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An Analysis of the Potential, Constraints and Strategies for Development of Marirangwe Farm (A Project of the Women's University in Africa)

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Authors' contributions

This work was carried out in collaboration between both authors. Author WMM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed the literature searches. Author GBN managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of the study was to conduct an analysis of the potential, constraints and strategies for development of Marirangwe Farm. Marirangwe Farm is a project of the Women's University in Africa (WUA) in Mashonaland East Province of Zimbabwe.
Place and Duration of Study: This case study was conducted in July 2014 in Zimbabwe.
Methodology: The methodology involved administering a questionnaire with structured and open-ended questions to key informants who are part of the management team at the farm.
Results: The following constitute formidable constraints to crop production activities: market availability; availability of suitable land for expansion of crop enterprises; high labour requirements for the crops cultivated; high cost of labour; poor soil structure and fertility; and shortage of rain at

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critical times of crop growth. The major constraints which inhibit the full realization of the potential for improving animal enterprises at Marirangwe Farm include unsuitable climate and physical environment for livestock production; and high insect, parasite and disease risk of the animals. The financial analysis revealed a negative Whole Farm Gross Margin of -$800.00 and a huge negative Whole Farm Profit of -$32,400.00 in the 2013/14 farming season. Partial Budget Analysis revealed that the viability of farm operations and proposed changes in the structure of enterprises depends on the relative prices of dairy milk to other livestock products. An analysis of machinery costs based on depreciation found that the farm manager has to put aside at least $9,100 towards the replacement of farm machinery.

Conclusion: Several options can be pursued to improve the financial performance of the farm. Several options can be pursued. First of all, the potential and scope for implementing more intensive crop production should be considered. Implementation should include the resuscitation of boreholes and increasing irrigable area, resuscitating greenhouses and use of certified seed/ materials, and conducting research to identify potential market outlets for produce. The lack of enough organic material to improve soil structure and fertility could be redressed by purchasing organic manure from surrounding farms. Alternatively and in addition, animal dung could be harvested from the pens and open veld and applied to the fields. The high cost of herbicides as an impediment to effective weed control could be reduced by pursuing manual or mechanical methods of weed control. There also needs to be a move towards high-value crops such as tobacco and horticultural flowers. The farm should also invest in product market development in order to identify market niches and market segments with relatively inelastic demand where the farm can charge higher prices for its products. Measures to improve machinery efficiency include keeping engines tuned up, using machines at near capacity, performing operations that reduce the number of trips across the field, avoiding driving machinery at excessive speeds, and sticking or adhering to the manufacturers' maintenance schedule. In addition, adequate amounts of money need to be put aside towards replacement of old machinery. Improvements in the management and operations of farm machinery could be achieved by replacing all machines that are too old and proving uneconomical to maintain in terms of costs, or performing minor modifications on existing machinery to enhance their operational efficiency. Since much of the farmland is rocky and forest, alternative land use practices could be introduced that generate additional income for the farm. These could include game farming and apiculture (bee keeping).

The introduction of additional livestock enterprises such as goats (which are browsers) can turn the rocky shrub-lands into productive farmland. The problem of unsuitable climate and physical environment for the exotic dairy breeds and their high insect, parasite and disease risk could be addressed by cross breeding exotic breeds with indigenous breeds for particular strains such as such as high disease resistance, temperature, drought and heat tolerance, while maintaining the basic traits of high productivity among the cross-bred animals.

Keywords: Crops; livestock; machinery; constraints; profits.

1. INTRODUCTION

1.1 Background

Marirangwe Farm is a peri-urban agricultural settlement situated on the outskirts of Marondera Town, the provincial capital of Mashonaland East Province in Zimbabwe. The farm was acquired by the Women's University in Africa (WUA) in the year 2000. It was bought from a white farmer who was running the farm as a dairy enterprise to supply milk and milk products to the residents of Marondera and the surrounding communities. Maize production was undertaken as a supplementary enterprise to provide stock feeds and food for the workers.

The most critical challenges/ constraints at start-up were the shortages of stock feeds, high mortality rates among dairy cattle, and limited expertise on dairy production. The most important opportunities at start-up were the availability of a ready market due to proximity of the farm to an urban area, and the general goodwill of the surrounding community.

The management structure at acquisition facilitated more autonomous decision making at the farm level. The farm manager was appointed by WUA, and below him was the farm supervisor who had the responsibility of supervising the labour force. Later, the management structure was modified somewhat, with the addition of another level of management above the farm

manager. This current structure consists of a management committee, and the farm manager makes decisions in close consultation with this committee. Thus the autonomy of the farm manager in decision making has been somewhat curtailed, for he must now liaise with the management committee in critical matters concerning farm operations.

Marirangwe Farm has a total land area of 285 hectares. Of this total farm size, 145 hectares is used for agriculture. Of the 145 hectares of agricultural land, 100 hectares is suitable for animal production, and 45 hectares for crop production. The rest (140 hectares) is unsuitable for agriculture.

1.2 Statement of the Problem and Justification of Study

The agricultural sector is the backbone of the Zimbabwean economy. It contributes 15-20% to the GDP, 40% to exports, and 60% of the raw materials used by the domestic manufacturing industry [1]. More significantly, food in its various forms being one of the basic necessities for life, is the main product of agriculture [2]. However, over the past decade there has been increased food and nutrition insecurity in the country at household and national levels [3]. The functional unit of agriculture is the farm or agricultural project [4]. Too often however, there has been too much emphasis on socio-economic criteria (food security, employment creation, and nutrition enhancement, etc.) in justifying increased investments in agricultural production [5], while ignoring economic and financial criteria [6]. This has resulted in projects being funded or implemented without conducting adequate financial analysis or without adequate recommendations to improve their viability [7]. The aims of the study were to conduct both financial (gross margin and profitability) analysis and non-financial (potential and constraints) analysis of an agricultural project, and to recommend strategies for its development.

1.3 Objectives

The objectives of the study were to conduct a study of Marirangwe Farm through an analysis of the following aspects with a view to enhancing development of the farm:

(1) Crop farming activities, constraints and potential;
(2) Livestock farming activities, constraints and potential;
(3) Efficiency of farm power; and
(4) Financial performance of the whole farm.

2. METHODOLOGY

This was a case study and therefore sample selection did not require statistical sampling of respondents. The respondents were key informants knowledgeable about the farm, and these were the Farm Manager and Farm Administrator of Marirangwe Farm. A questionnaire with structured and open-ended questions was administered to the key informants during the period of data collection. Qualitative analysis was used to assess crop and livestock farming activities and potential for improvement. A Matrix was used to record and present the status of machinery and equipment at Marirangwe Farm. Machinery depreciation in the determination of machinery efficiency was calculated using the straight-line method: [cost-salvage value] / [ownership life]. In Gross Margin Budgeting, the Farm Gross Margin was obtained by deducting Total Variable Costs from Gross Income. In Whole Farm Budgeting, Whole Farm Profit was obtained by subtracting Total Fixed Costs from the Farm Gross Margin. In Partial Budget Analysis, the Net Gain of the proposed changes was found by deducting the Total Losses (i.e. Income Lost + Increase in Variable Costs) from Total Gains (i.e. Additional Income + Costs Saved).

3. RESULTS AND DISCUSSION

3.1 Crop Farming Activities, Constraints and Potential for Improvement

The current goals and objectives of conducting crop production activities at Marirangwe Farm are profit maximization, food security and nutrition enhancement, and employment creation. Other objectives are to provide training facilities for undergraduate students in the Faculty of Agriculture at WUA, and to raise money for the construction of the WUA University campus which will be situated in the environs of the farm.

Crop production is not a very important activity at Marirangwe Farm in terms of both land area and the amount of output generated. As mentioned earlier, only 45 hectares is available for crop production. The major challenges faced by the farm with regard to the land resource include limited land suitable for agriculture. Much of the land is rocky, forest and marshy. In addition, the

arable land is situated on infertile soils ranging from sandy to sandy loam soils.

The labour force consists of 40 workers, of which 36 are unskilled and 4 are semi-skilled. The major challenges and constraints faced by the farm with regard to the labour resource for crop production include high labour costs at planting and harvesting because the activities are done manually. Thefts of crop produce are another major challenge militating against improved financial performance.

The major crops grown are maize which is grown for food and fodder (silage), potatoes, tomatoes, cabbages, snap corn and green mealies. Tobacco is a new crop that was introduced in the 2012/13 farming season. There is also considerable scope for the introduction of other new crops such as seed maize and the English cucumber. Crop rotation is practiced to some extent on the farm to enable the soil to regain its fertility and to cut the life cycle of pest and disease pathogens. The general sequence of crops grown in rotation on a piece of land is potato-green mealies-cabbage.

Considerable scope exists for the implementation of more intensive crop production. Feasible methods for implementing more intensive crop production include the resuscitation of greenhouses and use of certified seed/ materials, and conducting research to identify additional market outlets for produce. The following constitute formidable constraints to crop production activities: market availability; availability of suitable land for expansion of crop enterprises; high labour requirements for the crops cultivated; high cost of labour; poor soil structure and fertility; and shortage of rain at critical times of crop growth.

According to [8], a fertile soil can be defined as "A soil that has adequate plant nutrients, good soil structure, is free from weeds, is not eroded, has a high population of useful micro-organisms such as earthworms and nitrogen-fixing bacteria, and a low population of harmful micro-organisms such as certain fungi, nematodes and viruses." At Marirangwe Farm, the following methods are currently being implemented for improving or maintaining soil fertility: crop rotation; fertilizer application to add nutrients to the soil; destruction of weeds (by use of herbicides or mechanical weeding); and restoring humus to the soil to improve soil structure. The major constraints to effective soil fertility management is the lack of adequate organic material to improve soil structure, as most of the soils on cultivated land are sandy soils. The major constraints to effective weed control are the high cost of herbicides, and the long residual effect of some herbicides on limited land.

3.2 Livestock Farming Activities, Constraints and Potential for Improvement

The major livestock types reared and production systems followed at Marirangwe Farm are dairy cattle (pen feeding and free ranging); piggery (pen feeding); and sheep (pen feeding and free ranging). As of July 2014, there were 112 dairy cows, 101 pigs, and 21 sheep. The scope for introducing new types of livestock at Marirangwe Farm depends on the performance of existing livestock enterprises. New types of livestock can only be introduced when the already existing livestock projects start to run smoothly, with no challenges such as availability of feedstuffs and markets. More intensive livestock production systems are in the pipeline. In particular, broiler production and aquaculture (fish farming) using modern production systems, offer opportunities for intensification of livestock production.

The following factors were noted with regard to livestock feed supply from pasture and crops. First of all, although land area suitable for agriculture is small, the undulating lands with good drainage are suitable for pastures and fodder crop production. The suitability of soil types to support pasture and fodder crop production is limited, principally because of the inherent poor soil fertility of the sandy to sandy loam soils.

The presence of rocks and non-edible vegetation such as certain tree species, thorny shrubs and unpalatable bushes limits the potential for livestock production [9]. Much of the livestock production area is rocky, the main vegetation is *brachystegia* species which is not palatable, and there is forest encroachment of *lantana camara* vegetation on pasture land. The *Star Grass* which is present is palatable and has good digestibility [10]. *Kikuyu Grass* and *Katambora Rhodes Grass* are also palatable and have good digestibility [11]. Crop residues are also available for livestock feed. For example, maize stover is available when harvesting is complete. Horticultural by-products such as fine beans, cabbages, rape, etc. are also available for livestock feed. Special crops which are grown for animal feed include maize silage and snap corn.

The strategies used by the farm to maximize feed availability in the event that seasonal feed production on the farm is worse than normal include buying-in bulk by-products from processing industries such as cotton hulls, maize/wheat bran, and *masese* (used malt) for stocking, as well cutting and baling hay from the veld. There is also potential to improve livestock production from animals that feed off the veld by sowing improved pasture species especially grass species and legumes on paddocks that are colonized by *sporobolus*. There are also plans to increase the area under velvet beans.

With regard to the feasibility of applying fertilizers on the pastures to enhance their growth, the high cost of fertilizers and irrigation water is currently the limiting factor. However, plans are underway to resuscitate boreholes and buy in irrigation pumps and pipes to irrigate pastures where fertilizers have been applied. The major constraint to getting or realizing the full potential of feed supply from pasture and crops is the high cost of seed, fertilizer and of growing fodder crops.

Grain-based feed to animals is obtained either by mixing the grains on the farm, or buying feed from a processor who has already mixed it. Thus grain-based feed is either purchased or produced on the farm. The main method of mixing the grain on the farm is to use a shovel; the principal method of storing grain is to use a store room; and the major method of feeding grain-based feed to the farm animals is to use a tractor-drawn trailor. About 80% of the feed ingredients are produced on the farm, hence saving on costs. Factory supplied feed costs more than home-mixed feed because the former accumulates a margin consisting of factory labour costs, milling costs, and costs of transporting the feed to the farm.

The potential for improving the quality of farm-grown and farm-mixed grain-based feed rations lies in growing recommended grain breeds (e.g. yellow maize) and fodder grasses [12]. Quality can also be improved by cutting and feeding the feed at the appropriate time, as is the case with silage and hay. The potential for reducing or preventing losses/ wastage during storage (e.g. through insects, rodents, or weather damage), and when feeding out, is realized by constructing better structures, use of appropriate equipment, and control measures taken for insects and rodents (e.g. chemicals, traps) [13]. The main barrier to achieving the full potential for improvement of grain-based feeding systems at Marirangwe Farm is the shortage or unavailability of appropriate equipment for feed production and processing, such as tractors, planters, and combine harvesters.

At Marirangwe Farm, the semen supplied during mating of animals does not come from natural sources (e.g. bulls), but from artificial insemination (AI) services provided by the private sector. The advantages of using AI sources of semen are that good records are maintained, and the semen is easy to store, handle and transport (e.g. one can have “a thousand bulls” in a single canister) [13]. In addition, AI sources are disease free, and it is easy for the farmer to make an appropriate choice of the type of bull that he wants. However, maximum care is needed with AI; an experienced person is needed to do AI; and it calls for accurate heat detection in cows, which is not always easy.

The livestock replacement programmes for each type of livestock (i.e. either by breeding own replacement stock, or buying in replacement stock) are as follows: dairy cows (own breeding, and buying in); piggery (own breeding); and sheep (own breeding). The advantages of breeding own replacement stock are that it is cheap; there is good well monitored selection; and there are well maintained sire-and-dame records. The disadvantages of breeding own replacement stock are that it takes a long time to obtain replacement stock, and hereditary problems are most likely to occur.

The advantages of buying in the replacement stock are that there is quick herd growth and improvement, and quick production without cost rearing followers. The disadvantages of buying in replacement stock are that one can buy bad genetics; there are high costs of buying in and transporting, and there may be heavy losses in the event of stock mortality. In addition, the bought-in stock needs time to adjust, adapt and acclimatize to the new environment at the farm. The methods which are being used to maintain or improve the genetic merit and hybrid vigour of the herd or flock are to maintain trueness to type (pure breeding) and cross breeding.

The options available for improving the profitability of animal activities at Marirangwe include controlled grazing/ paddocking, segregation of age-groups during feeding processes, and using feeding facilities which reduce wastage. The measures which are being

implemented for disease and parasite control of the livestock include proper animal feeding/nutrition to reduce susceptibility to diseases and parasites; use of medicines and chemicals; and veterinary advice for insect, disease and parasite control.

The major constraints which inhibit the full realization of the potential for improving animal enterprises at Marirangwe Farm include unsuitable climate and physical environment for livestock production; and high insect, parasite and disease risk of the animals.

3.3 Farm Power

In terms of farm power (equipment and machinery), Marirangwe Farm owns 2 tractors, 1 plough, 1 disc harrow, 1 silage cutter, 1 mower, 1 side/grass cutter, 1 boom sprayer, 1 hay baler, 1 tobacco ridger, 1 dam scooper, 1 irrigation pump, 1 tobacco planter, 1 lime box spreader, 1 hammer mill, 1 grinding mill, 1 bowzer feed mixer, and 1 herring bone milking machine. These machines and equipment are wholly owned by the farm, and there are no options for hiring or use of contractors to supply a full package of farm power services.

Table 1 was completed in response to the following questions about farm machinery: How many years will it be before the machine has to be replaced? How well is the machine being maintained? What tools and facilities for maintaining the machine are needed and available? Is the machine the right capacity (size) and design for the job at hand? and, Are spare parts readily available and affordable? In terms of existing machinery (Table 1), it is apparent that it will take quite some time (ranging between 5-25 years) before the farm has to replace any of the existing machines. This would imply that the farm might be able to devote much of its variable resources into improving crop output and financial performance without having to worry about heavy capital outlays involved in the purchase of new machines.

However, the disturbing feature in Table 1 is the unavailability of spare parts for the tractor, silage cutter, hay baler, and side cutter. If a machine breaks down and spare parts are not readily available, there will be a lengthy period of down-time of the machine and loss of production during the period when spare parts are being sourced. Table 1 also indicates that the side cutter, the disc harrow and the plough are too old and as a result are becoming too costly to maintain.

In addition, the information in Table 2 demonstrates that alternative machines can perform better than the existing silage cutter, hay baler, side cutter, and irrigation pump. Furthermore, there is greater scope and potential for improvement in the operations of the silage cutter, hay baler, side cutter, milking machine, and irrigation pump. The greater efficiency in operation would come about if minor but appropriate modifications are performed on the machinery, or if new types of materials are introduced to improve the quality of the machine's operation.

3.3.1 Machinery efficiency: estimating machinery costs

Machinery is costly to purchase, own and operate. A manager must be aware of the costs of owning and operating a machine and understand how they are related to machinery use, interest rates, useful life, and other factors [14]. Depreciation is a non-cash expense that reflects a loss in value of machinery due to age, wear, and obsolescence. Annual depreciation can be estimated using the straight-line or declining balance methods. However, if only the average annual depreciation is needed, it can be found from the same equation as for straight-line depreciation [14]: Depreciation = [cost-salvage value] / ownership life. It is a measure of the money that has to be put aside annually towards replacement of a new and similar machine.

The salvage value at various ages can be estimated as a percentage of the new list price of a similar machine. The following depreciation values (Table 1a) are derived from calculations using the straight-line depreciation method and the salvage values using estimated percentages of the new list price of similar machines, based on guidelines by [14-18], and data on cost and useful life obtained from the field survey.

As stated above, annual depreciation is also a proxy of the amount of money that should be put aside by the manager of the farm for purposes of buying new machinery when the existing machinery is past its useful life. The total depreciation for all machinery at Marirangwe Farm, as can be observed from Table 1a, was $9,098.00. This is the total amount of money which the manager should put aside on an annual basis towards replacement of machinery. This should be quite a useful piece of information to be given as advice to the owners of Marirangwe Farm (Women's University in Africa).

Table 1. The status of machinery and equipment at Marirangwe farm

Machine type	Period before replacement	How well machine is being maintained	Tools & facilities necessary for efficient maintenance	Machine capacity & design vis-à-vis the job at hand	Availability of repair services & spare parts
Tractor	10 years	Well maintained	Spanners& spare parts	X804 YTO	Not readily available
Silage cutter	5 years	Well maintained	Spanners & spare parts		Not readily available
Hay baler	15 years	Well maintained	Spanners & spare parts		Not readily available
Side cutter	15 years	Too old and costly to maintain	Spanners& spare parts		Not readily available
Hammer mill/ Drosk	20+ years	Well maintained	Spanners, grease, bearings, blades	30HP	Available
Milking machine	20+ years	Well maintained	Liners, pulsetter, vacuum pump		Available
Irrigation pump	25 years	Well maintained	Rubber gasket, peking, impeller	30HP	Available
Mower	10 years	Well maintained	Bearings, belts		Available
Disc harrow	15 years	Too old and costly to maintain	Bearings, discs	20 Disc hurrow	Available
Plough	20 years	Too old and costly to maintain	Bearings, discs	3 Furrow plough	Available

Source: Field Survey, 2014

Table 1a. Depreciation of machinery at Marirangwe farm

Machine type	Ownership life	Cost	Salvage value	Depreciation
Tractor	10 years	$100,000	$67,000	$3,300
Silage cutter	5 years	$80,000	$56,000	$4,800
Hay baler	15 years	$5,000	$2,800	$147
Side cutter	15 years	$4,000	$2,800	$80
Hammer mill/ Drosk	20+ years	$15,000	$10,050	$248
Milking machine	20+ years	$12,000	$6,240	$288
Irrigation pump	25 years	$3,000	$1,800	$48
Mower	10 years	$2,500	$1,750	$8
Disc harrow	15 years	$3,500	$2,135	$91
Plough	20 years	$4,500	$2,745	$88
Total				**$ 9,098**

Sources: Field Survey, 2014; [14-18]

Table 2. Comparisons with alternative machines

Machine type	Can other machine do job better?	Can other machines allow more timely operations?	Are there cheaper alternative sources of machinery?	Does machine allow minor modifications to bring about major operational improvements?	Scope for new types of materials to improve quality of machine's operation or ease of the task being performed
Silage cutter	Yes	No	No	No	Yes
Hay baler	Yes	No	No	Yes	Yes
Side cutter	Yes	Yes	Yes	Yes	Yes
Milking machine	No	No	No	No	Yes
Irrigation pump	Yes	No	No	No	Yes

Source: Field Survey, 2014

Table 3. Gross margin budgeting and whole farm budgeting for the 2013/ 14 farming season

Item	Amount (US $)
Crop income (total)	[A] = $ 65 000.00
Livestock income including dairy (total)	[B] = $ 59 200.00
GROSS income = Crop income + Livestock income	[C]= [A] + [B] = $124 200.00
Crop variable costs	[D] = $81 000.00
Livestock variable costs	[E] = $44 000.00
Total variable costs = Crop variable costs + Livestock variable costs	[F] = [D] + [E] = $125 000.00
Farm gross margin = Gross income – Total variable costs	[G] = [C] – [F] = **($800.00)**
Total fixed costs	[H] = $31 600.00
Whole farm profit = Gross margin – Total fixed costs	[I] = -$800.00 - $31 600.00 = **(32 400.00)**

Source: Field Survey, 2014

Table 4. Partial budget analysis for Marirangwe farm

Gains			Losses		
New/ Additional income (4 dairy cows)	A	$146,000.00	Income lost (3 pigs)	D	$405.00
Costs saved (3 pigs)	B	$178.23	Income lost (5 sheep)	E	$1,050.00
Costs saved (5 sheep)	C	$714.30	Increase in variable costs (4 dairy cows)	F	$1,250.00
Total gains		$104,415, 109.00	**Total losses**		$2,705.00

Net gain *= Total gains – Total losses = $104,415,109- $2,705 = + $104,412,404.*

From the above discussion of farm power at Marirangwe, it appears that several options are available for improving the operations of machines. These are (a) selling off all the machines which do not have readily available spare parts, and replacing them with new or good second hand machinery; (b) replacing those machines identified as having alternative machines which could 'do the job better', with the machines that could do the job better; (c) replacing all the machines that are too old and are becoming too costly to maintain; and (d) hiring the services of reputable engineering companies to perform appropriate minor modifications on some machines, or to bring in new types of materials that could improve the quality of work of machines.

3.4 Financial Aspects

Table 3 shows the calculation of the Whole Farm Gross Margin (Gross Income less Total Variable Costs) and Whole Farm Profit (Gross Margin less Total Fixed Costs) for the 2013/14 farming season.

The Whole Farm Budget Analysis incorporated in Table 3 reveals a negative Whole Farm Gross Margin of -$800.00 and a huge negative Whole Farm Profit of -$32,400.00 in the 2013/14 farming season. Whole Farm Profit was calculated by deducting Total Fixed Costs [H = $31, 600.00] from the Gross Margin [-$800.00].

However, partial budget analysis results tend to reaffirm the heavy dependence of Marirangwe Farm on dairy as an income-earning activity. When asked to respond to the question of how they would respond to a $1.00 increase in milk prices from the current $1.50 per litre to a new likely price of $2.50 per litre, the management of the farm said they would settle for a barter trade in which they would forfeit 4 dairy cows for 3 pigs and 5 sheep.

Table 4 shows the results of the partial budget analysis based on this transaction and the prevailing prices of pork and mutton.

Therefore the partial budget analysis based on the proposed barter trade of bringing in four additional dairy cows in exchange for smaller stock (three pigs and five sheep) is likely to yield dividends to Marirangwe Farm. This is indicated by the large positive value of the net gain (= total gains – total losses) arising from the proposed change.

4. CONCLUSION

The following are the main conclusions from the above results and discussion. While there are other non-monetary objectives in conducting farming activities at Marirangwe Farm, the bottom line is profit maximization. This is because unless the farm is financially viable, it cannot sustain additional objectives like food security and nutrition enhancement, employment creation, and student training. Both gross margin budget and whole farm budget analysis, however, indicated that the farm made a huge loss in the 2013/14 farming season. Partial budget analysis indicated viability of farming operations based on increasing milk prices and constant pork and mutton prices. This indicates that the viability of Marirangwe Farm is based on relative prices of milk against other livestock products.

What can be done to improve the financial performance of the farm? Several options can be pursued. First of all, the potential and scope for implementing more intensive crop production should be considered. Implementation should include the resuscitation of boreholes and increasing irrigable area, resuscitating greenhouses and use of certified seed/ materials, and conducting research to identify potential market outlets for produce. The lack of enough organic material to improve soil structure and fertility could be redressed by purchasing organic manure from surrounding farms. Alternatively and in addition, animal dung could be harvested from the pens and open veld and applied to the fields. The high cost of herbicides as an impediment to effective weed control could be reduced by pursuing manual or mechanical methods of weed control. There also needs to be a move towards high-value crops such as tobacco and horticultural flowers. The farm should also invest in product market development in order to identify market niches and market segments with relatively inelastic demand where the farm can charge higher prices for its products.

Measures to improve machinery efficiency include keeping engines tuned up, using machines at near capacity, performing operations that reduce the number of trips across the field, avoiding driving machinery at excessive speeds, and sticking or adhering to the manufacturers' maintenance schedule. In addition, adequate amounts of money need to be put aside towards replacement of old machinery.

Improvements in the management and operations of farm machinery could be achieved by replacing all machines that are too old and proving uneconomical to maintain in terms of costs, or performing minor modifications on existing machinery to enhance their operational efficiency. Since much of the farmland is rocky and forest, alternative land use practices could be introduced that generate additional income for the farm. These could include game farming and apiculture (bee keeping).

The introduction of additional livestock enterprises such as goats (which are browsers) can turn the rocky shrub-lands into productive farmland. The problem of unsuitable climate and physical environment for the exotic dairy breeds and their high insect, parasite and disease risk could be addressed by cross breeding exotic breeds with indigenous breeds for particular strains such as such as high disease resistance, temperature, drought and heat tolerance, while maintaining the basic traits of high productivity among the cross-bred animals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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