DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

WORKING PAPER

EX ANTE BENEFIT COST ANALYSIS OF SMALL FARM MAIZE RESEARCH AND DEMONSTRATIONS, ZIMBABWE

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1. INTRODUCTION

With the increasing scarcity of public funds for agricultural research--agricultural research as a percentage of GDP is falling--pressure is being placed on research managers to justify their expenditures. Budget reductions are resulting in reduced farm demonstrations and inappropriate combinations of researchers/technicians. The research strategy of "yield and quality" has been successful for many agricultural research institutes in the past. Improved performance of agricultural research institutes can be achieved by selecting alternative research programs and projects using benefit/cost(B/C) criteria.[2]

Ex ante benefit/cost analysis can be used as an investment criterion to select research and demonstration activities with potentially high investment returns. Ex post or historical investment analysis is useful but is not directly relevant for identifying current high pay-off research projects and programs. The ex ante benefit measure focuses on improvements in future farm financial gross margins for small farmers resulting from current research and demonstration activities. The time, travel and other costs associated with a given research and demonstration activity by agricultural researchers and extension staff are considered as a capital investment cost on an incremental project basis.

The purpose of this paper is to illustrate the potential for analyzing the returns to joint agricultural research and extension activities considered as prospective capital investments. Agricultural researchers and extension workers have a range of alternative joint activities which exceed the limits of available financial and human resources. Research capital investments involve a major current expenditures on research projects to-day with the expectation of generating a future pay-off in terms of increasing future farm incomes. Research and extension activities are referred to as joint investment activities because potential quantifiable income benefits to farmers will not be achieved without integrated efforts by both entities together with participation by farmers. Research includes activities conducted by the Agricultural Research Trust (ART) Farm and the Agricultural Economics and Extension staff, University of Zimbabwe. The ART Farm operation was set up in 1981 with grain and oilseed association funds which had historically been accumulated from levies on Zimbabwe's commercial farmers. These funds were used to purchase farm land near Harare and establish a structure to conduct research and extension and operate a demonstration farm. Continued support from commercial farmers is received through the levying authorities. Funds to operate the farm and conduct research continue to be provided from levies on commercial farmers.

ART Farm research in the communal small farm areas began in the 1990/91 crop year, with trials of maize hybrids thought to be better adapted to local conditions and responsive

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[2]For a discussion of the role of benefit/cost analysis in agricultural research management see J. MacMillan, G. Mudimu, L. Rugube and E. Guveya, "Agricultural Research Management Training Needs in SADCC", Working Paper, Department of Agricultural Economics and Extension, July, 1991.

to improved technology. Improved technology includes the following agronomic practices: appropriate amounts and timing of fertiliser application, timely planting, optimal plant population, use of ridges in some areas, pest control measures, and timely weed control and harvest.

Economic research includes evaluation of: farm financial returns associated with adoption of alternative maize varieties and agronomic packages and policy analysis of market oriented maize pricing--in contrast to government controlled maize pricing within a benefit/cost analysis framework. In the benefit/cost framework, the magnitude of the increase in farm financial returns is assessed as the major component of agricultural research benefits. The number of farmers switching to new varieties under the guidance of extension staff determines the size of the aggregate community and regional benefits associated with agricultural research.

Market oriented maize pricing consistent with import/export parity pricing concepts illustrates the impacts of agricultural price policy on the magnitude of aggregate farm financial benefits generated by research and extension activities. If prices of agricultural commodities such as maize are set by government below international and regional market prices established by import/export trades then the benefits of agricultural research measured by farm financial returns will be lower than the level with import/export parity pricing. Alternatively, benefits of research will be higher than the level consistent with economic efficiency if government controlled commodity prices are higher than the import/export parity level.

Extension activities are carried out by AGRITEX staff. A district agricultural extension officer is the manager of village extension workers each of whom are responsible for farm extension activities in about eight villages. Villages are estimated to include about 100 farm households.

The following major topics are discussed below: 1) objectives, 2) need for integration of research and extension activities, 3) community description and technology adoption, 4) estimating farm financial benefits associated with research and extension activities, 5) B/C analysis, 6) market oriented maize pricing, and, 7) expected B/C results for 1991/92 activities. The B/C calculation procedures are outlined in Appendix A. Data from farm interviews and multiple regression results are summarized in Appendix B. Research trial results are summarized in Appendix C. Areas, yields and price changes for the crops produced are summarized in Appendix D.

2. OBJECTIVES

The first objective involves maize varietal research to demonstrate superior yields expected under local community conditions with adoption of alternative high yielding hybrid maize varieties. A second objective involves an assessment of the extent of potential farm financial benefits achievable with additional research and extension activity on improving agronomic practices. Two high yield and returns levels--one associated with "new" hybrid varieties and one associated with a high level of agronomic practices--is established by field trials comparing a "communal farmer" versus "ART Farm" production system. The "communal farmer" system includes the "old" variety R 215 and a lower level of agronomic practices than the "ART Farm" production system. Adoption in terms of hectares switched to higher yielding varieties and use of improved agronomic practices is expected to generate a "satisfactory" return per dollar invested in the research and extension activities.

Four sites were selected by ART Farm staff in collaboration with local AGRITEX extension personnel. Material inputs for the trials were provided by ART Farm, and all the other management practices, including land preparation, fertiliser applications, and weed and pest control were done by the communal farmer under the guidance of ART Farm personnel. This production system is referred to as the "ART Farm" production system. On adjacent land the communal farmer planted R 215 using a "communal farmer" production system involving less fertilizer and less labour. This procedure was designed to ensure that the farmer gained the maximum benefit from the association.

Six maize hybrids, four from the Seed Co-operative Company, and one each from Pannar Seeds(Pvt) Ltd and Cargill(UK) (Pvt) Ltd were grown in randomised complete blocks replicated five times at each of the following sites: E. Karodza, Kamoto Ward, Chiweshe Communal Land, Glendale and P. Jiri, Rosa Ward, Chiweshe Communal Land, Glendale. Ten maize hybrids (five from the Seed Co-operative Company, three from Pannar Seeds(Pvt) Ltd and two from Cargill (UK) (Pvt) Ltd were grown as above at the following sites: E. Mupindi, Dotito Communal Land, Mount Darwin (also referred to as Kandeya Communal Land), and N. Nyamhunga, Musana Communal Land, Harare.

Two statistical methods are used in the study. Multiple regression analysis of "representative" farm survey data(73 farms in Kandeya Communal Area) is conducted to determine the net effects on yield of the "old" maize varieties R 215 and R 201 as well as agronomic practices. The farm survey provides "baseline" information on current farm management practices and yields. The research and demonstration activities are intended to identify means of increasing average maize yields. Statistical analysis of ART Farm trial results is performed to determine the maximum yield potential of: 1) "new" maize varieties and 2) "ART Farm" agronomic practices on yield variation in four communal farm locations.

Economic analysis can be used to compare the incremental costs and returns associated with increasing yields using net yield increments indicated by the regression coefficients estimated from the farm survey. Trial results indicate the upper limits associated with the adoption of new hybrid varieties and improved agronomic practices. Extension activities are required to communicate the potential farm income benefits associated with the use of new varieties and improved agronomic practices. The majority of communal farmers grow hybrids R 215 and R 201 and have not switched to the other hybrid varieties recommended by seed companies. The lack of information on the new varieties is hypothesized to be the major reason communal farmers have not switched to the recommended new varieties. When the Seed Coop was the only producer of new varieties the screening information was all provided by one agency. With several companies producing competing varieties, the communal farmers do not have an objective basis for selecting one hybrid over another relative to their farm management practices and local conditions.

The variety trial project was co-ordinated with the District Agricultural Extension Officer for Mount Darwin District, Francis Mashayamombe. ART Farm Research Manager, J. MacRobert and Senior Research Officer, L. Mutemeri designed the project with Village Extension Worker, Matthias Chinhema. Mutemeri and Chinehema each made about 6 visits to the demonstration trial throughout the project: prior to planting, at planting, through the growing season, harvest and presentation of yield results. Ten hybrid varieties were selected for the research/demonstration and planted in a 40m by 20 m plot in Mount Darwin as well as in Musana Communal Land, Harare.

Yield ranges for the hybrid varieties, obtained from the Seed Co-operative Company, are given below:

1) SR 52--full season 160 days to maturity. Expected yield ranges from 2-8t/ha,
2) SC 601--a popular new variety. Expected yield ranges from 3-13 t/ha (low management,3-4, middle management, 4-8 and high management, 8-13 t/ha),
3) SC 501-expected problems with leaf blight and cob rot with late rains and unstable yields. To be replaced with SC 601 by the Seed Coop. Expected yield ranges from 2-8 t/ha-- 2-4 t/ha in communal areas,
4) R 215 --short to medium maturity, 140 days in production since 1980. Expected yields from 1-5 t/ha,
5) R 201--short to medium maturity, 135 days. Expected yields range from 1-5 t/ha,
6) PNR 695--medium maturity
7) PNR 6549--long maturity of 145 days,
8) PNR 473--136 days to maturity,
9) CG 4539 and
10) CG 4585

The trial was fertilized at recommended levels and planted in early December. Yield levels for the ART Farm trial locations are given in Appendix C.

Agronomic practices are analyzed in the context of "ART Farm" versus "Communal Farm" production systems in two Chiweshe Communal Land sites by K. Chakanyuka. The major differences in the "ART Farm" production system was an increase in fertilizer levels to 400 kg/ha for each of Compound D and Ammonium(AN) compared to the "communal farmer" system of 300 kg/ha each of D and AN fertilizers, use of Thiodan stalk bore chemical and additional labour relative to the "communal farmer" system. Trial results are given in Appendix C.

The economic analysis of the interview data and trial results for Kandeya by the Department of Economics and Extension, U of Zimbabwe, staff: J. MacMillan, G. Mudimu, L. Rugube and E. Guveya is viewed as a complementary joint study with ART farm staff and M. Matthias, AGRITEX Village Extension Worker. The economic analysis of questionnaire data from Mount Darwin, Kandeya communal farmers provides a baseline for comparing the trial results with the broader farm population.

3. NEED FOR INTEGRATING RESEARCH and DEMONSTRATION ACTIVITIES

Integration of research and demonstration activities with farmers participating is essential to achieve the greatest payoff to investment in research and extension activities. In a market context, farmers are the consumers of research and extension activity. As such, farmers need to provide signals directing research and extension. In a market situation farmers' needs would be communicated through a price mechanism. Due to "market failure", it is not possible for farmers to provide appropriate direction without integrating the activities of research and extension staff. Considerable potential exists for priorizing research and extension investment activities by increasing the dialogue between researchers, extension workers and farmers. Without adoption of research results by farmers research and extension activities have minimal economic value.

Research expenditures can be analyzed as capital investments. Capital expenditures involve a major expenditure with the expectation that a series of future income will be generated. The research and demonstration activities are considered as an incremental capital project investment activity separate from capital project investments in plant breeding research by the Seed Co-operative Company and other commercial seed companies[3]. In agribusiness operations capital investment criteria such as benefit/cost criteria are used to screen acceptable from unacceptable projects.

If a potential capital project cannot generate a B/C ratio greater than one, the investment is generally considered to be unprofitable and the project is not initiated. Similarly if research and extension activities cannot be expected to generate financial benefits to farmers greater than the costs of completing the research a case can be made for not initiating the research project. If research and extension activities cannot generate financial benefits to farmers greater than the costs farmers would probably be better off if the research expenditures were put in a savings and farmers paid the annual interest earnings.

Results of the research have to be communicated in a format understandable by farmers and extension workers. The Kandeya village extension worker and farmers planned meetings to discuss the research trial results as well as the farm survey results. Agronomic

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[3]See MacMillan, J.A., A. Kolody, A. Loyns, and P. McVetty, "Evaluating Producer Returns to WGRF Research Project Investments", Canadian Journal of Agricultural Economics, 38 (1990) 123-36, for an application of benefit/cost analysis to a hybrid Canola plant breeding project investment.

practices of the farmers obtaining high yields compared with practices used by farmers with average and below average yields are expected to generate discussion and promote adoption of improved practices.

The income benefits to small farmers as a result of research and extension activities are a form of public good financed by the government of Zimbabwe through Agritex and by Commercial farmers through ART Farm. In the case of agricultural research and extension services consumption of research and extension services by one farmer does not exclude benefits of research being appropriated by another farmer. There is no market which organizes the pricing, production and distribution of research and extension services because of the difficulty of pricing and selling research when the benefits of research cannot be restricted to the consumers of research. A "market" indicator for the value of agricultural research can be estimated using B/C analysis.

4. COMMUNITY DESCRIPTION and TECHNOLOGY ADOPTION

The trial land is located in Natural Region IIa and IIb with fertile soils which are suitable for intensive farming with expected rainfall ranging from 750-1000 mm per year. All trial areas received rainfall of more than 500 mm in the 1990/91 season which was evenly distributed throughout the growing season. Kandeya communal land is organized into 16 wards with 6 villages of about 100 communal farm households per village. Assuming an average household size of 8.8 (based on questionnaire data) there is an estimated 5,280 people per ward. Wards have hereditary chiefs. Each village may have kraal heads, which are hereditary positions, and a village chairman which is an elected political position. Land is allocated to farm households by the chiefs and kraal heads who have larger than average land holdings. Land is not as limiting a factor as the constraint of funds to purchase fertilizer and other inputs according to the Kandeya farmers.

The village is 15 km from Mt. Darwin, the site of a Grain Marketing Board Depot. Questionnaire data for Kandeya indicate that 67 percent of the maize produced is sold to the Grain Marketing Board, 3 percent is sold in the local community and 30 percent is retained for household consumption including family food, payment for labour, and livestock feed. The average price of maize sold locally, $21, was slightly higher than the maize sold to the Grain Marketing Board, $19.06. Average per person consumption of maize per year is estimated at 1.8 (90kg) bags. The average maize production is 15 (90) kg bags per acre on an average of 3 acres per farm. Production on approximately one acre is enough to feed the average household. Maize production is about 50 percent of the total crop acres. Other crops include cotton, groundnuts, tobacco, sunflowers, soyabeans and rapoko.

The adoption process is expected to proceed first from the ward in which the research and demonstration variety trials are located to about 10 other maize producing wards in Kandeya. Agritex officials suggest that the adoption process might proceed with 15 percent of farmers in the ward switching after 2 years of significant demonstrations. It was suggested that 75 percent might switch after 3 years successful data and 90 percent after 5 years. The AGRITEX Village Extension Worker works with village "groups" to promote advanced farming methods including variety selection.

Baseline data was collected to measure the hectares of maize, varieties, yields and agronomic practices for the maize harvested in 1991. Follow-up monitoring of the adoption process is required, over a five year period, to measure actual changes caused by the ART Farm and AGRITEX research and demonstration activities relative to forecast changes from the baseline situation. Ten communal farmers were present at the harvesting of the maize and can be expected to be "early adopters" as well as other farmers "participating" in the research and demonstration activities. Extension officers indicated that baseline survey data would be useful in discussing the farm management practices and yield for a particular farm compared to the average or high production farmers in the community.

5. ESTIMATING FARM FINANCIAL BENEFITS ASSOCIATED WITH RESEARCH AND EXTENSION ACTIVITIES

The first task in estimating farm financial benefits associated with research and demonstration activities is to identify farm management variables subject to influence by research and extension activities. Second estimates of the impact of changes in the farm management variables on farm income is required.

Considerable information is available from agronomy and crop breeding research trials conducted on other communal farms in Zimbabwe. Communal farm research results on fertilizer levels, date of planting and conservation practices are available[4]. Based on concepts of production economics and a review of research institute results we hypothesize that: maize yield/acre will be affected by the number of maize acres, variety, seeding date, planting rate, fertilizer levels and timing for basal, top dressing, manure, cultivation of seed bed and weeding (hand, oxen, tractor), chemicals excluding fertilizer, and conservation practices. The impact of rainfall on yield will vary with the time of adequate rainfall for germination and plant establishment.

In terms of an "experiment", the value of the maize crop needs to be estimated "with-versus-without" the research and demonstration activities. A production function indicating the net effects of varying levels of inputs and management practices can be used to estimate impacts of alternative research and demonstration activities designed to change production systems of farmers. A production model estimated from cross-section data

[4]See Agronomy Institute, Annual Report, Summer 1984/85, p17, and Crop Breeding Institute, Annual Report 1983/84, Zimbabwe Ministry of Lands, Agriculture and Rural Resettlement, and Farming Systems Research Unit, University of Zimbabwe, Annual Report, 1983/84.

obtained from farm interviews, is based on the assumption that all producers and production conditions are homogeneous except for differences arising from the variables included in the function. Yield response to varying levels of fertilizer and other practices in reality varies between farmers depending on the specific technique used and timing of fertilizer applications. Missing variables will affect the goodness of fit of the production function. In addition a problem of measurement errors exists which is associated with farmers ability to recall production inputs and practices accurately.

Considerable variation is indicated in the economic response to fertilizer applications on communal farms. According to Agronomy Institute fertilizer trials for Region II, net marginal benefits were highest at one quarter of the recommended fertilizer rate and gross margin appeared to be maximized at fertilizer rates ranging from half of the recommended rate to the recommended rate.

It is essential to obtain sufficient information to separate out the individual net yield effects of differences in production practices among farmers. With sufficient responses from participating communal farmers, regression analysis can be used to measure the net effect of production practices on yield. The regression coefficients can then be used to estimate the net effect of changing variety on yield, separate from changes in other production practices. The regression coefficients also can be used to estimate alternative benefit/cost scenarios for alternative research and demonstration activities.

A questionnaire was designed to obtain baseline data on maize production. Data was collected for the production of maize from farmers selected by the Village Extension Worker to give "representative" baseline data for eight villages for yields, varieties and agronomic practices. A more accurate sampling process could be introduced by random sampling from village household lists established in the Census planned for Zimbabwe in 1992.

The yield and cultural practice information can be combined with price and cost information to estimate the potential net income benefits associated with research/demonstration activities with the adoption of new hybrid maize varieties. The eight villages under the influence of the village extension officer are considered to be reasonably similar with respect to soil capability and climate.

Linear regression (See Appendix B) was used to estimate net effects of production and management variables. Regression coefficients, significantly different from zero, based on t values indicate: 1) an additional acre is associated with an additional 1.04 bags per acre yield, 2) additional conservation practices individually add 1.21 bags per acre, 3) waiting an additional day to plant on average is associated with an additional .13 bags per acre (This is contrary to results of other studies which may indicate a unusual rainfall distribution)[5], 4) one additional kg of An is associated with .03 bags per acre, and 5) an additional kg of Compound D is associated with an additional .03 bags per acre. No statistically significant effect is associated with the use of different varieties, the application of stalk bore chemical, or in planting rates.

A review of the correlation coefficient matrix indicates that multicollinearity is not a problem. The highest correlation coefficient between the independent variables was .505 between the AN and Compound D fertilizer variables. Logarithmic transformations of the variables which was carried out to capture nonlinear relations did not improve the regression results. The low $R^2=.234$ which is characteristic of cross-section estimates from survey data indicates that important variables are missing from the regression model.

The tests of significance for the regression coefficients indicate low standard errors for important production inputs and practices and a reasonable degree of statistical reliability for the estimates of regression coefficients. A majority of econometricians seem to agree that low standard errors of estimates are more important than high R^2 as a criterion "when the purpose of the research is the explanation (analysis) of economic phenomena and the estimation of reliable values of particular economic parameters"[6].

The survey results indicate that 68 percent of the farmers use R 215 with the remainder using R 201. In some cases farmers were growing several varieties. The large majority own and use oxen. It was not possible to obtain reasonable information on hours per acre for cultivation practices. Additional analysis with individual farmers is required. The average yield is 15 bags per acre with 3 acres per farm. The average score for conservation practices was 2.2 out of a possible score of 11. Conservation practices being used by farmers included: winter ploughing, contours, gully protection, culverts, digging planting holes to catch early rain, tied ridges, mulching, cultivated ridges, terraces, deep ploughing and crop rotation. The average planting date was Dec.3. Farmers used an average of 69 kg per acre of both AN and Compound D, although a wide variation in application levels exists.

Using a cost of $.54 per kg for AN fertilizer (34.5 percent N, priced at $27 per 50 kg bag) and a return of $25.30 per 90 kg bag the regression equation coefficients indicate a total return of $.759 (or $.219 net of the fertilizer cost) per additional kg used. The cost of D (8 percent N, 14 percent $P_2 0_5$ and 7 percent $K_2 0$) is higher, $.56 per kg, giving a lower net

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[5]See Waddington, S.R., M. Mudhara, M. Hlatshwayo and P. Kunjeku, "Extent and Causes of Low Yield in Maize Planted Late by Smallholder Farmers in Subhumid Areas of Zimbabwe", CIMMYT Maize Programme, Harare, 1991.

[6]See Koutsoyiannis, A. Theory of Econometrics, 2nd ed, Barnes & Noble Books, N.J, 1985, p96.

return of $.199 per additional kg of D fertilizer used. The regression equation results indicate, that for the maize crop harvested in 1991, on average the farmers could have increased net returns substantially by applying more fertilizer.

Statistical analysis of ART Farm trials at four locations (See Appendix C) supports the conclusions based on the regression analysis of village questionnaire data from Mount Darwin with respect to the economic returns to additional fertilizer and improved agronomic practices. The ART Farm "communal farmer" production system used a total of 236 kgs of fertilizer per acre (600 kg/ha) with an average yield of 25 bags (90kg) per acre (5.7 t/ha) for two Chiweshe communal area sites. The average yield of the 23 percent of communal farmers interviewed in the Kandeya villages who use more than 236 kg/acre total fertilizer is 27 bags per acre, which indicates the applicability of the Chiweshe ART Farm trial results to farmers achieving high yields in Kandeya.

The "ART Farm" production system, using a total of 315 kg of fertilizer per acre resulting in a yield of 44 bags per acre (10 t/ha), is not being used by any of the Kandeya communal farmers. It is concluded from analysis of the ART Farm trials that substantial benefits exist with the improved agronomic production system. In the communal areas under study top farmers--in trials produced under supervision of ART Farm staff--achieved maize yields of 44 bags per acre (10 t/ha)--65 percent higher than the average yield of the top 23 percent of Kandeya communal farmers using high fertilizer levels. Switching to a new variety results in a smaller 6 percent yield increase. The combined benefit of improved methods and hybrids resulted in a 75 percent increase in yield (5.7 versus 10.0 t/ha).

The total potential yield increase associated with the "ART Farm" production system and new hybrid varieties is almost three times the average of 15 bags per acre produced by the sample of 73 Kandeya communal area farmers. ART farm staff estimate that the "ART Farm" production system results in a gross margin of $830.80 per hectare relative to the "communal farmer" production system. In contrast, the gross margin associated with the average yield of new hybrids compared to R 215 is $162.00 The increase in gross margin of $992.80 associated with both hybrids and improved methods represents an increase of 97 percent in gross margin compared to the "communal farmer" production system.

The 1990/91 growing season favoured the late maturing hybrids, and yields were high even at the late planted Rosa site. The recently released Seed-Coop hybrids SC 601 and SC 501 produced the highest yields followed very closely by SR 52. The standard deviation of hybrid yield over all sites has been included in Appendix C as an indicator of the stability of the hybrids over the wide range of environmental conditions. The old short to medium season hybrids R 201 and R 215 had the lowest variability in yield across all sites, although their yields were not as high as the relatively new long season hybrids SC 601 and SC 501.

6. BENEFIT/COST ANALYSIS

Most benefit/cost analyses of agricultural research use complex economic surplus calculations[7]. Improving farm financial benefits is the major target of ART Farm and AGRITEX research and demonstration activities. Simplifying assumptions are made which result in estimating the farm financial benefits associated with research and demonstration activities as a function of the gross margin per acre and acres of the new variety adopted. Increments in gross margins per acre for new varieties relative to gross margins for the old varieties are estimated for the forecast number of farms adopting new varieties as a result of the research and demonstration activities (See steps 1-3 in Appendix A). The adoption path and present values are calculated in steps 4 and 5. Sensitivity analyses are outlined in step 6.

Ex ante B/C analysis (See Appendix A) indicates that if a very small percentage of farmers switches to higher yielding varieties as a result of the research and demonstration activities by ART Farm and AGRITEX then a positive B/C ratio is generated. The analysis assumes that five years after the first trial, 50 out of an estimated 1000 maize hectares are switched to new higher yielding hybrids and improved agronomic practices as a result of the trials. The estimate of 1000 maize hectares under the influence of a single village extension worker is based on the average 1.25 maize hectares per farm from the Kandeya farm survey with an average of 100 farm households per village in 8 villages.

In the trials the "ART Farm" production system yield was 10 t/ha relative to the "communal farmer" system of 5.7 t/ha. The increment in gross margin was $992.80 associated with both new hybrid varieties and improved agronomic practices. The statistically significant regression coefficients estimated from the farm survey data (See Appendix B) indicate that more than an additional 1 t/ha yield could be achieved if farm management changes were made in the Kandeya sample to: increase the average size of maize planting by two acres, increase the average conservation practices by two, delay average planting date by four weeks, and increase average total fertilizer application by 200 kg. The ex ante B/C ratio of 1.35 is estimated based on: 1) a conservative yield increase of 1 t/ha and a constant gross margin of $250 associated with a new hybrid and improved agronomic practices, 2) adoption of new hybrids and agronomic practices on 50 ha out of 1000 maize hectares in villages under the influence of the village extension worker, 3) costs per year of research and demonstration activities is $4,000 per year, and, 4) a real interest

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[7] See Echeverria, R.G., G. Ferreira, and M. Dabezies, Return to Investments in the Generation and Transfer of Rice Technology in Uruguay, ISNAR, Working Paper No. 30, p9. Economic surplus calculations require the estimation of economic returns using shadow pricing of inputs, removal of transfers and use of export/import parity pricing. This complexity is not directly relevant to farm production decisions. In addition, assumptions concerning the shape of supply and demand curves as well as the form of the technology generated supply shift are required. As Echeverria et. al. indicate, the analysis can be simplified if a horizontal demand and vertical supply function with parallel supply shifts are assumed.

rate of 11 percent.

The trial yield increments for the "ART Farm" production system relative to the "communal farmer" system can be separated into two components, one yield increment due to variety and the other due to improved agronomic practices. The yield advantage of growing an improved hybrid, that is, average yield of hybrids yielding better than R 215 grown under the "ART Farm" improved package, was 0.6 t/ha, a 6 percent increase in yield (See Appendix C) compared to the yield increment of 3.7 t/ha, a 65 percent associated with the "ART Farm" production system. Trial results also indicate that SC 601 outyielded R215 on two sites by 1.2 t/ha. The "ART Farm" production system average yield for was 44 bags per acre(10t/ha) for the four hybrids with yields greater than R 215.

The"ART Farm" production system, using high levels of fertilizer (400kg each of both Compound D and AN and other inputs, can be viewed as a maximum yield and revenue case. The "communal farmer" production system, using 300 kg/ha each of both Compound D and Ammonium Nitrate (An) fertilizer, can be viewed as an above average, high input case based on the baseline data obtained from Kandeya communal farm survey.

ART Farm estimates from past research indicate that commercial farmers should be able to achieve 75 percent of research trial results. Using the same adjustment for communal farmers 8 t/ha (36 bags) should be achievable by communal farmers using the Art Farm production system with the SC 601 hybrid (See Appendix C). The 8 t/ha yield for SC 601 is 2.4 times the average yield of 3.3 t/ha (15 bags) achieved by the sample of 75 Kandeya farmers. Additional trials and analysis of farm surveys are required to accurately establish feasible yield increments associated with the new varieties and improved agronomic practices under local conditions. For the 1990/91 production year crop (planting occurs in November and harvesting in May) prices are fixed by the government in May, 1991. Assuming similarity in production capability, a cross section analysis estimation of the function indicated above in physical units provides technical production relationships which are not affected by annual price variations. Over time product and input price variation will affect the farming practices. For example, fertilizer prices have increased for the 1991/92 crop. It will be essential to separate out the effect of fertilizer price increases on yield for 1991/2. Maize and other relative product price changes especially cotton, tobacco and oilseeds also will affect the level of net benefits associated with the maize research/demonstration activities. The benefit/cost model, using single year gross margins (See Appendix A), will need to be expanded to include product and input price variability[8].

[8]For additional background on applying capital investment analysis and benefit/cost analysis to agricultural research projects, see MacMillan, J.A., G. Mudimu, L. Rugube, and E. Guveya, "Micro-computer Ex Ante Small Farm Agricultural Research Benefit/Cost Analysis: Zimbabwe, Zambia, and Tanzania" Working Paper Department of Agricultural Economics and Extension, July 1991

7. MARKET ORIENTED MAIZE PRICING

Under Zimbabwe's Structural Adjustment Program import and export controls on the general economy with the exception of key food commodities such as maize are to be removed by 1995. According to Kingsbury, Zimbabwe is expected to have a competitive edge in intra-SADCC trade over South Africa, the major exporter of white maize in Southern Africa, if government agricultural policy impediments to trade are removed.[9] If market oriented maize prices based on import/export parity concepts is instituted under the Zimbabwe Structural Adjustment Program, significant increases in returns to agricultural research on maize are expected.

Policy analysis scenarios for market decontrol are suggested in step 6, Appendix A. The demand curve for maize faced by communal farmers in Zimbabwe, is horizontal because the government sets a price for each season just before harvest in May. ART farm and AGRITEX are interested in improving farm financial income levels associated with maize production. As a result the farm financial estimate of the increment in gross margin per acre is the appropriate measure for B/C analysis of research and extension activities. The usual "economic" supply and demand curves used in producer and consumer surplus calculations are not appropriate.

Market pricing of maize based on export parity prices could result in a short term maize price to farmers in the $ 570 range assuming $US1=$3ZIM (See The Herald, May 23, 1991, p31, a price of US$190 is quoted for exports to Zambia). Exports from Zimbabwe have been made to Zambia, Malawi, Mozambique and Botswana. Longer term maize prices based on export prices might be expected to be in the $110-120 U.S. range. Continual adjustments in market oriented maize prices paid to farmers in Zimbabwe dollars would be required if the rapid devaluation of the Zimbabwe dollar relative to the US dollar continues. Maize available for export from the 1991/92 crop would increase substantially if market oriented pricing of maize replaced the current system of government controlled maize pricing and increased prices were announced in November 1991.

The common argument against import/export parity pricing of maize is based on the potential negative impact on low income households of increased consumer prices for maize and roller meal. The current system of food relief delivers maize to low production and low income communal areas. Kandeya is one of the communal areas receiving maize from the government as drought relief and yet significant maize production potential exists in Kanadeya. Market oriented maize price increases would increase the level of self-sufficiency in Kandeya and reduce the need for drought relief.

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[9]Kingsbury, D. Agricultural Pricing Policy and Trade in Several SADCC Countries: Preliminary Results", p 261,in G. Mudimu and R.H. Bernstein, eds. Household and National Food Security in Southern Africa. Proceedings, UZ/MSU Food Security Research Project, 1989.

Levies could be introduced on the export revenues generated from maize exports in 1991/92 to finance maize distribution to low income households in Zimbabwe. Contributions to the newly created Structural Adjustment Program Social Fund could be made from the levies on maize export revenues. The potential economic benefits to be gained from import/export parity pricing for maize combined with contributions to the Structural Adjustment Social Fund appears may be a case of an agricultural price policy change which generates substantial net benefits in Zimbabwe.

It is possible that the maize price would remain high with additional production for export markets from Zimbabwe. In this case consumers not receiving free maize would bear a net cost associated with maize import/export parity pricing. Economic analysis is required to estimate the total benefits relative to the level and distribution of costs associated with maize market oriented pricing based on import/export parity concepts.

If the maize price paid to farmers is doubled in November 1991 to approach the likely export parity price and the number of maize acres under production does not change then the B/C ratio for the research and extension activities would be double the ratio associated with the 1991 government controlled price of $270 per tonne. However, if the price of maize paid to farmers is doubled farmers will increase production inputs and likely expand maize acres. Depending on relative prices and costs, shifts could occur from other crops such as cotton and oilseeds. The maize supply response is extremely complicated because cotton and oilseed prices are controlled by the government but tobacco is sold on the open market. Supply response analysis is required to determine the final impacts on farm financial returns. Farmers indicate that without higher prices maize acres will not be expanded. At planting farmers expected higher prices and net returns for cotton, tobacco and groundnut production relative to maize prices.

Substantial acreage changes are observed for the total sample of Kandeya farmers between 1989/90 and 1990/91 in response to price changes (See Appendix D). For 1990/91 relative to 1989/90 maize acres remained about the same for the 73 farmers because the of the low 5 percent price increase for white maize but the number of farmers growing an average 1.71 acres of cotton increased by 18 because of the higher 19 percent increase in price of cotton. For groundnuts the number growing, .73 acres increased by 13, and the number growing 1.03 acres of tobacco increased by 12 because of the large price increases. The production response for tobacco to the 86 percent price increase would have been greater except wood available for construction of drying sheds is limited. It is expected that if market oriented maize pricing was initiated in Nov. 1991 significant increases in maize acres in Zimbabwe would result permitting substantial maize exports.

The Nobel prize winning agricultural economist T.W. Schultz has maintained that "correct" market pricing of agricultural commodities in the developed and developing countries results in major economic benefits. Correct pricing in terms of market oriented import/export parity pricing can be demonstrated to increase the economic returns to research and extension activities for Kandeya communal maize farmers(See Appendix A steps 6 and 7). Benefit/cost ratios will be considerably higher if import/export parity prices are paid to farmers for maize. Additional costs may occur to maize consumers--economic analysis is required to assess the likely regional market maize price with additional exports from Zimbabwe.

8. EXPECTED B/C RESULTS FOR 1991/92 RESEARCH AND DEMONSTRATIONS

A case has been made above for additional investments in agricultural research and extension activities because of high benefit/cost estimates for additional maize research and demonstration activities. It is concluded that there is an under investment in research and extension to assist communal small farmers in increasing their maize yields. Based on the research results summarized above, high incremental farm financial returns to communal farmers are expected to be associated with additional research and extension activities relating to analysis of: fertilizer levels and application placing and timing, conservation including rotations, conservation tillage and moisture control, planting dates associated with alternative expected rainfall distributions, timing and extent of weeding, and profitability of maize and groundnut rotations.

ART Farm trials indicate a potential for .5 t/ha extra yield from maize following groundnuts. Fifty-six percent of the farmers interviewed in Kandeya grew almost an acre of groundnuts. Significant economic benefits could result from research and extension activity testing groundnut varieties, chemicals and the impact of rotations on yields. If the conclusions about the significant responsiveness of communal farmers to price changes are valid, the government announced constant price of groundnuts in 1991/92 relative to 1990/91 will cause a decrease in the number of Kandeya farmers planting groundnuts in the fall of 1991. As a result the expected economic returns to groundnut variety and agronomic research in Kandeya will be reduced.

Adoption rates associated with research and extension activities are required to refine the benefit/cost measures for alternative activities. In addition, analysis of the likely distribution of benefits relative to costs of research across high versus low rainfall regions is required. Estimates of the number of communal farmers by region is required to establish the aggregate impacts associated with research and extension activities in specific groups of villages. Net benefits from research and extension activities for maize will likely decrease with the high drought sensitivity and low soil capability in some regions.

Given the scarcity of research and extension funds, restricting research investments to commodities and regions where a positive return to investment expenditures exists might be advisable. For example in drought sensitive regions high economic returns to research is expected for commodities other than maize. From an economic efficiency point of view investment of research funds in projects with a benefit cost ratio of less than 1 return fewer financial benefits to drought prone farmers than the alternative of putting research funds into a "savings fund" and distributing the annual interest earnings to farmers.

Analysis of the expected high returns to research and extension activities associated with market oriented maize pricing and subsequent contributions to the structural adjustment social fund from export levies should, in itself, have a high pay-off. The impact of variability in potential export trade and the supply response of communal area farmers to higher maize prices requires analysis.

9. CONCLUSIONS

Ex Ante benefit/cost analysis of expenditures for research and extension activities can be used to select activities with a high pay-off to public and private investment. Based on the trial results and economic analysis it was decided to reduce the intensity of maize variety trials and emphasize research and demonstrations to improve agronomic production practices. Analysis indicates that substantial increases in small farm maize yields can be achieved in the Kandeya Communal Lands, Mount Darwin District, Chiweshe and Musana communal areas. The farmers in these areas produce maize on very small holdings. For the Kandeya sample the average farmer produced maize on three acres out of a total 6 acres. Other crops grown included cotton, groundnuts, tobacco, sunflowers soyabeans and rapoko.

Activities with high expected yield and economic impacts include: continuing examination of the yield potential of "old" hybrids versus "new" hybrids for maize and groundnuts. Other activities with high yield and economic impact include increasing levels and timely application of fertilizer, timely sowing, use of water and soil conservation systems, optimal plant populations, appropriate disease and pest control, and timely weed control and harvest.

The results for delayed planting require additional analysis of the rainfall distributions in the Kandeya Communal Lands. Ten percent of the farmers sampled did not apply any fertilizer other than manure. Yield increases on the order of three times the average 15 bags per acre to a level of 44 bags per acre (10 t/ha) appear feasible with adoption of new hybrid varieties and improved agrononiic practices. The high expected returns from additional agricultural research requires joint extension inputs to communicate research results to farmers as well as confirm and refine research conclusions.

Extension officers indicated that baseline survey data would be useful in discussing the productivity and impacts of a particular farm compared to the average or high production farmers in the community. Additional trials on a range of representative communal farmer fields with known cropping histories would provide more conclusive results. Baseline survey data for individual farmers and villages are required to estimate the aggregate impacts of research and demonstration activities on higher productivity and net income.

Analysis of the economic impacts of market oriented pricing of maize with contributions to the Structural Adjustment Program Social Fund are expected to indicate significant positive net benefits to the Zimbabwe economy, as well as increase returns to investments in agricultural research. Contributions to the Structural Adjustment Social Fund for maize deliveries to low income households could be financed by levies on maize export revenues.

APPENDIX A:

Ex Ante Benefit/Cost Analysis, ART Farm Communal
Maize Cultivar Selection and Improved Agronomic Practices Research/Demonstration

1) Estimated potential benefits based on 1990/91 yield data

Area	Farm Gate Maize Price $/t	Incremt Yield t/ha	Rev $/ha	Variable Costs: chem,fert, cult,labour $/ha	Gross Margin $/ha,90/91
1	270	1	270	20	250

NOTE: In the ART Farm trials with the "Communal Farmer" production system, there are no additional costs of new hybrids versus old varieties. The gross margin benefit associated with "new" hybrids is $162.00 per hectare. In the "ART Farm" production system the additional cost of variable inputs fertilizer and labour was $168.20 per hectare versus an income benefit of $999.00 (3.7 t/ha) associated with the higher yield. The gross margin/ha of the improved agronomic practices in the "ART Farm" production system was $830.80 per hectare. The total gross margin feasible with both new varieties and improved agronomic practices is $992.80 per hectare.

2) Estimate adoption in terms of ha in HYV per year
Communal hectares to be planted with HYV

Area	91/92	92/93	93/94	94/95	95/96
1	1	5	10	25	50

NOTE: It is assumed that ART farm speeds the rate of adoption causing 4 farmers to switch .25 ha each to HYV in 1991/92 increasing to 50 ha in 1995/96

3) Estimate Art Farm and Agritex costs per community
ART Farm
AGRITEX

Communal Area — Research Demonstration Costs

Communal Area	1990/91	1991/92	1992/93
1	4000	4000	4000

NOTE: It is assumed $2000 staff and $2000 travel per community per year made up of 6 visits requiring 1 week staff time and $500 travel cost.

Appendix B: Kandeya Data and Multiple Regression Analysis

1. Data

Farm No.	Yld Bags/ac	Mze	Cons ac	Var *	Pltg Dte **	Tot Fert ***	An kg/ac	D kg/ac	Chem kg/ac	Pltg Rte **** kg/ac
1	12.5	4.0	2	0	57	113	38	75	1	19
2	20.0	1.0	1	1	40	50	50	0	1	20
3	10.0	5.0	1	1	25	140	50	80	1	10
4	3.8	4.0	1	1	35	0	0	0		6
5	13.3	1.5	1	0	53	0	0	0		7
6	13.0	2.0	2	1	48	300	150	150	1	30
7	30.0	3.0	1	1	41	183	83	100		15
8	25.0	2.0	1	1	41	75	25	50		25
9	25.0	6.0	3	1	36	43	18	25	1	22
10	12.5	4.0	3	1	36	38	13	25		6
11	24.3	3.5	3	1	56	57	29	29		10
12	16.7	3.0	4	1	18	0	0	0		10
13	10.0	4.0	3	1	48	163	163	0		13
14	13.0	1.0	2	1	36	100	100	0		10
15	13.6	5.5	2	1	36	55	27	27		25
16	10.0	1.5	2	1	52	167	67	100		33
17	10.0	1.5	2	1	30	233	133	100	1	20
18	17.5	4.0	2	1	42	75	0	75		10
19	10.0	2.0	2	1	43	50	0	50		10
20	25.0	4.0	1	1	30	188	75	113		10
21	8.8	4.0	1	1	30	213	113	100		13
22	20.0	3.0	1	0	31	133	67	67		13
23	16.7	3.0	1	1	30	267	133	133		30
24	22.2	4.5	2	1	8	111	111	0		22
25	7.5	4.0	2	0	36	38	25	13	1	13
26	10.0	1.0	2	1	47	100	100	0		10
27	1.1	1.5	2	1	23	33	33	0		7
28	4.8	2.5	2	0	30	40	40	0		10
29	12.5	8.0	2	1	12	0	0	0	1	10
30	8.3	6.0	3	1	29	0	0	0		13
31	17.8	4.5	5	0	18	133	78	56		11
32	1.5	4.0	3	1	18	100	50	50		13
33	7.2	2.5	4	1	20	60	60	0		20
34	16.0	2.0	4	1	18	275	175	100		25
35	7.7	3.0	4	0	20	83	67	17		17
36	18.3	6.0	3	1	18	0	0	0		4
37	13.3	3.0	3	0	51	117	67	50		17
38	8.0	2.5	2	1	40	20	20	0		10
39	9.0	2.0	2	1	0	250	100	150		13
40	5.0	4.0	2	0	48	0	0	0		13
41	8.3	6.0	1	1	31	67	50	17		8
42	7.3	3.0	2	0	29	83	33	50	0	13
43	18.8	4.0	3	0	36	300	150	150	0	10
44	20.0	2.0	3	0	39	300	100	200	0	10
45	30.0	4.0	2	0	39	238	200	38	0	10
46	25.0	2.0	4	1	31	375	75	300	1	18
47	13.3	3.0	4	0	14	300	100	200	0	10
48	12.0	3.5	2	1	36	100	43	57	0	7
49	16.7	6.0	3	1	48	167	83	83	1	8

50	16.0	5.0	2	0	36	70	30	40	1	8
51	15.0	3.0	2	1	56	367	100	267	1	17
52	8.0	2.5	2	1	48	240	120	120	0	10
53	12.5	2.0	3	0	37	50	50	0	1	13
54	25.0	1.0	3	0	53	100	100	0	0	10
55	17.5	2.0	3	1	58	125	50	75	0	13
56	23.3	3.0	3	0	28	283	83	200	0	17
57	10.0	1.0	2	0	48	50	50	0	0	20
58	15.0	3.0	2	0	48	200	100	100	0	10
59	23.3	3.0	3	1	18	83	33	50	0	17
60	30.0	2.0	3	1	58	300	100	200	0	25
61	33.3	3.0	3	1	48	300	150	150	0	17
62	23.0	1.0	3	0	28	250	100	150	0	10
63	20.0	1.5	3	1	59	100	33	67	0	7
64	16.0	2.0	2	0	29	300	150	150	0	10
65	25.0	2.0	3	1	48	300	150	150	1	15
66	14.3	3.0	3	1	48	117	67	50	0	7
67	25.0	10.0	3	1	18	50	50	0	1	16
68	17.5	2.0	3	1	38	300	150	150	1	10
69	20.0	1.0	4	1	58	50	50	0	0	10
70	8.5	2.0	4	1	5	125	50	75	0	25
71	15.0	4.0	1	1	48	200	63	138	0	13
72	8.0	1.0	2	1	58	150	50	100	0	20
73	8.0	1.0	3	0	34	50	50	0	0	20
Mean	15.23	3	2	0.68	36	138	69	69	0.40	14
Min	1.11	1	1	0.00	0	0	0	0	0	4
Max	33.30	10	5	1.00	59	375	200	300	1	33
StdD	7.21	2	1	0.46	14	104	49	70	0	6

*Conservation Index: a unit value is given to conservation practices: winter ploughing, contours, terraces, culverts, ridging(cultivating or tied), mulching, digging planting holes, crop rotation, and deep ploughing

**Variety Index; 0 for R201 and 1 for other hybrids eg, R215

***Planting date index: 0 is assigned to the earliest 28/10/91 and unit values to successive planting dates

**** Chemicals 1 for stalk borer, 0 otherwise

2. Multiple Regression Equation, R2 =.234

	Intercept		TotA	Cons	Var	PltgD	FertA	FertD	Chem	PltgR
Coef.	-0.71	1.04	1.21	0.63	0.13	0.03	0.03	-0.45	0.06	
t val	2.0	1.3	0.4	2.1	1.5	2.0	0.25	0.45		
		**	^		**	^	^^			

**statistically significant for a 2 tailed t test,5% level
*statistically significant for a 2 tailed t test,10% level
^^statistically significant for 1 tailed t test,2.5% level
^statistically significant for 1 tailed t test, 10% level

See A. Koutsoyiannis, Theory of Econometrics Barnes & Noble Books, NJ, p.660, for t values

4) Calculate five year time path of benefits, 1991/92 to 1995/96 for each of the five communities

Year	Incremental Rev/ha/yr	HYV hectares	Total Benefits/yr
1	0	0	0
2	250	1	250
3	250	5	1250
4	250	10	2500
5	250	25	6250
6	250	50	12500

NOTE: It is assumed that the 1990/91 gross margin is constant

5) Compare present value of benefits versus costs assuming a constant real 11 percent cost of money. The present value of benefits is $13,156 and costs is $9,775, giving a B/C ratio of 1.35

6) Sensitivity Analysis:

A. Increase B/C ratio by increasing rate of adoption

Year	Total HYV hectares	Incremental Rev/ha/yr	Total Benefits/yr	
1	0	0	0	New PV of B = 16,865
2	1	250	250	
3	5	250	1250	New B/C = 1.73
4	10	250	2500	
5	50	250	12500	
6	50	250	12500	

Note: Increasing product prices, or yields and reducing expenses will increase incremental revenue per hectare and hence increase the B/C ratio

B. A 11% real interest rate with inflation of 18% implies a market rate of 29%; a 6% real rate with inflation of 18% implies a market rate of 24% See step 6 above.
Using 6% interest in step 5 changes B/C ratio. The present value of benefits is $16,735 and the present value of costs is $10,692. The new B/C ratio is 1.57.

APPENDIX C: ART Farm Research Trial Results

Maize hybrids grain yields for four communal area sites.
Yields are ranked according to mean yield across sites
t/ha (bags/acre)

Cultivar	Communal Dryland Sites				Adjusted		
	Mt Darwin	Musana	Kamoto	Rusa	Mean	Mean	Std
Planted:	28 Nov.	28 Nov.	27 Nov.	12 Dec.	(100%)	(75%)	Dev
SC 601	9,9(44)	11,5(51)	-	-	10,7(48)	8,0(36)	1.1
SC 501	9,1(41)	11,0(49)	10,3(46)	10,1(45)	10,1(45)	7,6(34)	0,8
SR 52	8,3(37)	10,7(48)	9,7(43)	11,0(49)	9,9(44)	7,5(33)	1,2
R 201	9,2(41)	9,6(43)	10,3(46)	9,2(41)	9,6(43)	7,2(32)	0,5
PNR 473	8,5(38)	10,4(46)	9,6(43)	9,2(41)	9,5(42)	7,1(32)	0,8
R 215	8,7(39)	10,0(45)	9,9(44)	9,1(41)	9,4(42)	7,1(32)	0,6
PNR 695	8,0(36)	10,7(48)	-	-	9,3(41)	7,1(32)	1.9
CG 4585	8,6(38)	9,8(44)	-	-	9,2(41)	6,9(31)	0,8
PNR 6549	7,7(34)	10,1(45)	-	-	8,9(40)	6,7(30)	1,7
CG 4539	7,4(33)	10,1(45)	8,0(36)	8,2(37)	8,4(37)	6,3(28)	1.2
Farmer R215	-	-	6,9(31)	4,5(20)	5,7(25)	5,7(25)	1,7
Mean	8,5(38)	10,4(46)	9,3(41)	8,8(39)	9,2(41)	7,0(31)	
S.E.	0,41	0,37	0,44	0,46	-	-	
LSD (0.05)	1,20	1,06	1,35	1,42	-	-	
C.V. (%)	9,72	7,03	8,20	9,11	-	-	

Note: The adjusted mean at 75 percent of the actual mean is the level ART Farm researcher expect commercial farmers to be able to achieve compared to plot trial results. LSD (0.05) test if the means are statistically different by greater than the LSD the results are significant at the 5 percent probability level (See Gomez, K.A. and A.A. Gomez, Statistical Procedures fo Agricultural Research, 2nd ed, John Wiley & Sons, NY, 1984, p 189. At the Musana site, fo example, the difference between R 215 and SC 601 is 1.5 t/ha which is greater than the LSD o 1.06 indicating a significant difference between SC 601 and R 215 at the Musana site.

APPENDIX D:

Table 1
Crops Produced and Yields, Kandeya Sample 1990-91

Crop		Av Acres	No. Prod	Yield
Maize	1990	2.86	73	15.95 bags/acre (90kg bags)
	1991	3.12	73	15.36 bags/acre "
Cotton	1990	1.68	38	518 kg/acre
	1991	1.71	56	608 kg/acre
Ground nuts	1990	.86	28	7.0 bags/acre (65kg bags)
	1991	.73	41	7.5 bags/acre "
Tobacco	1990	.76	19	663 kg/acre
	1991	1.03	31	849 kg/acre
Sunflower	1990	.93	10	7.0 bags/acre
	1991	1.21	12	8.7 bags/acre
Soyabeans	1990	1.06	3	4.8 bags/acre
	1991	.79	4	9.4 bags/acre
Rapoko	1990	.75	3	3.17 bags/acre
	1991	.75	6	2.17 bags/acre

Table 2
Producer Prices, Zimbabwe, 1989/90-1991/92

White Maize ($/t)

1989/90	215
1990/91	225
Change	5%
1991/92	270
Change	20%

Cotton (c/kg)

1989/90	92.5
1990/91	110
Change	19%
1991/92	135
Change	23%

Groundnuts ($/t)

1989/90	1000
1990/91	1250
Change	25%
1991/92	1250
Change	0%

Burley Tobacco ($/kg)

1989/90	na
1990/91	3.5
Change	na
1991/92	6.5
Change	86%

Sunflower ($/t)

1989/90	455
1990/91	505
Change	11%
1991/92	580
Change	15%

Soyabeans ($/t)

1989/90	435
1990/91	485
Change	11%
1991/92	560
Change	15%

Note: Prices are effective for a 12 month period, eg. May 1989--April 1990