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Estimating the economic value of the national cultivar trials in South Africa: A case for sorghum, sunflower, soybeans and dry beans

Thula Sizwe Dlamini¹, Litha Magingxa² and Frikkie Liebenberg

¹ Agricultural Research Council, Agricultural Economist, Pretoria, South Africa

² Agricultural Research Council, Agricultural Economist, Pretoria, South Africa

³ University of Pretoria / Department of Agricultural Economics, Extension and Rural Development. Senior Lecturer, Pretoria, South Africa

DlaminiTS@arc.agric.za / thulad1@gmail.com

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Summary

This study assesses the economic impacts of the national cultivar trials in South Africa over the period 1978 - 2012. The study uses experimental yield data to estimate the yield losses that have been prevented by providing farmers with information that has facilitated the selection of adapted cultivars on their localities. Using attribution methods, the study estimates the contribution of the programme to yield growth, along a range of assumed plausible yield gain estimates attributable to the trials. It finds that the yield benefits are equivalent to 13.10kg and 7.67kg for sunflower and sorghum output per hectare per year, respectively, whilst the soybean and dry bean trials contributed yields equivalent to 16.42 kg and 17.13 kg per hectare per year, respectively, at the assumed plausible yield gain estimate attributable to the trials of 5 percent. In present value terms, the estimated total economic benefits that have accrued to South Africa over the period 1978 – 2012 amounted to R200 million in 2012 prices, which is equivalent to 4 percent of the total gross value of production for these crops in 2012. Of these benefits, about R23.2 million came from the evaluation of sunflower cultivars, R84.7 million from dry beans, R85.7 million from soybeans and R6.6 million from the evaluation of sorghum cultivars. Overall, the results imply a benefit-cost ratio of 1.90, using a real discount rate of 7.8% per annum and a modified internal rate of return of 16% per annum. These results confirm that investment in the national cultivar trials at the ARC has been a profitable undertaking for South Africa and that continuing with the trials would be justified.

Keywords: cultivars, evaluation, benefits, costs, MIRR

JEL Classification codes: Q160

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1. INTRODUCTION

Are there any economic and social benefits that have accrued to South Africa from the systematic evaluation of modern varieties for dry beans, sorghum, sunflower and soybeans seed? How big are they and is it justifiable to carry on using public funds to conduct the trials? These are particularly important questions to South Africa a country that has seen a decrease in the funding of public agricultural research and development (agR&D) (Liebenberg and Kirsten, 2006) amidst an expanding population that is increasingly demanding that more food is produced with less under difficult production environments. The national cultivar trials are a key research initiative geared towards averting yield losses due to farmers planting poorly adapted cultivars on their environments. The trials focus on developing seed performance information in different commercial farmer localities which is then disseminated to farmers using multiple platforms. Farmers supposedly use the information to make decisions regarding which cultivar or cultivars to plant in their localities.

The information makes it possible to curtail the use of poorly adapted crop cultivars in farmer localities by summer grain crops farmers in South Africa. The trials are therefore an important aspect of productivity maintenance research in that they counteract yield losses that may come about because of poor seed selection capabilities by farmers. Yet many have questioned the relevance of the trials and have maintained that eventually farmers were going to get seed performance information even in the absence of the trials. The general feeling is that the trials are no longer important to farmers and that the continued use of public funds to evaluate cultivars is a waste of resources. Confounding the situation is that the decrease in funding for agR&D has meant that different research projects have to compete for limited funds from the Agricultural Research Council (ARC) of South Africa's annual Parliamentary Grant, which has also been decreasing in real terms in the last 10 years. This has presented a situation that calls for more evidence on the economic value of different research initiatives in the ARC.

The purpose of this study is to quantify the economic value of the yield benefits that have accrued to farmers and to South Africa as a result of past investments into the trials. In particular, the study addresses questions related to whether or not the evaluation of cultivars using public funds in South African agriculture should be continued. This is especially so given an upsurge in budgetary pressures to fund various research activities within the ARC, which is the premier agricultural research institution in South Africa. The results of this study are particularly important to research policymakers, clients and administrators, who make the ultimate judgements on the distribution of research funding for agR&D in South Africa.

The study uses experimental yield data to estimate the yield losses averted through farmers being able to select a cultivar that is adapted on their localities for the period 1978 to 2012. However, since the exact contribution of seed choice to yield is unknown, the study uses plausible yield gain estimates to attribute the contribution of seed performance information to yield loss prevention. The benefit-cost (BC) ratio and modified internal rate of return (MIRR) are used to evaluate the economic impacts of the benefits associated with, and the returns to past investments in, the trials.

The remainder of the paper is structured as follows: section two provides a brief background to the decision value of the trials. It goes on to provide a brief explanation of the statistical models that are used to assess the adaptability of cultivars in a locality in the trials. The purpose of the section is to provide information on the strategic importance of the national cultivar trials in South African agriculture. Section three discusses the method of analysis whilst section four presents the results. The last section concludes.

2. CULTIVAR EVALUATIONS

Sorghum, dry beans, sunflower, and soybeans play an important role in the economy of South Africa. Dry beans are an important source of protein especially for people in the low income bracket whereas sunflower and soybeans are important sources of oil and protein for both household and industrial purposes. Sorghum is an important feedstock in the manufacture of beverages and acts as a source of carbohydrates for human consumption. These are economically important grains in South Africa, and their production is central to ensuring and fortifying food and national security. Because of the importance of seed as a carrier of the genetic material that sets the potential frontier of production in as far as quality and quantity are concerned (Eaton, 2011), the national trials are fundamental in guiding farmer seed selection decisions. This makes it possible to avert yield losses that may occur due to farmers planting crop cultivars that are not adapted in their environments. The trials recognize the variation in environmental conditions across a wide range of environments in South Africa and provide unbiased seed performance information for a wide range of commercially available seed in South Africa. The ARC is mandated by the state to evaluate the growth potential and reaction of different cultivars to a variety of climatic and agronomic factors across the key summer grains producing environments. This leads to the production of useful information that when used by farmers may lead to an increase in crop yields at no extra costs.

The decision value of the trials is found through farmers being able to compare the performance of alternative new cultivars, against each other, and with that of existing cultivars, in their environments. The trials minimise the risk element associated with limited performance information of cultivars and make it possible for farmers to conduct, to draw from Hall and Khan (2003), robust calculations that compare the incremental benefits that a new technology would bring against its costs in relation to existing technologies in an uncertain environment. They provide decision makers with unbiased performance information of new and existing summer grain crops cultivars in various localities *a priori* and thus reduce information asymmetries between farmers and producers of seed with regards to seed performance. In turn, farmers use this information for seed selection support. In its absence, it is highly unlikely that farmers would be able to make informed decisions regarding which seed to procure and plant in their localities. As well, the alternative of not having access to the information produced by the trials would be costly to farmers.

2.1 Evaluating the adaptability of cultivars

In the national cultivar trials, varietal and environmental influences of a given cultivar's performance are expressed using the additive mean effects and multiplicative interaction (AMMI) model. The AMMI model provides a statistical measure of the adaptability and stability of different genotypes for different environments. The model calculates the genotype + genotype x environment interaction (GGE), the adaptation of the genotypes to environments using a GGE bi-plot and the stability of a genotype over a wide range of environments using a technique called the principal component interaction analysis (PCA). The PCA score is expressed graphically in a two dimensional scatter gram of PCA 1 (along the x – axis) and PCA 2 (along the y-axis). The greater the absolute value of the PCA score, the more specifically adapted a genotype is to a particular environment. A genotype that is stable over all the environments covered by the trials for a particular crop is denoted by a PCA score which is closer to, or is zero in all environments.

Through the use of a variety of variables, the AMMI analyses helps increase the accuracy of data patterns which makes the genotype-environment interactions more evident. To assess the stability of a genotype over all environments, the AMMI Stability Value (ASV) is used. The ASV is denoted by the distance from zero in a two dimensional scatter-gram of PCA 1 and PCA 2 scores. A genotype is considered more stable for an environment if the ASV score is, or nears, zero. Cultivars are then ranked based on their scores (which focuses mainly on yield) and the lower the ASV score of a cultivar relative to other cultivars in a locality, the better the ranking of that cultivar. The information is then disseminated to farmers using multiple platforms. Farmers supposedly select a cultivar from the top four ranked cultivars in a locality as opposed to subjectively selecting from all the available cultivars in South Africa.

3. ESTIMATING THE FARM-LEVEL BENEFITS OF THE NATIONAL CULTIVAR TRIALS

The preceding discussion shows that the farm-level benefits of the trials are found through farmers being able to identify a cultivar or cultivars from the top four cultivars that are adapted on their environments. Given that the actual yield benefits of a given cultivar are found in the seed (germplasm effect) and transferred to the farmer through the choice of seed – a process that is aided by the national cultivar trials-, to estimate the proportion of yield gain attributable to the trials, this study draws from Pardey, Alston, Chang-Kang, Magalhaes and Vosti (2004) in their study of assessing the benefits of varietal improvement in Brazil. As suggested by Pardey *et al.* (2004), this study assumes that the total gross annual research benefits (GARBs) attributable to the trials are roughly equivalent to a proportion of the value of the additional output attributable to crop breeding research (CBR), measured by the value of production (PQ) and the proportional gain in yield (k) (k -shift) associated with the adoption of the information provided by the trials. Such that:

$$GARB = kPQ \quad 1.$$

However, using equation one as it is could overstate the benefits of the trials since yield is influenced by a variety of factors. Second, noting that it is generally difficult to isolate the exact contribution of seed

choice on yield; to specify the contribution of seed choice on yield the study draws from Morris (2002) who uses a procedure that estimates economic benefits generated by an agR&D initiative under a range of plausible yield gain estimates (α). Such that equation 1 is rewritten as:

$$GARB = \alpha k P Q \quad 2,$$

where α denotes the assumed plausible yield gain estimate attributable to the trials. Using the advice of plant breeders at the GCI, α is estimated subjectively to range anywhere between 5 and 10 percent of the total yield gain benefits. These percentages are in no way accurate, however, they assist in attaching a monetary value to the benefits generated by the trials for the four summer grain crops considered in this study and provide useful insights in answering the question of whether or not the use of public funds to evaluate cultivars has provided any benefits to farmers and South Africa. To estimate the total benefits B_{it} attributable to the trials in locality l in year t , the k -shift and the plausible yield gain estimates are used as follows (Pardey *et al.*, 2004: 25):

$$B_{it} = \alpha k_{it} P_t Q_{it} \quad 3,$$

where P is the price of output, Q the quantity produced and α is as defined in equation 2. The k shift at locality l at time t for crop c for all the crops C considered in this study is obtained by:

$$k_{c|t} = \left(\frac{Y_{c|t}^a - Y_{c|t}^b}{Y_{c|t}^a} \right) \quad 4,$$

where $Y_{c|t}^a$ represents the experimental yield index of crop c in locality l at time t after the institution of the trials for all the crops C considered in this study (average yield of only the top four ranked cultivars in a locality), $Y_{c|t}^b$ represents an index of experimental yields for crop c at locality l at time t in the absence of the cultivar evaluation trials (average yield of all the cultivars evaluated in a locality). Experimental yields are used because “many of the variables that influence yields are deliberately held constant, a practice that helps to isolate the effect[s] of the ... [chosen cultivars]” (Pardey *et al.*, 2004: 24).

However, since experimental yields tend to be significantly higher than average commercial yields, this study assumes that the rate of change in commercial yields attributable to adopting the information derived from the trials is proportional to the rate of change in experimental yields attributable to adopting a cultivar from the best four cultivars in a locality. The rationale is that in the absence of the trials, farmers were going to select any cultivar from the commercially available cultivars in their localities based on formal and informal farmer information channels. The trials closed that gap by providing cultivar performance information to farmers. The estimate of k in equation 4 can be used to quantify the proportional decrease in production had the national cultivar trials been not instituted (or in the counterfactual scenario) given the actual scenario of improved production due to increased rate of adoption of high yielding cultivars as a result of the trials, all other things constant. Indeed, by simply multiplying the proportional decrease in production by the actual value of production gives a value of production forgone (Pardey *et al.*, 2004) had farmers continued to speculate about which seed to procure and plant.

3.1 Costs

To evaluate different cultivars for the four crops considered in this study, the ARC incurs costs. These costs range from simple costs such as costs of travelling to trial sites including subsistence and traveling allowances for researchers and technicians, equipment costs, chemicals, and fertilisers etc. Other costs include stationary costs, printing, data analysis, cultivar evaluation committee meetings, and office costs. To quantify the cost of conducting the trials, the study uses both the direct and indirect costs incurred in the evaluation of cultivars. These include labour costs, capital costs and operational costs.

- Labour costs

Labour costs are by far the most important costs incurred when conducting the trials. The labour requirements of the trials are activity-specific: there are researchers, technicians and support staff. Through a record of all staff involved in the trials, the study established the number of personnel at different levels of qualifications who conducted the different activities of the trials and the proportion of time each spent on the trials. These were then summed up to obtain the total labour costs involved in conducting the trials for each crop.

- Operational costs

Operational costs are the costs of activities conducted in the trials excluding labour. They include the costs of inputs (such as fertilisers), chemicals (field and laboratory), energy costs (electricity and fuel) and other kinds of supplies necessary to conduct the trials. A time series of operational costs was developed using data from the GCI and other forms of data mined from the DAFF and from other sources. This made it possible to generate an estimate of the operational costs connected directly to the national cultivar trials for each of the years and crops considered in this study.

- Capital costs

Capital expenditures relate to the purchase or rental of items that last longer than a year. To conduct the trials, the ARC needs various classes of capital which include land, machinery and equipment, furniture, computers, vehicles, buildings, depreciation costs, and interest charges for past capital investments. Drawing from Alston *et al.* (1995) and Pardey *et al.* (2004), a risk-free discount rate is used.

4. DATA

The study uses experimental yields to quantify the economic benefits of the national cultivar trials. Experimental yields data for dry bean, sorghum, sunflower and soybean were obtained from past publications of the trials for the different crops in South Africa. Salary and expenditure data from 1992 to 2012 was obtained from the ARC-GCI whilst from 1978 to 1991 it was estimated using various data sourced from the Department of Agriculture, Forestry and Fisheries' (DAFF) library. To quantify the costs of conducting the trials incurred by seed companies in the localities that they oversee, it was assumed that these

costs are equivalent to those incurred by the ARC in a locality. Care was taken to differentiate localities that have traditionally been operated by seed companies and co-conspirators in the trials from those that have traditionally been a responsibility of the ARC. Note that even these trials are monitored by the ARC. In cases where ARC shared responsibility with co-conspirators, costs were divided equally.

4.1 Adoption rates and efficiency measures

The adoption curve for modern varieties of sorghum, dry beans, sunflower and soybeans are assumed, as suggested by Alston *et al.* (1995), to follow a sigmoidal function and the relationship is shown by the following equation:

$$f_t = \frac{1}{1 + \exp(-a + bT)} \quad 5,$$

where, a and b are parameters that are functions of the initial rate of adoption (x) and the time (T) it took to reach the maximum or ceiling rate of adoption (Z). Diffusion of different cultivars differ from one locality to the other, however, the maximum area planted to modern varieties of the four crops considered in this study was assumed to be 75%. This assumption is based on estimations by Laubscher (1970) and Gevers (1988) which revealed that the sale of modern varieties struggled to gain traction in South Africa, so much that the commercial area planted to hybrid maize only reached 70% in 1970 after 21 years since the introduction of the first successful hybrid, the Kansas line K64 (Gevers, 1988: 8). The adoption of other summer grains was behind that of maize and had not reached more than 50%. Similarly, SANSOR (2005) shows that farmers used farm saved seed and that it varied between 0% for sorghum and sunflower to 35% and 65% for dry bean and soybean, respectively. Other baseline values of the parameters used are shown on Table 1.

Table 1. Values of parameters used in calculating adoption rates and economic value of benefits

Parameter	Value	Unit
Adoption ceiling (Z)	75	%
Initial rate of adoption (x)	50	%
Number of years to full adoption (T)	10	years
Discount rate (C)	7.8	%
Reinvestment rate (δ)	10	%
Plausible yield gain estimate attributable to the trials (α)	5 - 10	%

Source: own elaboration

To quantify the rate of return to investments made in the trials, the applicable discount rate used is the annual rate of return on the long-term government bond because it reflects the long-term opportunity cost of public capital. A discount rate of 7.8% is used given that in 2012 the South African Government's 10 year Treasury bond was 7.8%. A reinvestment rate of 10% is assumed for the purposes of quantifying the modified internal rate of return (MIRR), which is the rate of return that makes the future value (FV – positive cash flow, δ^r) equivalent to the negative of present value (PV – negative cash flow, δ^c) (see Rao *et al.*,

2012). These discount rates are also subjected to a sensitivity analysis to indicate the likely changes in benefits under different rates.

5. RESULTS AND DISCUSSIONS

The results of the analysis at different rates of assumed plausible yield gain estimates attributable to the national cultivar trials are presented in Table 2. Taking the applicable plausible yield gain estimate attributable to the cultivar trials to be 5%, enhanced capabilities of farmers to select a cultivar from the top four cultivars in a locality generated additional yield benefits equal to 13.1 kg per ha per year for sunflower, 17.1 kg per ha per year for dry beans, 16.4 kg per ha per year for soybeans and 7.7 kg per ha per year for sorghum. These yield benefits represent an estimate of the yield losses that were averted through farmers being able to select an appropriate cultivar for their localities at the 5% level and increase as the plausible yield gain estimates are increased. These are significant benefits. For illustrative purposes, consider a commercial farmer producing sunflower on a 1000 ha farm. The extra yield that accrues to the farmer by being able to select adapted sunflower cultivars on the environment would be equal to 13.1tons. As the assumed plausible yield gain estimates are increased, so do the incremental gains in yield attributable to the trials. Perhaps, what is worth noting here is that the benefits could still be higher than 10kg/ha/year for most of the crops even at a yield gain estimate of 2.5% except for sorghum which would return about 5kg/ha/year.

Table 2. Yield gain benefits attributable to the national trials

Crop	Years of trials	Assumed Plausible Yield Gain Estimate (Kg/ha/year)		
		5%	7.5%	10%
Sunflower	1977 - 2012	13.10	16.38	19.65
Dry beans	1978 - 2012	17.13	21.41	25.69
Soybeans	1978 - 2012	16.42	20.53	24.63
Sorghum	1977 - 2012	7.67	9.59	11.50

Source: own elaboration

In monetary terms, the yield gain benefits generated through farmers being able to select the appropriate cultivar in their localities are shown in Table 3. At the 5% level of assumed plausible yield gain estimate attributable to the trials, the benefits attributable to the national cultivar trials for all the four crops equal to R200 million (in 2012 currency values) in present value terms during the period 1978 to 2012. These benefits are equivalent to 4% of the total value of production of sorghum, dry beans, sunflower and soybeans in 2012. Of these benefits, about R23.2 million came from the evaluation of sunflower cultivars, R84.7 million from dry beans, R85. 7 million from soybeans and R6.6 million from the evaluation of sorghum cultivars. The results in Table 3 also represents an estimate of the value of production that would have been forgone had farmers continued to speculate on which seed to plant for the different crops in South Africa. Again, for illustrative purposes, consider the sunflower farmer who produces sunflower on a 1000 ha farm, who before the introduction of the trials speculated on which seed to plant. The value of production at an additional yield gain benefit of 13.1tons attributable to selecting an appropriate cultivar is equal to about R57 thousand. Note that the estimates in Table 3 are based on the maximum adoption rate of 75%. For some of the crops such as sorghum and sunflower, the maximum adoption rate assumed in this study could lead to

an under estimate of the value of benefits whilst for soybean and dry bean, they could lead to an overestimate. During the analysis, the study dealt with this difficulty by trying out different adoption ceilings. This is considering that the adoption rates of cultivars also differ from one locality to another and given that data on the district level adoption of modern varieties is considered confidential by different seed companies in South Africa.

Table 3. Present value of benefits from the national cultivar trials in South Africa

Crop	Total benefits if national trials contributed (‘R Million)		
	5%	7.5%	10%
Sunflower	23.2	34.8	46.4
Dry beans	84.7	127.0	169.3
Soybeans	85.7	128.6	171.3
Sorghum	6.6	9.8	13.1
All crops	200 .1	300 .1	400.2

Source: own elaboration

Similarly, given that the contribution of seed choice to yield growth is unknown, this study recognizes that the benefits may either be underestimated or overestimated. For example, seed is an important component of crop production. Its diffusion however depends on the extent to which farmers know about the seed in relation to other cultivars in the market. Limited information on cultivar performance in a farmer locality may lead a farmer to select a cultivar that is less adapted in a locality in relation to other cultivars available on the market which could have an impinging effect on yield. For this reason, the use of a range of plausible yield gain estimates allows us to estimate the streams of benefits attributable to the information provided by the trials over a wide range of levels.

Table 4 presents the benefits that accrued to South Africa as a result of continued investments into the trials. These were calculated by dividing the present value of benefits presented on Table 3 by the cost of conducting the trials during the same period which yielded the benefit-cost (BC) ratio of investing in the national trials in South Africa. Table 4 shows that for every one rand invested in the national cultivar trials for sorghum, dry beans, sunflower and soybeans, R1.90 worth of benefits accrued to South Africa at the 5% level. These benefits increased to R2.85 and R3.80 at the 7.5 and 10% level, respectively. At the 5% level, sunflower returned R0.71 worth of benefits for every rand invested by the ARC in the trials, whilst R5.14, R4.95 and R0.52 accrued to the South African economy for every rand spent by the ARC in the dry bean, soybean and sorghum trials, respectively. As expected, the benefits improve as the assumed plausible yield gain estimates are increased from 5 to 7.5 then 10%. The benefit-cost ratios for sunflower and sorghum are lower most likely because of the effect of the implicit cost of capital used in conducting the trials and a lower value of production for these costs. As well, the experimental yield index for sorghum, in particular, show that the production of the crop coincided with a lot of production side difficulties such as bad weather which could have masked the benefits of the trials.

Table 4. Economic impacts of the benefits derived from conducting the national cultivar trials

Crop	Benefit-Cost ratio if cultivar trials contributed			MIRR
	5%	7.5%	10%	
Sunflower	0.71	1.07	1.42	17%
Dry beans	5.14	7.72	10.29	16%
Soybeans	4.95	7.42	9.90	33%
Sorghum	0.52	0.78	1.04	10%
All crops	1.90	2.85	3.80	17%

Source: Authors' own elaboration

The extreme right hand side of Table 4 also show that the overall rate of return to investments made in the national cultivar trials for sorghum, dry beans, sunflower and soybeans as measured by the MIRR is 16%. The rate of return differs for all the crops. Sorghum returned the lowest rate of return of 10%. The highest rate of return came from investments into the soybean (33%) cultivar trials, followed by sunflower (17%) whilst dry bean (16%) returned the second lowest MIRR during the period 1978 to 2012. The high rate of return for soybeans suggest that most of the benefits obtained were realized in the later years of the trials, after yields picked up owing to the introduction of transgenic varieties of soybean.

Generally, the foregoing analysis suggests that the use of public funds to evaluate summer grain crops' cultivars in South Africa has been a wise use of public funds by the ARC. However, a question remains whether or not a change in the discount rate and reinvestment rate would change the rates of return? The study conducted a sensitivity analysis of the results by changing the discount rates. This made it possible to assess the impact of different levels of the opportunity cost of capital on the rates of return. As can be seen in Table 5, increasing the discount rate (c) caused the MIRR for all the four crops to increase. The overall rate of return to investments made into the trials increased from 17 to 20% whilst soybeans continued to return the highest MIRR. On the other hand, decreasing the discount rates caused a decrease in the rates of return suggesting that they are sensitive to the changes in the opportunity cost of capital.

Table 5. Sensitivity analysis of rates of return to investments made in the trials

MIRR if	$c = 10,$ $\delta = 14$	$c = 5,$ $\delta = 7.5\%$
sunflower	20	16
beans	26	20
soybeans	35	32
Sorghum	13	8
All	20	16

Source: Authors' own elaboration

6. CONCLUSIONS

The results presented in this study indicate that the continued evaluation of cultivars for dry bean, sorghum, sunflower and soybean have produced significant yield benefits for farmers and substantial pay-offs for South Africa. The estimated yield loss averted by the trials range from 7.67 kg per ha per year for sorghum to 17.13 kg per ha per year for dry beans, at the 5% level of assumed plausible yield gain estimate attributable to the information provided by the trials. The economic benefits associated with the information derived from the trials are equally significant. They range from R6.6 million for sorghum to R85.7 million (in 2012 currency values) for soybeans, at the 5% level. Collectively, the continued evaluation of the four

crops in South Africa returned benefits that are equivalent to R200 million in 2012 currency values. These are substantial benefits that are equivalent to about 4% of the total value of production for these crops in 2012, which could have been lost had the programme been not started. The benefit-cost ratio estimates the economic impacts of the national cultivar at R1.90 for every unit of investment made by the ARC in the trials for the four crops. These benefits have accrued to farmers in the form of increased yields; to industry in the form of increased grains outputs and have led to an increase in processed industrial outputs of these crops and to South Africa through a decrease in imports for such crops. The decrease in imports is equivalent to the amount of yield losses that have been averted by the trials. There are also benefits that have accrued to consumers. The rate of return shows that investing in the evaluation of trials in South Africa has generated attractive benefits to South Africa. The greatest benefits came from the evaluation of soybean cultivars whilst sorghum returns the lowest social benefits.

Currently, the trials cover a variety of localities in the summer grains producing environments in South Africa. However, given the variations in environmental and climatic conditions, especially the existence of micro-climates in South Africa, the trials are still considered limited in their reach. There is further scope to increase the capacity of farmers to select highly adapted cultivars in their environments. Since the trials generate multi-locational data on the adaptability of varieties over a variety of environments, introducing information technology platforms that could make it easier for farmers to assess the suitability of different cultivars in their environments by just uploading the environmental properties of their farm into the platform could go a long way in enhancing the seed selection capabilities of farmers.

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