African Journal of Agricultural Research Vol. 7(27), pp. 3898-3905, 17 July, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1023
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

The Impact of contaminated fertilizer on pineapple growers in the Eastern Cape, South Africa

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Accepted 18 May, 2012

A framework has been established to determine the economic impact of contaminated fertilizer on pineapple growers in the Eastern Cape. Farmers in the region unwittingly made use of contaminated fertilizer which infected pineapples with higher than permissible levels of the heavy metal toxin, cadmium. The fruit was deemed unfit for use, translating into large financial losses for growers and influencing all participants in the industry. The pineapple trade was devastated. Pineapple production costs and revenues are adapted from previous studies as much of the necessary data was *sub judice* because of the pending legal action. Despite the problems with data, it was established that the farming operations were severely compromised because of the contamination.

Key words: Cadmium, fertilizer, crop contamination, pineapple, Eastern Cape.

INTRODUCTION

The agricultural sector plays an important role in the growth of the South African economy. Although the sector has a relatively small share in GDP (2.5% in 2010), it is a key contributor to growth. This is apparent when considering that the sector is a major provider of employment and a solid earner of foreign exchange (Vink and Kirsten, 2003). The sector is also important since it has strong ties with the manufacturing sector, providing it with raw materials and being reliant on manufactured goods (Directorate of Agriculture, 2010a: 6). As would be expected, many of these features of the agricultural sector can be attributed to the role of commercial farming in the country. A negative impact on a commercial farming operation, or industry, is thus likely to have major effects on the economic contribution of agriculture in South Africa. Crop contamination arising from a pollutant being present in the farming environment is an example of a negative impact.

A recent incident of this nature occurred in the Eastern Cape where pineapple growers in the region unwittingly made use of a contaminated fertilizer. Because of the use of the zinc-phosphate fertilizer, pineapples were infected with higher than maximum permissible levels of the heavy metal toxin, cadmium (Cd). There are many implications for the pineapple industry in the Eastern Cape. Large crop losses translated into financial loss for growers, processors, transporters, distributors and others. The costs of these crop losses are increased when the related costs of investigations, regulation, insurance and litigation are added (Pimentel, 2005: 239).

Further losses were realised when canned pineapples due for export were rejected and creditability among sensitive export markets was damaged. The contamination also had severe effects on the market structure of the industry. Growers were forced to reduce the size of their pineapple crop while many had to terminate their pineapple operations altogether and explore other uses for their land. In extreme cases, some farms were forced to shut down (Burgess, 2007).

The impacts of contaminated fertilizer on the pineapple industry in the Eastern Cape have been briefly highlighted and appear to be significant. The valuation of affects on all participants in the industry is necessary to quantify the total impact of the incident on the industry. In this study, the economic impacts on pineapple growers will be explored, in isolation from other participants in the industry.

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This paper aims to establish a framework that can estimate the economic impact of the use of cadmium-laced fertilizer on pineapple growers in the region. Pineapple production costs and revenues are estimated from previous cost of production studies.

Pineapple farmers in the Eastern Cape first utilized the contaminated fertilizer in 2004. The fertilizer was sourced in China, and sold locally by a local fertilizer company (Cobbett, 2007). The incident caused the industry a major setback; influencing around 40 farmers, disturbing over 2 000 ha of planted pineapples and placing 2 700 jobs at risk (Sparg, 2009). A further 35 000 people that derive a level of dependence from the industry were also affected negatively (Keetch, 2000: 7).

The contamination was first detected in an exported consignment of canned pineapples in Switzerland in November 2006. It was only at this stage that the fertilizer was identified as being the source of the toxin, and that use of the fertilizer ceased. The product was found to exceed the European Union (EU) permissible Cd level of 0.05 parts per million (ppm) (Morris, 2007a). Much damage was done among this premium export market, and all growers had their EU certification withdrawn. Pineapple processors searched for other export markets that would accept the contaminated produce, but these markets were only interested in price, not quality. Many of these efforts failed and crops were left to rot (Gosling, 2007).

Growers suffered massive financial losses as they could only utilize small percentages of their total crop. There is also the high cost of having to rehabilitate the soil, a process that is still ongoing. It is estimated that this procedure could cost up to R 60 million and take more than five years to fully rehabilitate the land (Hayward, 2008).

Summerpride Foods Ltd. in East London is South Africa's only pineapple processing plant. The ownership of this factory is vested in the pineapple growers and a few people close to the industry, which means that they are vertically integrated (Keetch, 2000). The factory previously produced canned pineapple chunks and rings, but now, only the production of juice remains viable (Summerpride Foods, 2008). The juicing process is able to dilute the levels of Cd, which makes it suitable for human consumption. Raw fruit used for juicing earns growers, on average, 20% less per ton than what was realised for canning and thus reducing farming profits (Burgess, 2007: 40).

The processing factory was forced to lay off 500 of its workers. Prior to 2007, the industry consistently harvested 140 000 tons of raw fruit. In 2009, only 93 000 tons could be harvested and 77 000 tons are projected for 2010 (Sparg, 2009), which will affect the amount of seasonal labour employed and a loss of income to these workers and also a reduction of income to the processing factory.

The industry lost most of its market, which previously accounted for 3% of the world's production of canned pineapples. This may seem inconsequential but is a major contributor to the economy of the Eastern Cape (Keetch, 2000: 7). Prior to the contamination, Summerpride processed 75% of South African pineapples, and supplied 90% of canned pineapples consumed in South Africa (Hayward, 2008).

Summerpride Foods Ltd., and the Pineapple Growers Association (PGA), are jointly in an ongoing legal battle with the fertilizer company. The PGA represents all pineapple growers in the region. The company has allegedly been sued for R 100 million in damages to the industry (Hayward, 2008). The R 100 million is believed to be conservative, and will be enough only to kick-start the industry. The amount is being constantly revised by auditors KPMG. In their 2009 annual report, the company acknowledges the claim from the pineapple industry, although an amount is not specified (Protea Chemicals, 2009: 13). The investigation being conducted by the Department of Agriculture is believed to be resolved in the near future (Hayward, 2008).

To-date, government has contributed R 12 million to enable stressed pineapple growers to continue farming (Sherry, 2010). The Eastern Cape Development Corporation (ECDC) has granted a further R 28 million to the pineapple industry in an attempt to facilitate rejuvenation of the industry.

A R 700 million project is also underway, which will reinvent the ailing industry (Sherry, 2010). The ECDC, Ndlambe Natural Industrial Products and the Eastern Cape Government have invested in the project. The turnaround strategy involves the creation of industry sub-sectors in pharmaceutical, nutraceutical and biotechnological products (Sherry, 2010). The project is currently in its first phase, which involves the entire relocation of the industry from East London to Bathurst. This will save growers about R 8 to 10 million per year in transport costs and bring new jobs to the area beset by 75% unemployment (Sherry, 2010).

LITERATURE REVIEW

Cadmium (Cd) is a trace element, required by humans in small doses, but is highly toxic in large amounts (Friberg et al., 1971: 400). When Cd is present in soils and water, there is the obvious danger that the metal is absorbed by the roots of plants. Cadmium is then well established in the food chains of both humans and animals (Dudka et al., 1996: 181). The extent of the plant uptake of heavy metals is influenced by various factors unique to the environment and the condition of the plants (Koeppe, 1977: 198).

Cadmium's toxicity has stimulated much legislation regarding the restriction of its use. This effort has been especially prominent in the EU (Tolcin, 2009: 37). Incidences of contamination of food have become increasingly frequent, raising questions about their human health and economic consequences (Smith et al., 1998: 513). According to Jonsson et al. (2001: 91), the implementation of restrictive legislation has helped to reduce Cd emissions since the 1970s; although Prasad (1995: 525) shows that the production and usage of Cd would continue unless non-hazardous substitutes are found.

Many countries still need to enforce restrictions on heavy metals (Bonnieux et al., 1998: 275). In South Africa, there is currently no legal limit to the amount of toxic heavy metals allowed in agricultural products (Morris, 2007b). The Department of Agriculture recognizes that the Feeds and Fertilizer Act of 1947 is outdated in some areas, and attempts to make improvements are in progress (Morris, 2007b).

The fact that the legislation is outdated in some countries means that parties affected by the use of contaminated fertilizers, feeds, or pesticides may find it difficult to claim damages from guilty suppliers of the substandard products. The user of the contaminated chemicals is thus left to bear the costs, which will ultimately be passed onto the consumer (Morris, 2007b).

Cd is an example of a pollutant that is able to influence the environment. It is clear that pollution in the environment poses a great challenge to modern society. It is important to realize the extent of associated consequences of pollution in the environment and that economic impacts are just one of these consequences (Nriagu, 1981: 1071).

Contamination in agriculture

The main purpose of chemical application in agriculture is to improve the conditions of the soil (through use of fertilizers), or to protect crops from diseases and pests (through use of pesticides) (Gimeno-Garcia et al., 1996: 19).

Chemical manufacturers have been known to minimize the purification process of production in order to decrease production costs and improve financial gains (Gimeno-Garcia et al., 1996: 19). This can lead to chemicals containing impurities and result in soil contamination. Metal contamination of soils presents a major cause for concern due to the adverse affects that are borne by the environment and the corresponding economic impacts (Dudka et al., 1996: 181).

Fertilizers in farming operations are applied to soils with the aim to increase crop yields. This can be reversed when incorrect dosages are applied and when excessive fertilizer residue accumulates on crops, causing destruction of the harvest. Residues of fertilizer that persist in the soil can have implications for sensitive crops being planted in rotation; as well as for future crops of the same type (Pimentel, 2005: 239). This results in crop losses which affects all market participants. When growers have their produce contaminated, they are forced to accept a lower price or even dispose of their crop (Schmale and Munkvold, 2009: 344).

The indirect economic and environmental costs associated with the use of these chemicals are often overlooked (Pimentel, 2005: 230). These costs need to be measured to improve the development and implementation of policies pertaining to the optimal use of chemicals in agriculture. There is a great need for an appropriate analysis that can achieve this, especially since there are limited papers that exist on this subject (Pimentel, 2005: 230). They illustrate that data on crop losses due to chemical use in agriculture are difficult to obtain. The reason for this is that many losses are not reported to government authorities because injured parties often settle privately (Pimentel et al., 1992: 755).

Since most infected crops above tolerance levels are neither detected nor destroyed, they are consumed by the public, implying that farmers avoid huge financial loss. Economic costs of food contamination would be much higher if the testing of foodstuffs were more efficient (Pimentel et al., 1992: 755).

Economic incentives and potential benefits to reduce pollution

It is generally accepted that policies attempting to fully eliminate pollution would not maximize general welfare (Bonnieux et al., 1998: 275). Pimentel (2005) undertook a comprehensive analysis of the environmental and economic costs of pesticide application in the US. From a pure cost/benefit approach, the study showed the use of pesticides is beneficial (Pimentel, 2005: 230).

The trade-off between the damages resulting from pollution and the resources required to reduce the pollution (abatement costs), is of important consideration with all pollution control decisions (Bonnieux et al., 1998: 276). The ‘optimal’ level of pollution is the level where marginal damages are equal to marginal abatement costs (Clites et al., 1991: 218).

Improvements and degradation of the environment can have many impacts. Degradation of soils can reduce agricultural activity, creating shifts in supply and demand of certain commodities and decrease consumer and producer surpluses (Bonnieux et al., 1998: 283). Soil rehabilitation leads to direct and indirect benefits. Directly, humans can gain from on-site benefits such as increased agricultural productivity. Indirectly, the link between soil and water quality provide off-site benefits through support to related economic activities and to the functioning of the ecosystem (Bonnieux et al., 1998: 281).

The efficient level of restoration of damaged soils is an important aspect of the economic impact of a pollutant. The economic costs of a pollutant entering the environment are a) costs of rehabilitation of the resource and b) costs associated with lost service flows. A trade-off with the restoration effort exists between the costs of clean up, and limiting the losses in service of natural resources (Bonnieux et al., 1998: 283).

Methods of calculating costs of soil restoration can be those based on cost estimation or on lost use valuation methods (Bonnieux et al., 1998: 283). Benefit valuation is a topic considered more difficult. The factor income method and damage function methods are appropriate for measuring restoration benefits (Bonnieux et al., 1998: 283).

Valuation of natural resources

The efficient use of natural resources is essential for social and economic development (Lutz and Munasinghe, 1994: 37). The accurate valuation of natural resources is an important task, since the outcomes of such projects can help determine the impacts of an externality on these resources.

Lutz and Munasinghe (1994: 37) view cost-benefit analyses, and variations thereof, as most suitable for such valuation projects. These types of analyses are applicable when impacts are clear and direct; such is generally the case in agriculture (Van Rooyen et al., 2004: 348). Various types of economic impact assessment methods must often be combined to form an integrated model, which is sometimes necessary to create the most efficient assessment method (Lindhjem et al., 2007: 2). The generalized formula for impact assessment is to calculate the net outcomes of the event; the outcomes which are attributable to the occurrence of the incident, free of effects from other impacts (Van Rooyen et al., 2004: 337). When the effects from irrelevant factors are deducted from the gross outcome (the total change recorded), the net outcome can be determined (Van Rooyen et al., 2004: 337).

METHODOLOGY

The method of this study involves four steps: (a) estimation of pineapple production costs; (b) estimation of pineapple production returns; (c) estimation of a suitable framework to capture the costs to producers who used the contaminated fertilizer; and (d) incorporating the data obtained from affected farms in the region to test the suitability of the model.

Methodology established in a pineapple study conducted in Hawaii by Leon-Guerrero et al. (1994), was closely followed. In order to conduct an overall cost study, pineapple costs and revenues are calculated in terms of unit costs. Costs and revenues are derived as a unit cost of Rands per hectare (R/ha), and calculated on an annual basis to provide a comparable time reference (Leon-Guerrero et al., 1994: 95).

The summary of costs and revenues are shown in Table 1. The table shows operating costs for a cycle of pineapple production, prior to pineapple contamination occurring. Table 2 shows the operating costs of the same cycle of production, subsequent to crop contamination occurring. Table 2 incorporates the impacts of the contamination into farming costs.

The costs and revenues are computed according to the gross margin, which is the value of output from one hectare less the cost of allocatable variable inputs required to produce that output (Romero et al., 1987: 79). Data relating to capital costs and fixed costs of production are therefore excluded. It can be seen that only after two years will the first profit be realized. Pineapple production costs and revenues are estimated from a previous study carried out by the Cacadu District Municipality (CDM) in 2006. The CDM report outlines a potential budget for a pineapple enterprise, and is based on a classic example. The CDM report is applicable for this study since pineapples in the province are grown almost exclusively in the Cacadu region (Cacadu, 2006).

Within the CDM, pineapples take approximately 12 to 18 months to flower after planting has taken place. The first crop is harvested 18 to 24 months after planting. Since the growth of the pineapple fruit declines with each year of the plant life, commercial pineapples are generally grown in the region according to a two-year crop cycle that produces one harvest (Cacadu, 2006). A pineapple plant produces fruit once in its lifetime and dies thereafter. The Cayenne and the Queen pineapple are the two varieties of pineapple grown in the province. The two pineapples require differing farming methods and procurement, and fetch varying prices on markets (Cacadu, 2006). The Cayenne is more popularly grown and for the purposes of this study, it will be assumed that only this variety is grown by farmers.

Estimation of pineapple production costs

Pineapple production costs include normal overhead costs for growing pineapple in the region. The quantities and varieties of fertilizers and pesticides will differ for conditions relevant to each pineapple field. Furthermore, farming techniques are likely to be unique for each farmer. For the purposes of this study, these factors will be considered constant, and we will assume farming practices and the applications of farming chemicals are the same throughout the region.

Rainfall, soil and climatic conditions will also influence crop yields. These will also be held constant. The industry standard of 1 ha producing on average 30 tons of pineapples will be used. Production costs include materials and labour for pre-planting operations and harvesting. Pre-planting costs of applying fertilizer and pesticides are considered. The preparation of the land, which involves grading and the formation of contoured growing beds, are assumed established from previous crop cycles, and these costs will therefore be excluded. Detailed data on the costs associated with legal proceedings, investigations and insurance were not attainable, and are similarly excluded from analysis.

Soil rehabilitation costs are highly variable. This is due to various factors unique to the soil influencing the extent of the contamination (Koeppe, 1977: 198). It is assumed that each hectare land was contaminated to the same extent and required the same level of restoration effort. R 60 million was given as a rough estimate by the PGA, which would be the total cost of rehabilitating all contaminated soils in the region (Sparg, 2009). According to Sparg (2009), around 2 000 ha of pineapple lands and thus soil were disturbed. This provides an estimated unit cost of R 30 000/ha for full restoration of the soil. Since soil rehabilitation is an ongoing process, these costs will be distributed over a scale of five years. The full rehabilitation cost per hectare equates to R 6 000 per year, for five years.

Costs of harvesting include packaging, transport and casual labour costs. 4 500 boxes are needed per hectare and transport costs are R 60 per ton. The added weight of boxes and other factors increases the total weight of goods transported to 36 tons per hectare (Cacudu, 2006).

Estimation of pineapple production returns

Growers receive various prices for their produce depending on the

Table 1. Years 1 and 2 operating costs prior to contamination.

Activity	Price per unit (R)	Qty.	Per ha (R)
Year 1			
Gross income			0
Product income: Pineapples sold	0	0	0
Direct Variable costs			16 204.67
Pre harvest costs:			16 204.67
Granular fertilizer:			
ASN 27% (ton)	2 075.00	0.8	1 660.00
KCI (ton)	2 395.60	0.3	718.68
Urea (46) (ton)	3 100.00	0.15	465.00
AMP (20) + 0.5% Zn (ton)	2 375.00	0.2	475.00
Potassium sulphate (ton)	5 437.80	0.7	3 806.46
Lime and manure:			
Dolomite lime (ton)	600.00	3.5	2 100.00
Weed control: Chemicals:			
Dluron 500 SC (litre)	49.99	4	199.96
Gesapax (litre)	25.77	10	257.70
Pest control: Chemicals			
EDB Fumigation (litre)	34.79	80	2 783.20
Malathion (kg)	0.54	0.13	0.07
Methyl bromide (kg)	47.10	6	282.60
Casual labour			3 456.00
Gross margin above variable cost			-16 204.67
	Year 2		
Gross income			99 912.00
Product income: Pineapple sales	3 330.40	30	99 912.00
Direct Variable costs			27 191.36
Pre harvest costs:			4 601.36
Fertilizer			
Granular fertilizer:			
Urea (46) (ton)	3 100.00	0.05	155.00
Hormones/Minerals:			
Ethrel (litre)	67.84	4	271.36
Swelpine (litre)	265.00	2	530.00
Casual labour			3 645.00
Harvest cost			22 590.00
Packaging: Pineapples box (each)	3.64	4500	16 380.00
Transport (ton)	60.00	36	2 160.00
Casual labour			4 050.00
Gross margin above variable costs			72 720.64
Total gross margin after 2 years			56 515.97

Cacadu (2006).

quality of their fruit. For the purposes of this study, we assume that quality of the fruit is constant and farmers in the region receive the same price.

According to the Directorate of Agriculture's Abstract of Agricultural Statistics (2010b: 50), the average price on the local market for pineapples over the past six years is R 3 340.40 per ton. Importantly, infected fruit that was only suitable for juicing earned farmers on average, 20% less per ton than what could normally be realised (Burgess, 2007: 40). The opportunity cost in this case is the difference between the price producers actually earned, and the price they would have earned otherwise for their fruit.

The export price for processed fruit will not be considered as this has no direct influence on farmers, and relates only to pineapple processors. Many tons of fruit were neither suitable for canning nor juicing and were left to rot in the fields (Sparg, 2009). The opportunity cost of not receiving any income for spoiled produce at

Table 2. Year 1 and 2 operating costs after contamination.

Activity	Price per unit (R)	Qty	Per ha (R)
Year 1			
Gross income			0
Product income: Pineapples sold	0	0	0
Direct variable costs			16 204.67
Pre harvest cost			16 204.67
Gross margin above variable costs			-16 204.67
Year 2			
Gross income			55 938.72
Product income: Pineapples sold as fresh produce (15%) (ton)	3 330.40	4.5	14 986.80
Product income: Pineapples sold for canning (25%) (tons)	3 330.40	7.5	24 978.00
Product income: Pineapples sold for juicing (20%) (ton)	2 662.32	6	15 973.92
Direct variable costs			29 591.36
Pre harvest costs			4 601.36
Harvest cost			22 590.00
Packaging: Pineapples box (each)	3.64	4 500	16 380.00
Transport (ton)	60.00	36	2 160.00
Casual labour			4 050.00
Rehabilitation cost (40%) (hectare)	6 000.00	0.40	2 400.00
Gross margin above variable costs			26 347.36
Total gross margin after 2 years			10 142.69

CDM (2006).

the prevailing market price for pineapples will be computed. Table 2 shows the classic example of pineapple costs and revenues subsequent to contamination. Table 2 is a concise version of Table 1. The details relating to the quantities of chemicals are omitted, but are the same as reflected in Table 1.

As the actual figures were not available due to the *sub judice* nature of the case, estimates of the effect of the contamination were obtained from a member of the Pineapple Growers Association. The estimate was made that, of the total 30 tons produced per hectare, only 15% and 25% were uncontaminated and could be sold as fresh produce and for canning respectively. Furthermore, 20% of crops per hectare were partially contaminated and appropriate for juicing. The remaining 40% of the fruit which is assumed to be heavily contaminated is unable to be utilized and, accordingly, earns growers zero income. In practice, these weights would be different for each farm, with further variation from hectare to hectare. The figures in Table 2 are therefore based on a hypothetical case. This will provide an indication of the net impact per grower, as a consequence of the use of the contaminated fertilizer.

Finally, we postulate that a conservative 40% of land per hectare requires rehabilitation at the cost previously established. R 6 000/ha is the annual cost to fully rehabilitate the soil. It is estimated that only 40% of land per hectare will require treatment. The derived cost of soil rehabilitation is therefore R 2 400/ha.

RESULTS AND DISCUSSION

As a result of the on-going law suit between the fertilizer supplier and members of the pineapple industry, participants to the case are forbidden to release any information that relates to the cadmium saga. Summerpride Foods Ltd. was thus unable to provide any records which relate to the growers that supply them with raw fruit. It therefore became impossible to obtain data on actual prices paid to farmers. All pineapple growers in the region are affiliated to the PGA, and were also prohibited to speak on the issue. It was hoped that a sanction could be obtained from the PGA allowing a few growers to provide information relating to the impact of use of contaminated fertilizer on their farms. This sanction was not granted.

Since data was not available from the principle industry of the Eastern Cape, operating costs and revenues of pineapple production were obtained from a previous study. Although the CDM study does not use the current data, it is the best information available.

Input costs before and after contamination occurred are computed on the same basis. In Tables 1 and 2, direct allocatable variable costs for the first year amounted to R 16 204.67. This is the pre-harvest cost of nurturing the fruit. Since no pineapples are produced in this first period, a loss after year one of R 16 204.67/ha is recorded. Pre-harvest and harvest costs for the second year of production, in both scenarios, are equal at R 27 191.36/ha. For post contamination, rehabilitation expenses of R 2 400/ha were added to the direct variable cost, which raised the figure to R 29 591.36/ha.

Prior to contamination, gross income from sales amounts to R 99 912.00/ha, with gross margin earned for year two at approximately R 72 720.64/ha. Preceding contamination, total gross margin earned over the two years of production was R56 515.00/ha.

Following contamination, gross income from sales declines to R 55 938.72/ha, a direct loss of R 43 973.28/ha due to a decline in production and quality of the fruit. This is attributed to 40% of the crop not being usable, and comes to a direct loss of R 39 964.80/ha. Furthermore, 20% of the crop was suitable for juicing, and was sold for a lower price at R 2 664.32/ton. Sales from fruit sold for juicing totaled R 15 973.92. The opportunity cost in this instance is the difference between the juicing price producers earned, and the price they would have earned otherwise for their fruit, which amounts to R 668.08/ton.

Incorporating the pre-harvest and harvesting costs, and the cost of soil rehabilitation, the gross margin earned from after contamination in year two is R 26 347.36/ha. Post contamination, gross margin earned for the second year, minus costs from year one equals around R 10 142.69/ha. This equates to a difference of R 40 373.28/ha than the profit earned prior to contamination.

With the approximation of 2 000 ha of pineapples being affected, it is estimated that the total cost of the use of cadmium fertilizer to farmers in the region amounts to R 40 373.28 × 2 000 = R 80 746 560.

Conclusion

The pineapple industry in the Eastern Cape suffered a major setback from the use of contaminated fertilizer. Increasing farming and input costs, volatile exchange rates and cyclical pricing have contributed to the decline of the industry over the years, but the cadmium issue has been the most devastating (Hayward, 2008). The industry plays an important role in the province's economy, and has recently received support from various parties in a bid to restore the pineapple trade. A R 700 million project spearheads to the revival effort. The ECDC, Ndlambe Natural Industrial Products and the Eastern Cape Government have invested in the project Hayward, 2008). These efforts to stimulate the industry illustrate its importance in the province.

Crop contamination in farming presents a major cause for concern due to the adverse effects that are borne by the environment and the corresponding economic impacts (Dudka et al., 1996: 181). Crop losses due to contamination translate into financial implications for all stakeholders in the industry. The pineapple industry and the economy cannot afford the loss of income and employment and strict measures need to be put in place to avoid the importation of contaminated fertilizer in the future. If the multiplier effects of the contamination are included the effect is even greater.

In this study, a framework was developed to determine the impact on pineapple growers in the region. Pineapple production costs and revenues were estimated from previous studies. Costs and revenues typical of growers before and after contamination were established, and the results from the two scenarios were compared. A variation in profits of R 40 373/ha for the two scenarios was estimated, which equates to a total loss of approximately R 80.7 million to growers in the region.

The pending court case made the collection of statistical data difficult. The unavailability of data from growers and processors entails that results provide an estimation of the impact of the contaminated fertilizer. The framework is considered appropriate to determine the impact of contaminated fertilizer per hectare, which can further be adapted to determine the net impact per grower.

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