in Africa. For example, the rosette epidemic in 1994-1995 in central Malawi and eastern Zambia destroyed the crop to such an extent that the total area of groundnut grown in Malawi fell from 92,000 ha in 1994-1995 to 65,000 ha in 1995-1996. Losses in Zambia were estimated at US$ 5 million that year. Overall losses due to rosette disease in Africa were estimated at about US$ 156 million per annum.

Through the auspices of ICRISAT and the USAID-funded Peanut CRSP, peanut varieties with resistance to Rosette virus have been developed and released in Malawi and Uganda, countries with high incidence of poverty. It is estimated that the majority of people in both countries live below a poverty line of US$ 1.00 per person per day. Benefits of the agricultural research that developed the virus-resistant peanut may have had and may continue to have significant economic benefits, and more importantly, may have reduced poverty at the margin in these countries. Benefits may have resulted from, higher yields, reduced risk, lower production costs per quantity of peanuts produced, lower food prices, and increased marketed surplus with possible positive effects on household income.

Little is known about the economic impacts of research on peanut viruses and disease resistance in Uganda and Malawi. An example of such research is the project on "Control strategies for peanut viruses: Transgenic resistance, natural resistance, and virus variability" being carried out in the two countries, with support from the Peanut CRSP and ICRISAT, the benefits of which have never been estimated. An understanding of the impact of this research could provide useful information that might help guide the level of effort and funding required for similar projects, either now or in the future. Funding organizations are interested not only in impacts on crop losses, yields, and incomes, but on poverty reduction. Knowledge of the impact on poverty could provide information that would lead to a reallocation of scarce research resources to activities with a likelihood of reaching intended objectives. In addition, continued research support may depend on demonstrating effects on intended beneficiaries. Given this need for impact assessment, this paper summarizes results of a study to estimate the economic benefits of peanut virus research in Uganda at the aggregate level, and then estimates the impacts of the research on the poor. It begins with a brief review on methods used for assessing poverty levels and impacts of agricultural research on poverty.

Agricultural research and poverty

Scientists, research administrators and policy makers face increasing pressure to justify continued public investment in agricultural research. As demands proliferate for scarce government funds, better evidence is needed to show that agricultural research generates attractive rates of return compared to alternative investment opportunities. The result has been an upsurge in studies, seeking credible ex ante estimates of the expected benefits of current and proposed programs of research and ex post estimates of benefits from previously performed research (Smith and Pardey, Morris and Heisey).

Ex ante or ex post estimates of the impact of increased agricultural productivity on poverty are not easy to quantify as they depend on many factors. There may be effects on labor if increased productivity affects labor demand, which in turn may affect both on-farm and off-farm wages. The poor have little land or capital, so they gain disproportionately from employment generated by agricultural growth and from lower food prices, as do the urban poor, who spend most of their incomes on food (Thirtle, et al,). Technology may bring along with it new cropping patterns whose characteristics are difficult to predict, but with effects on household allocation of resources, labor included, and thus affecting welfare. Higher productivity resulting from such technologies could also bring along broad-based multiplier effects within the rural community that could result in employment creation in industries related to the crop, e.g. fertilizer and post-farm, oil making, and roadside marketing.

Considering these factors as a whole, there is a general consensus within agricultural economics that agricultural productivity growth drives pro-poor growth, benefiting poor farmers and landless laborers by increasing both production and employment. It benefits the rural and urban poor through growth in the urban and rural non-farm economy. It leads to access to crops that are high in nutrients and empowers the poor by increasing their access to decision making processes, increasing their capacity for collective action, and reducing their vulnerability to shocks, through asset accumulation (Hazell and Haddad, 2001). However, measuring these myriad effects can be difficult.

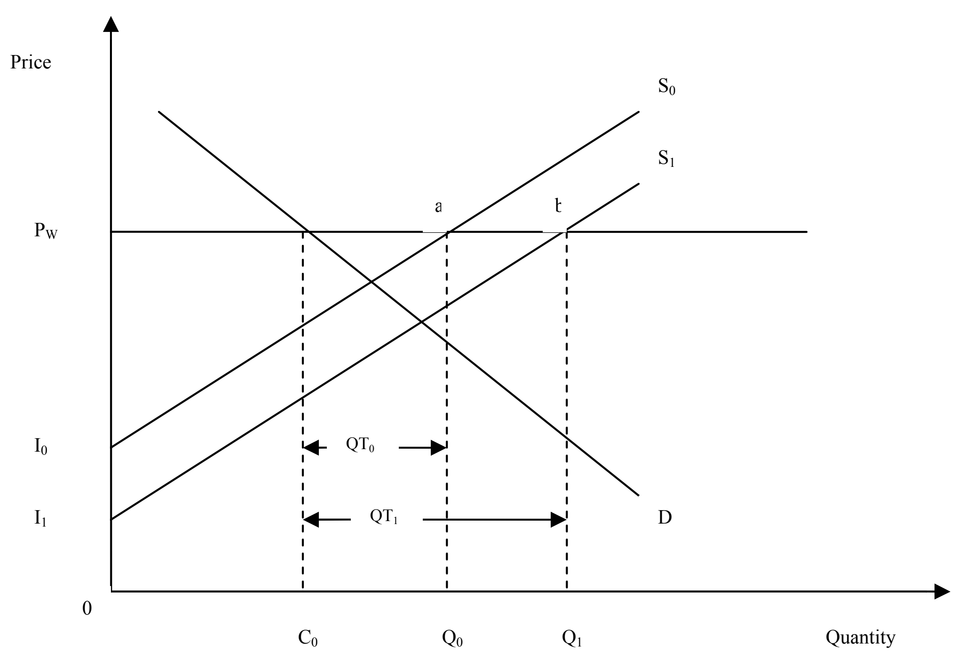
Alwang and Siegel present a relatively simple method of measuring the impact of agricultural research that can be used in research evaluations when there is an interest in assessing poverty effects, once the first round aggregate income effects are measured. That method relies on calculations of changes in poverty rate measures of the Foster-Greer- Thorbecke (FGT) type. Of course first-round effects, although potentially large, positive and widely distributed for plant genetic improvement research, are themselves subject to many methodological and practical challenges in documentation and measurement (Morris and Heisey, 2003). Problems are associated with measuring adoption and diffusion of hybrid or improved seed, and with apportioning benefits attributable to new hybrid or improved varieties as opposed to other factors. Alston et al. (2000) argue that when greater attention is paid to methodological issues, estimated rates of return are not as high as is generally believed. However, in this paper we present results based on a fairly standard set of economic surplus calculations, recognizing its potential limitations, and then link the results to poverty rate changes.

Methods and data

The overall economic impacts of the research that developed Rosette Virus-resistant peanut in Uganda are estimated over a 15 year period, focusing on the region of the country where peanuts are most prevalent. Peanut producing households are studied in a second analysis to quantify the effects of research on the livelihoods of the poor.

First, changes in economic surplus are calculated that result from adoption of virus-resistant peanut varieties. A small open economy model is assumed, which implies that the primary beneficiaries are the peanut producers, either through sales or through home consumption. Economic surplus gains imply an increase in real income of producers. In a diagrammatic depiction of the small open economy model (figure 1), the initial equilibrium is defined by consumption, C_0, and production Q_0, at the world market price, P_W, with export quantity QT_0 equal to the magnitude of the difference between consumption and production. Research causes supply to shift from S_0 to S_1 and production to increase to Q_1. As a result, exports increase to QT_1. Because the country does not affect the world price, economic surplus change is all producer surplus and is equal to area I_0abI_1.

Figure 1: Research benefits in a small open economy



To enable estimation of the economic surplus changes, primary data on yield and costs changes as well as realized and expected adoption were obtained from breeders at research institutes, extension officers, farmers, and other industry experts in Uganda during July and August of 2003. More specifically, the data consisted of current peanut yields and costs of production for traditional and virus-resistant varieties (Serenut 3 and 4) as well as realized and projected adoption rates. Research costs were also collected, as well as basic price, quantity, trade, and elasticity data from secondary sources. These varieties were released in 2001 and therefore there has already been some adoption (15 percent) and a higher adoption rate is expected over the next few years (up to 50 percent).

The second step involves taking the change in producer surplus resulting from the technical change and plugging it into FGT additive measures of poverty to compute poverty changes. The FGT indices are the most commonly used measure of poverty and are useful because they are additively decomposable with population share weights and therefore allow quantification of poverty for different population subgroups in terms of depth of poverty and its severity, and therefore allow possible evaluation of effects of agricultural and other government policies.

The FGT class of poverty measures is defined as $P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z-y_i}{z}\right]^\alpha$, where n is the total population, q is the number of poor households, y_i is income or expenditure of the i^{th} poor household, z is the poverty line and is measured in the same units as the is y, and α is a parameter of inequality aversion. When $\alpha = 0$, P_α is the headcount index, which is a measure of the prevalence of poverty or the proportion of the population that is poor. When $\alpha = 1$, P_α is the poverty gap index, a measure of depth of poverty. It is based on the aggregate poverty deficit of the poor relative to the poverty line. When $\alpha = 2$, P_α is a measure of severity of poverty. Each α tells the analyst different things about the patterns of poverty in a population and allows comparison of policies. The index is also additively decomposable, allowing comparison of changes in poverty among population sub-groups.

Household income data are used to compute poverty indices which permit poverty decomposition by income group. Realized research benefits from the economic surplus model are incorporated into the poverty indices to estimate how households of differing economic profiles move relative to the poverty line as their incomes are affected by the improved technology.

With methods for estimating economic surplus and poverty formulated, it is necessary design a procedure to identify those farmers likely to adopt hybrid or improved seed varieties. For that we turn to a probit model. Consider a decision maker (deciding on behalf of a household) faced with choosing between two alternatives. If we assume that the household derives a certain amount of utility from each of the outcomes, then it follows that the individual will choose the alternative that provides greater utility. For any household we can observe the alternative chosen and define a discrete (dummy) economic variable as the outcome, $y_i = 1$ if household i adopts the technology and $y_i = 0$ if household does not adopt.

The probit model can be specified as $\Pr ob(y=1) = 1 - F\left(-\sum_{k=1}^{K}\beta_k x_k\right) = F\left(\sum_{k=1}^{K}\beta_k x_k\right) = \Phi\left(\sum_{k=1}^{K}\beta_k x_k\right)$, where the more general form of the cumulative distributive function, F, is replaced by the standard normal cumulative distributive function, Φ. The probit model can be used to predict probabilities of adoption for each household. Households can then be ranked in order of decreasing probability of adoption and "adopting households" can be identified based on the total percentage assumed to adopt.

Data for calculation of poverty indices were obtained from national household surveys conducted by The International Food Policy Research Institute (IFPRI). The data sets are extensive (2949 households in the peanut growing region), enabling computation of the poverty indices and providing information on other socio-economic characteristics that may affect producer behavior in the two countries.

The total number of holdings, which is the same as the number of households carrying out crop farming for Uganda, was estimated to be about 3.3 million in 1999. Thus each crop farming household had only one holding. The eastern region, the area of focus for this research, had 922,000 holdings (slightly less than 30% of total number of holdings in Uganda).

Results

Results are presented in two main sections. The first section presents the economic surplus model results, while the second identifies farmers most likely to adopt hybrid seed and then presents the impact of adoption of rosette resistant seed varieties on their poverty status.

Economic surplus estimation

Data on supply and demand elasticities, production (yield and costs changes), adoption rates, output prices, and research costs were collected. Use of these different types of data in estimating economic surplus is described in detail below.

Years of operation of the project

The National Agricultural Research Organization (NARO) had been conducting research on Groundnut Rosette Virus (GRV) for several years when the Peanut CRSP came on board in May 2001 to supplement ongoing research. This analysis estimates changes in economic surplus for a fifteen year period starting from inception of Peanut CRSP activities in May 2001 through 2015.

Supply and demand elasticities

Many studies have been carried out to determine the responsiveness of supply to changes in prices for a variety of crops. Examples include work by Askari and Cummings (1977), Tsakok (1990) and Rao (1998). Although none of these studies included peanuts in Uganda, a lot can still be learned from them. Rao (1988) states, for example, that crop-specific acreage elasticities range between zero and 0.8 in the short run while long run elasticities tend to be higher (between 0.3 and 1.2). Yield responses to price are smaller and display much less stability than acreage elasticities. Askari and Cummings (1977) emphasize that there is likely to be a wide variation in the quality of the estimates presented in studies of supply responsiveness. Specifically, the differences of definition in the price variable itself, in the price deflators, and in the output measures preclude rigid comparison of elasticity estimates.

Economic theory suggests that agricultural commodities that use relatively little land and few other specialized factors tend to have high elasticities (Alston et al, 1995). The peanut crop in Uganda is in most cases grown on small plots of land by poor farmers using limited resources, in most cases with only seed and labor costs. It is therefore easy to increase or decrease production in the short run in response to changing price incentives. Alston et al (1995) propose that in the absence of adequate information it might be appropriate to assign a supply elasticity of 1 since long run elasticities for most agricultural commodities are greater than one, while short run and intermediate elasticities are usually close to one. Therefore using a supply elasticity of one as a starting point might not be a far fetched assumption, thus this idea is adopted in computing economic surplus for eastern Uganda. The elasticity of demand is assumed to be infinite because Ugandan production is small on a global market scale and the Ugandan economy is relatively open.

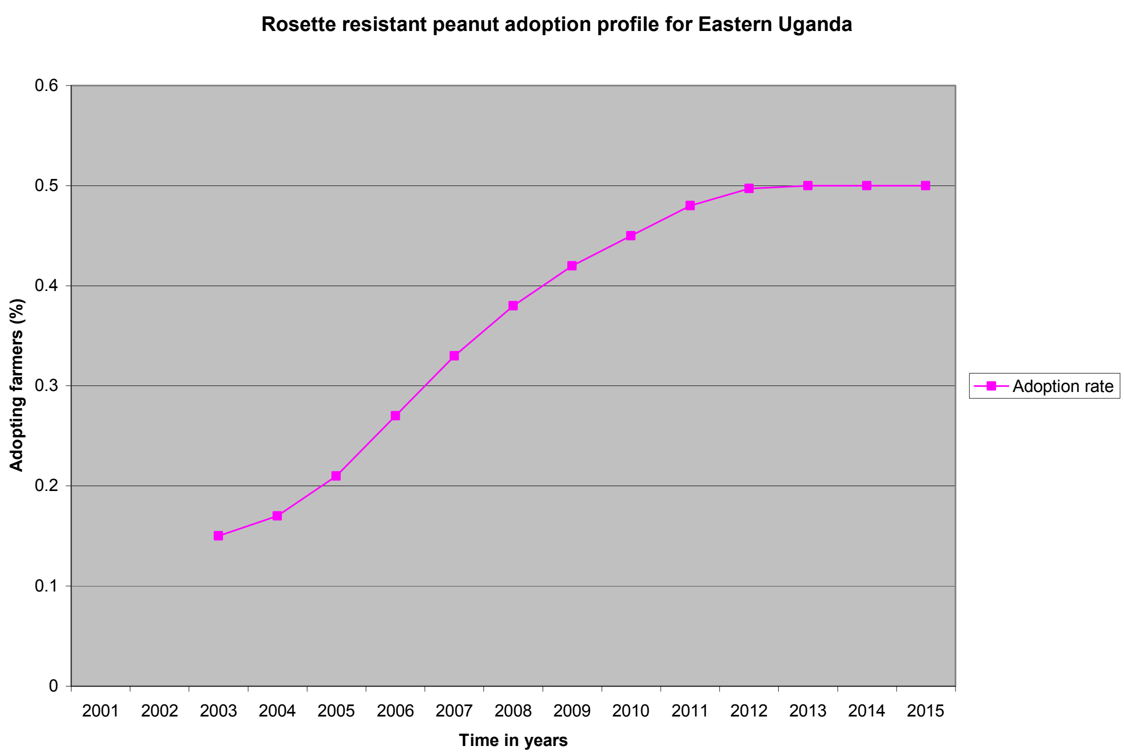
Yield and cost change

Based on evaluation data by Ugandan scientists and other experts of the two varieties of seed involved, Serenut 3 and 4, an average yield increase of 67 percent is assumed[1]. We converted the expected yield change to a per unit cost change by dividing it by the elasticity of supply. Input use is expected to increase by 50 percent per hectare upon adopting the technology, mostly due to higher seed costs. We converted this per hectare cost change to a per ton cost change using the formula in Alston, Norton and Pardey, and subtracted it from the per unit cost change due to the yield change to arrive at a net per unit cost change of 37.1 percent.

Adoption rate

[1] The estimates for yield and cost changes are based on on-farm trial data and opinions of peanut breeders and extension workers.

At the time of data collection the project had already created a rosette resistant variety, so part of the objective had been achieved. Fifteen percent of farmers were estimated by extension workers to be using the rosette resistant peanut seed varieties in 2003. For subsequent years, we project adoption, which is expected to reach a maximum of 50 percent after nine years. The projected maximum adoption rate is based on expert opinion. A plot of the assumed adoption profile is shown below.



Price

Although peanuts are traded, Ugandan production is assumed not to influence world prices because of its low output relative to other producing nations. A three-year average border price for 1999 to 2001 was used as the base price in the economic surplus model. Based on this average, a ton of peanuts was assumed to be worth $750 in 2001, the time of inception of the Peanut CRSP project. This price is used in estimating the economic surplus generated by the project.

Quantity

Quantity produced refers to production volumes specific to the part of the country (Eastern Province) where the evaluation is being carried out. Between the 1999 and 2001 agricultural seasons, Eastern Province districts combined produced an average of 42.8 thousand tons of peanuts. This quantity is used as the base quantity in the estimation. Quantity is also assumed to have an exogenous growth rate of one percent per year, irrespective of the new varieties.

Research cost

USAID, through the Peanut CRSP, will have contributed approximately $56,000 to the project by September 2004. This amount represents only part of the costs. Other costs were incurred by the public sector in Uganda, by ICRISAT in Malawi, and by the University of Georgia. Looking at it from USAID/Uganda perspective, a 20 percent adjustment was made to account for cash inflows from other Ugandan sources, for example to cover salaries of breeders and certain other costs. The total cost (Ugandan plus USAID) of the project is estimated to be about $67,120 or $16,780 per annum, for the four-year period (2001-2004) in which the research was carried out. The other costs incurred by ICRISAT and Georgia need not be considered when calculating the returns on the USAID/Uganda investment.

Potential changes in peanut income

With a supply elasticity of 1, the net present value (Total change in economic surplus minus research costs from 2001 – 2015) is projected to be $US 47 million, $38.8 million and $32.3 million at the 3 percent, 5 percent and 7 percent discount rates respectively. These net present values are equivalent to the sum of area I_0abI_1 calculated for each year in Figure 1 (minus the research costs which are only in the early years) discounted over the 15 year period.

To arrive at changes in poverty rates, the change in income as a result of a productivity change is first compared to the original income given by area P_waI_0 in the same figure. A comparison of the original income (producer surplus) and the income change due to the research gives a percent increase in income due to research and is summarized in column 4 of table 1 for different levels of adoption. Results in table 1 indicate that aggregate peanut income is expected to increase by approximately 75 percent, 78 percent and 81 percent for the 15 percent, 30 percent and 50 percent levels of adoption respectively if aunit peanut supply elasticity is assumed. These aggregate changes in income are then converted to a per household basis to examine changes in poverty rates. Column 5 in table 1 indicates the percent change in average household income for those who adopt.

Having determined changes in household peanut income for the Eastern Province, the next challenge is to identify those farmers who cultivate and report income from peanuts who have or are expected to adopt the technologies. It is this group of peanut producers for which the estimated income increases, with potential effects on poverty rates. A binary Probit model is estimated to determine the likelihood of adoption of hybrid seed technology for any crop by all the households (to assess whether adopters are likely to have initially had higher or lower income). Peanut producers are separated by their likelihood of adopting hybrid technology using predicted probabilities. The assumption being made here is that households likely to adopt and use any hybrid seed would also be most likely to adopt rosette resistant peanut seed.

Table 1: A comparison of research benefits for different adoption levels

Adoption rate (%)	Original Producer Surplus (US$)	Net Benefit due to research (US$)	% change in aggregate income	% Change in income for adopters
15.00	16,399,374.97	1,857,174.43	11.32	75.47
30.00	16,399,374.97	3,832,484.47	23.37	78.23
50.00	16,399,374.97	6,623,895.50	40.39	80.78

Determinants of adoption of hybrid seed

All the 2949 households in the sample from Eastern Province were asked in the crop survey questionnaire whether they used hybrid or improved seed as opposed to traditional varieties. The responses were binary in nature, yes if they used hybrid or improved seed and no if they did not. The table below summarizes the characteristics of households that fall into these two categories, i.e., those who used hybrid or improved seed and those who did not.

Table 2: Characteristics of adopting and non adopting households

Characteristic	Adopters (N=499)		Non adopters (N=1560)	
	Mean	SD	Mean	SD
Age of household head	43.22	15.46	45.29	16.64
Household size	6.39	3.74	5.53	3.26
Income per capita (UG Shillings)	313,429.73	310,032.76	241,967.25	304,496.43
Land owned per capita (Hectares)	2.90	4.35	2.89	3.88
Number of hoes	3.97	2.74	3.11	2.10
Extension advice	0.61	1.43	0.22	0.81
	N	%	N	%
Male household head	427	85.57	1144	73.33
Married household head	409	81.96	1142	73.21
Highest level of education				
- Primary	261	53.30	844	54.10
- Junior	20	4.01	43	2.76
- Secondary and beyond	135	27.05	224	14.36
Land tenure				
- Freehold	302	60.52	738	47.31
- Customary	160	32.06	745	47.76
Market information received	222	44.49	498	31.92

Fewer households (499) reported that they used hybrid or improved seed, than those that did not (1560). Non adopting households tended to be headed by slightly older people, had a smaller household size, and had lower income and land per capita holdings. Non adopting households were less likely to receive extension advice too, compared to their adopting counterparts. Adopting households were mostly headed by males, who were married in 82 percent of the cases. Adopting households had more (27 percent) people who had some form of post secondary education (university education included) than non-adopting households (14 percent). Most importantly, adopting households had more access to land, on a freehold tenure basis, and were more likely to receive some market information related to crop production and marketing.

The variables used to estimate the probit model were sex and age of household head, marital status, education, extension services, market information, land tenure, household size, income, land holdings and number of hoes owned. Some variables were not continuous, but were dummy variables. These were variables pertaining to sex, marital status, land tenure, market information and education. Results are summarized in table 3.

The signs for most of the variables conform to economic theory. For example, a positive relationship is expected between adoption and level of education, access to information, income, and ownership of production resources. The older the household head, the less likely he or she is to adopt hybrid or improved seed as shown by a negative sign on the parameter estimate. Marital status has a negative sign as well, but is statistically non-significant.

Table 3: Summary of the binary Probit results

Analysis of Parameter Estimates								
Parameter	DF	Estimate	Marginal Effect	Standard error	95% Confidence limits		Chi-square	Pr > Chi Square
Intercept	1	-2.91770		0.42910	-3.75860	-2.07670	46.24000	<0.0001
Sex	1	0.31070	0.087273	0.09490	0.12470	0.49680	10.71000	0.0011
Age square	1	-0.00010	-0.000015	0.00000	-0.00010	0.00000	5.87000	0.0154
Marital Status	1	-0.09080	-0.027704	0.10030	-0.28730	0.10570	0.82000	0.3653
Highest Education Junior	1	0.24510	0.079561	0.17440	-0.09680	0.58690	1.97000	0.1600
Highest Education Secondary	1	0.28640	0.091620	0.08210	0.12540	0.44730	12.16000	0.0005
Received Advise in 1998	1	0.14640	0.043946	0.03040	0.08700	0.20590	23.28000	<0.0001
Market information 1998	1	0.19180	0.058761	0.06670	0.06110	0.32250	8.27000	0.0040
Land holding per capita	1	0.03060	0.009175	0.03330	-0.03470	0.09590	0.84000	0.3587
Land tenure - Freehold	1	0.28240	0.084520	0.06450	0.15600	0.40870	19.18000	<0.0001
Household size	1	0.02640	0.007912	0.07490	-0.12050	0.17320	0.12000	0.7249
Income per capita	1	0.12170	0.036533	0.03300	0.05700	0.18650	13.59000	0.0002
No of Hoes	1	0.26610	0.079857	0.07040	0.12810	0.40420	14.28000	0.0002

N = 2059; Max-rescaled R-Square = 0.1278; Log-likelihood = -1048.13

Male headed households are 9 percent more likely to adopt hybrid or improved seed than female headed households. Households who have junior high school as the highest education achieved are 7 percent more likely to adopt than those households who have primary education as their highest education level achieved. Households with secondary education or higher are 9 percent more likely to adopt new seed technology than those with primary education.

An increase in the age of the household head by 1 year results in the probability of adoption decreasing by 2*(0.000015)*(43.45)*100 = 0.13035 %. For logarithmic variables, the marginal effect is divided by the mean, to get the impact on adoption of a unit increase in a variable. An increase in per capita income by a Shilling results in an increase in the probability of adoption by 0.036533/34593.89*100 = $1.055*10^{-5}$ %, a very small change. Similar interpretation applies to the number of hoes, household size, and landholding per capita, which are other variables transformed by natural logarithms.

The Probit results are used to identify farmers who are most likely to adopt new hybrid seed technology. The predicted probability of adoption is used to order the households according to likelihood of adoption. We then apply the income changes from the new technology to the first 15 percent, 30 percent and 50 percent according to adoption probability. The first 15 percent (90) peanut producing households in the survey experience a 75 percent peanut income shift (see table 1). The number of adopting households increases to 180 at 30 percent predicted adoption and 300 at a predicted 50 percent rate.

Impact on poverty

The economic surplus results indicated that adoption of Rosette resistant peanut seed would result in income derived from production of the crop increasing from 75 and 81 percent depending on the rate of adoption. To estimate the impact of this income change on welfare, the three FGT measures of poverty were computed for peanut producing households before and after the adoption of hybrid or improved seed for the three levels of adoption. Two poverty lines were also used, one pegged at $0.50 per adult equivalent and the other $0.75.

Based on the $0.50 poverty line, the headcount index is 0.2556 before adoption and 0.2333 after adoption, which implies that 25.56 percent of the households were poor before adoption and that level of poverty falls to 23.33 percent after adoption (table 4). The other indices, poverty gap and severity of poverty also change. The poverty gap decreases from 0.0872 before adoption to 0.0813 after adoption. The severity of poverty decreases from 0.0432 before adoption to 0.0393 after adoption. Based on the headcount index, two households escape poverty in this sample of households. The sample is representative of households in the region. The 601 peanuts producers in the survey are 20 percent of the households surveyed. Given that there are 922,000 households in eastern Uganda, 20 percent of those households are 184,400 households. This translates into an impact of 614 households ($\frac{2}{601} * 184{,}400 = 613.64$) across the eastern region of Uganda being lifted above the $0.50 poverty line as a result of adopting rosette resistant peanut seed (table 5). A similar number of households would be uplifted beyond the poverty line for the $0.75 poverty line.

An adoption level of 30 percent implies 180 households in the survey adopt the technology while 421 households do not. The $0.50 poverty line results in a headcount index of 0.3722 before adoption and 0.3389 afterwards. Six households out of 601 peanut farmers escape poverty due to adoption of the peanut technology, as measured by the headcount index. Region-wide, the impact on poverty is $\frac{6}{601} * 184{,}000 = 1{,}840.93$ households. After increasing the poverty line to $0.75, only 920 households are deemed no longer poor after adopting rosette resistant seed at the 30 percent level of adoption. The other two indices also decrease in value when the before and after scenarios are compared, an indication that household income is on the increase even for those who still remain poor.

Table 4. A comparison of poverty before and after adoption for different adoption rates (for households included in the survey)

	15 % adoption rate (N=90)				30 % adoption rate (N=180)				50 % adoption rate (N=300)			
	n[2]	\$0.50	n	\$0.75	n	\$0.50	n	\$0.75	n	\$0.50	n	\$0.75
Headcount Index before adoption	23	0.2556	34	0.3778	67	0.3722	96	0.5333	120	0.4000	191	0.6367
Headcount Index after adoption	21	0.2333	32	0.3556	61	0.3389	93	0.5167	111	0.3700	184	0.6133
Poverty Gap before adoption		0.0872		0.1687		0.1217		0.2382		0.1339		0.2702
Poverty Gap after adoption		0.0813		0.1577		0.1092		0.2231		0.1193		0.2505
Poverty Severity before adoption		0.0432		0.0922		0.0582		0.1291		0.0635		0.1435
Poverty Severity after adoption		0.0393		0.0857		0.0516		0.1182		0.0557		0.1299

[2] Whilst the 'N' in caps refers to the number of households that were at a level of adoption, N=90 for example for 15 percent adoption, the lower case 'n' refers to the number of households who fell below the poverty line for a particular level of adoption.

Table 5: Number of households in Eastern Province who escape poverty based on head count index as a result of adopting virus-resistant peanut varieties

Adoption rate	Households escaping poverty	
	Poverty Line: $0.50	Poverty line: $0.75
15.00	613.64	613.64
30.00	1,840.93	920.47
50.00	2,761.40	2,147.75

As the adopting sample is increases, more marked changes are observed for both poverty lines. As expected, the 50 percent level of adoption results in the greatest impact on poverty, as increased peanut income enables total household income to rise above the poverty line. The headcount index increases as adoption levels are increased, implying that at low adoption rates, the few that are adopting are relatively well-off households.

Considering each of the FGT poverty measures, and the different levels of adoption, it is clear that there is a modest impact on poverty as a result of adopting the new peanut technology. The headcount index might in some cases not indicate significant changes in poverty, but the poverty gap shows for example that a significant number of households are being moved closer to the poverty line, implying that households are benefiting from the availability of Rosette resistant peanut seed.

Conclusion

Results indicate that sizable research benefits are generated by adopting rosette resistant seed varieties and that they accrue mostly to farmers as there is no price effect in the model. These benefits are estimated to be $47 million, $38.8 million and $32.3 million at the 3 percent, 5 percent and 7 percent discount rates respectively. Poverty rates vary in the eastern province depending on whether the $0.50 or $0.75 poverty lines are used. The poverty gap and a severity of poverty measure show marked changes in poverty, reflecting the fact that more households are being drawn closer to the poverty lines (and hence escaping poverty) as a result of adoption. The headcount index indicates that over 2000 household would rise above the poverty line as result of adopting the varieties if 50 percent of them adopt; a reduction in the poverty rate of approximately 1.5 percent.

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