Agricultural Risk Management through Community-Based Wildlife Conservation in Rural Zimbabwe

Edwin Muchapondwa[1][2]
Thomas Sterner[3]

Working Paper Number 126

[2] School of Economics, University of Cape Town, Private Bag, Rondebosch 7701, South Africa. E-mail: edwin.muchapondwa@uct.ac.za Fax: +27 21 650 2854
[3] Department of Economics, Göteborg University, P. O. Box 640, SE405 30, Göteborg, Sweden. E-mail: thomas.sterner@economics.gu.se Fax: +46 31 773 1043.

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Edwin Muchapondwa[*][†]and Thomas Sterner[‡]

April 29, 2009

Abstract

This paper investigates whether the risk faced by rural farmers in Zimbabwe could potentially be managed by using community-based wildlife conservation. Community-based wildlife conservation could be an additional asset in the rural farmers' investment portfolio thereby potentially diversifying and consequently reducing the risk they face. Such investment could also help efforts to conserve wildlife. By making use of national historical data and statistical analysis, this paper finds that community-based wildlife conservation is a feasible hedge asset for agricultural production in rural Zimbabwe. The benefits of diversification into community-based wildlife conservation are likely to be high only in those rural areas that can sustain wildlife populations sufficient to generate adequate returns from wildlife activities such as tourism, trophy hunting, live animal sales and meat cropping.

JEL Classification: D81, G11, Q29

Keywords: CAMPFIRE, diversification, risk management, wildlife conservation, Zimbabwe

1   Introduction

It is widely recognised that a high level of uncertainty typifies the lives of rural farmers in developing countries (Ellis, 1993).[1] The presence of uncertainty means that more than one outcome is possible and typically not all possible outcomes are equally desirable. The outcome of uncertain events can often mean the difference between survival and starvation (*ibid*).

There are four main categories of uncertainty that are relevant from the point of view of agriculture – output, price, technological and policy uncertainties. Of primary interest to our analysis is output uncertainty, due to the fact that uncontrollable elements such as adverse weather, pests, disease outbreaks, wildlife intrusions and other natural factors play a fundamental role in agricultural production (Moschini and Hennessy, 2000). Output uncertainty may affect the outcome of planting decisions at any stage of agricultural production, from cultivation through to the final harvest.

In Zimbabwean agriculture, all the sources of uncertainty mentioned above are well-known. Most importantly, rural farmers are often victims of drought and wildlife intrusions. While droughts do not occur every year, continuous wildlife intrusions are worrisome in some wildlife-endowed rural areas.

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[1]A distinction is usually made between risk and uncertainty. In analyses regarding farmers, current economic analysis of risk is based on the decision maker's subjective belief about the occurrence of random events (Ellis, 1993, Moschini and Hennessy, 2000).

Since rural farmers assign subjective probabilities to some uncertain decision settings, such as drought and wildlife intrusions, some traditional uncertainty can be managed through risk management techniques. The purpose of risk management is to control the possible adverse consequences of uncertainty that may arise from production decisions. Farmers may manage risk by accessing more direct risk management tools, such as purchasing hedge assets on the capital markets, i.e. assets with payoffs (in the form of rates of return) negatively correlated with the rate of return on agricultural production. While purchasing hedge assets on the capital markets is an effective way of dealing with risk, more often than not, it is not a feasible option for rural farmers in developing countries due to high information and transaction costs.

It is thus instructive to consider alternative ways of dealing with the risk. We contend that if rural farmers in Zimbabwe engaged in community-based wildlife conservation then they could potentially diversify and consequently reduce the risk they face in agricultural production. Thus, community-based wildlife conservation is potentially a hedge asset conveniently at the disposal of rural farmers. Accordingly, this paper investigates whether the agricultural risk faced by rural farmers in Zimbabwe could be managed through diversification into community-based wildlife conservation.

The rest of the paper is organised as follows: Section 2 gives the background to the risk faced by rural farmers. Section 3 appraises the use of community-based wildlife conservation as a risk management strategy and gives the theoretical framework for such an assessment. Section 4 and 5 presents the methodology and results respectively. Section 6 discusses the results and the zoning of risk management strategies while Section 7 concludes.

2   Background

Indeed, with output uncertainty emanating from drought and wildlife intrusions, the rural farmers are likely to suffer losses in income. Therefore, the variable of interest is 'the losses in income that rural farmers are likely to suffer as a result of drought and wildlife intrusions'. The losses in income from drought are straightforward to comprehend given that rainfall is one of the necessities in the agricultural production function of rural farmers. As for the wildlife intrusions in our setting, wildlife damage affects the agricultural production function of rural farmers in the same way as pests, diseases, locust invasions, etc affect agriculture. This is due to the fact that, in several rural areas, agricultural damage is perpetrated by wild animals such as lions, leopards, buffalos, jackals, baboons, monkeys, wild pigs and elephants straying from adjacent national parks and indigenous forests. Some wild animals predate on livestock while others eat or trample crops.

Wild animals will always tend to roam around the rangelands disturbing agricultural activities of rural farmers for three main reasons. Firstly, national parks are located adjacent to rural areas. Secondly, over time, national parks have struggled to maintain frequent fence breakages perpetrated by ever growing populations of large mammals such as elephants. Thirdly, there is a continual existence of wild animals in the indigenous forests. In theory, the likelihood of damage depends on many factors including the proximity to wild animal concentrations, the composition of wild animal populations, the size of the wild animal populations, the availability of wild food for wild animals, agricultural food preferences of wild animal species in the vicinity, crop varieties planted, livestock varieties reared and the level of intrusion mitigation measures put in place. However, in reality, the possibility of agricultural damage from dangerous wild animals and invincible large mammals (such as elephants) impedes the rural farmers' ability to meaningfully reduce the likelihood of damage. Thus, the probabilities of losses in income are random.

Even though data generally does not exist on the extent of the agricultural damage suffered from wildlife in Zimbabwe, Kenyan studies show that the typical Maasai Mara wildlife-perpetrated crop damage is between US$200-US$400 annually per household and Shimba Hills elephant crop damage is US$100 annually per household, while in Zambia the Mumbwa Game Management Area crop damage is US$122 annually per household (various, quoted in Emerton, 2001: p218). We

estimate that the wildlife-perpetrated crop damages in Zimbabwe are of similar magnitudes. The problem of livestock predation is equally important. For instance, Jones (1994) reported a problem of massive livestock deaths in Binga rural district due to predators coming from the adjacent Hwange National Park. A compensation scheme that was put in place on an experimental basis in one of the wards paid out for 106 livestock deaths in a period of six months in 1992. For people living on income of the order of US$1 per day, the above-implied agricultural damages are very sizeable losses. Furthermore, rural farmers are often killed or seriously injured while trying to protect their crops and livestock from the marauding animals.[2] With this difficult background characterised by serious human-wildlife conflict, rural farmers incur many loses and, consequently, this poses a threat to sound wildlife conservation from disenfranchised and non-supportive rural farmers, and unchecked poachers.

Unfortunately, the wildlife laws that were promulgated over time until the early 1980s alienated rural farmers from all wildlife and vested its control and management with the state. Rural farmers received no compensation for any losses they suffered from having the wild animals on their land. Consequently many rural farmers developed very negative attitudes to views that perceive wildlife as a productive and useful resource. However, significant wildlife populations survived in remote, sparsely populated, rural areas especially if they did not impinge heavily on the rural farmers' livelihoods. Tolerance towards wildlife was limited mainly to herbivores, because they conflicted the least with human interests.

The way in which we envision rural farmers reducing some of the losses in income as a result of wildlife damage is by avoiding that wildlife damage in the first instance by removing agricultural activity from vulnerable areas. This could be done by switching to an alternative land-use, namely community-based wildlife conservation. At the minimum, given scarcity of land, community-based wildlife conservation entails giving up some land to wildlife, say, in the form of buffer zones. In the same vein, some of the losses in income emanating from droughts could be avoided by switching to a land-use that is relatively insulated against droughts i.e. wildlife conservation. Thus community-based wildlife conservation could be interpreted as an additional asset in the rural farmers' investment portfolio that is capable of diversifying and consequently reducing the risk they face.

3   Literature Review, Hypotheses and Theoretical Model

Evidence presented elsewhere suggests that by making wildlife another form of land use on commercial farms, wildlife outstripped crops and livestock in terms of economic value in Zimbabwe, particularly in the ecologically fragile marginal lands (Child, 1995). There are at least four reasons why wildlife conservation could potentially be used to diversify and consequently reduce the risk faced in agricultural production.

Firstly, it is usually observed, particularly in relation to physical and ecological catastrophes such as drought, that wildlife copes relatively better than either crops or livestock because wildlife is naturally more tolerant. Wildlife is more drought and disease tolerant. Wildlife is better at utilising local vegetation and therefore causes less erosion than, say, cattle. Child (1995) reports that wildlife makes a more efficient use of forage to produce income than cattle in medium rainfall areas. For a given level of profit, wildlife ventures retain better herbaceous cover, providing better financial and ecological resilience to droughts through increased plant production and reduced variability in available forage (Child, 1989).

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[2]For example, elephants killed 21 people in the Nyaminyami communal lands in 2001. Most of the victims were killed while trying to chase animals from their fields. The families of the victims were paid Z$15,000 (US$273) from CAMPFIRE revenue as compensation (*The Sunday Mail*, 18 August 2002). Twelve out of 27 Zimbabweans killed by wild animals between January and October 2005 were trampled by elephants. (*The Daily Mirror*, 21 December 2005 and *The Herald*, 13 December 2005). Nationally, as much as 300 elephants used to be killed annually as part of problem animal control in Zimbabwe's communal lands (CAMPFIRE Association 2002).

Secondly, there are ecological and other factors such as spatial heterogeneity that imply that some areas are best suited, or less risky, for wildlife than for livestock and crops. Most of the marginal areas on which most rural farmers practice agriculture are in fact suitable for extensive livestock production and intensive wildlife ranching rather than intensive crop production and livestock rearing which most rural farmers implement.

Thirdly, there could be ecological interdependence between some species of wildlife and livestock that could reduce risk. Some species of wildlife are browsers, rather than grazers, and therefore do not directly compete with livestock for grazing.[3] Often, foraging by wild herbivores, which tend to be browsers, has only minimal influence on production of domestic livestock, which tend to be grazers. A good example is that of the giraffe, which is a browser and could therefore co-exist with livestock without grazing competition and predation. Indeed, ranchers in Africa have taken advantage of the natural partitioning between browsing and grazing herbivores of different sizes in range management and meat production through game ranching.

Fourthly, the uncertainty that affects crops and livestock from instances of wildlife intrusions affects wildlife conservation differently. The variability of rates of return on agricultural production observed as a result of wildlife damage is not observed with respect to wildlife conservation since wildlife is more resistant to damage by itself outside predation relations. Thus, wildlife populations can afford to grow despite some species of wildlife preying on other species. Predation may even have a positive role in wildlife conservation since it selectively removes the weakest individuals from the prey. Crops and livestock populations are seriously negatively affected if they fall prey to some species of wildlife. While it may be conceivable that introducing wildlife alongside agricultural activities may even increase the risk of their destruction, this is not necessarily the case. Embarking on wildlife conservation could entail cutting back on agricultural activities and sparing some land to act as buffer zones between agriculture and wildlife, if they are conflict-ridden, thereby insulating agriculture from the risk of wildlife intrusions. It is expected that the benefit gained from adopting wildlife conservation would be greater than the benefit gained from the agricultural activities that it displaces.[4]

The beauty of diversification through community-based wildlife conservation is that it brings about two good attributes: (i) the overall risk faced by rural farmers is reduced, and (ii) a greater area of land is made available for wildlife to allow wild populations to increase.

We shall briefly illustrate how the addition of community-based wildlife conservation as an asset to the usual activities of agricultural production of rural farmers could be used to diversify and subsequently reduce risk faced by rural farmers with the help of the portfolio theory, which was propounded by Markowitz (1952). We put forward the contention that rural farmers already have an asset that we will term agricultural production, which for purposes of simplicity is made up of the aggregation of livestock rearing and crop production. Agricultural production does not yield a certain rate of return because of the risk and uncertainty characterised earlier. Rural farmers have the opportunity to acquire community-based wildlife conservation as an additional asset that gives them economic benefits by utilising the CAMPFIRE philosophy – which is essentially the framework of community-based wildlife conservation in Zimbabwe.[5] It should be noted that wildlife is a unique

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[3]The distinction between grazers and browsers is that the former feed on grasses while the latter feed on leaves, stems, flowers, seeds and fruit of trees.

[4]We could also add that, even though wildlife income is associated with risks, in the sense of variation in income, these risks that emanate from sources such as hunter and tourist boycotts are unlikely to be positively correlated with agricultural pests, agricultural disease outbreaks, drought, price shocks etc, which are usual sources of risk to agricultural income. In cases where there are common sources of risk such as business cycles, inflation, interest rates and exchange rates, it is likely that their impacts on the two enterprises are different, with agricultural production being more vulnerable since wildlife incomes depend on external factors given that safari hunters and most tourists are usually rich foreigners who cope relatively better with similar sources of risk in their own countries. However, this assertion might not be generally true and would require further research that makes use of real data.

[5]The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe was developed to (i) reduce the nuisance perpetrated on rural farmers by wildlife, (ii) give financial benefits to rural farmers through the commercialised use of wildlife, and (iii) protect wildlife through securing the support of the rural com-

resource; acquiring wildlife does not require the usual cash investment. Foregoing opportunities for economically rewarding uses of land within a territory could be interpreted as the most important kind of investment. Damage that people put up with, guarding fields against wildlife intrusions, protecting fields with thorny-bush fences, and looking out for poachers also constitute a kind of investment. Ideally, those who undertake a greater proportion of this kind of investment would expect to reap a higher proportion of the benefits. Like agricultural production, community-based wildlife conservation is characterised by uncertainty but we assume, based on what is usually observed, that the sources of risk in community-based wildlife conservation are not the same as those to which agricultural production is subjected. Since community-based wildlife conservation is a community activity, we assume the existence of a homogenous group of rural farmers that constitute the community. We suppose that a typical community has decided to invest in the two assets with the land fraction w_A in agricultural production, A, and the remainder $w_C(= 1 - w_A)$ in community-based wildlife conservation, C.[6] Each activity has a rate of return of r_i and an associated variance of σ_i^2 where $i = A, C$. The covariance between the two rates of return is $Cov(r_A, r_C)$. The variance of the community's two risky assets portfolio, σ_P^2, would be (Markowitz 1959):

$$\sigma_P^2 = w_A^2 \sigma_A^2 + w_C^2 \sigma_C^2 + 2 w_A w_C Cov(r_A, r_C) \tag{1}$$

While the expected return of the portfolio would be the weighted average of the expected returns of the individual assets, it is clear that the portfolio variance, and thus the risk faced, would be less than the weighted average of the variances of the individual assets if the covariance were negative.[7] It would be possible for rural farmers to invest in community-based wildlife conservation, and in some cases disinvest in agricultural production, as a way of offsetting exposure to risk in agricultural production without necessarily reducing the expected return if it could be shown that the rates of return of the two assets are negatively correlated.[8] This is a potentially feasible result considering the earlier discussion of the four reasons why wildlife conservation could potentially be used to diversify and consequently reduce the risk faced in agricultural production. Figure 1 illustrates the typical characteristics of community-based wildlife conservation and agricultural production that could reduce portfolio variance and bring about increased welfare for the rural farmers. As shown in the figure, different yields correspond to different seasons. Agricultural production offers higher yields in the normal season but lower yields in the dry and wet seasons. Thus, agricultural production is on average associated with higher yields but more risk. Given that it fares better in the dry and wet seasons, wildlife conservation generally has lower risk but also lower yield. Instead of specialising

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munities in wildlife conservation. Under the programme, trophy fees are charged to visiting hunters to hunt game in communal lands under very strict quotas approved by the national parks agency. These fees as well as those collected from tourists viewing game in communal lands go directly to the local rural communities, through their political administrative authorities called Rural District Councils (RDCs), to be used for social infrastructure or as a further source of income.

[6] Our unit of analysis is the community (i.e. a collection of individual agents) even though the underlying theory was propounded for individual agents. Given that agricultural production is individualised, we maintain that if the compensation schemes in community-based wildlife conservation are equitable in terms of provision to the common-pool resource and appropriation from it, then the underlying theory will equally hold for a community.

[7] Investors' risk preferences can be characterised by their preferences for the various moments of the distribution of the rate of return from an investment. However, when portfolios are revised often enough and prices are continuous the desirability of a portfolio can be measured by its mean and variance alone (Samuelson 1970). Through this approximation theorem, Samuelson (1970) provided the justification for the mean-variance analysis by showing that (i) the importance of all moments beyond the variance is much smaller than that of the expected value and variance hence disregarding moments higher than the variance will not affect portfolio choice and (ii) that the variance is as important as the mean to investor welfare.

[8] In fact, as our reviewer pointed out, this is an unnecessarily stronger condition. Normally, to illustrate the benefits of diversification for a two investment portfolio, the covariance is depicted as the product of the standard deviations and the coefficient of correlation i.e. $\sigma_A^\sigma C orr(r_A, r_C)$. It is therefore clear that as long as the coefficient of correlation between the two investments is strictly inferior to 1 (and not necessarily negative!), the standard deviation for a two investment portfolio is inferior to the weighted average of the standard deviations of the individual titles. Therefore, diversification reduces risk. The lower the coefficient of correlation, the greater the potential benefits of diversification.

in agricultural production, farmers could benefit from a combination of the two activities to attain a higher yield and a lower risk.

[Insert figure 1 about here]

4   Methodology

As we alluded to in the previous section, it would be possible for rural farmers to invest in community-based wildlife conservation, and in some cases disinvest in agricultural production, as a way to offset exposure to risk in agricultural production without necessarily reducing the expected return if it could be shown that the rates of return on the two assets are negatively correlated. Thus, our methodology involves conducting a statistical analysis to determine whether community-based wildlife conservation is a feasible hedge asset for agricultural production. Empirically, finding the correlation coefficient from historical data on the rates of return on agricultural production and community-based wildlife conservation for each district (community) can help us show the districts for which community-based wildlife conservation is the asset for rural farmers to offset exposure to risk associated with agricultural production. Unfortunately, district-level data on communal agricultural production are not published in Zimbabwe. As such, we cannot compute the correlation coefficients on the rates of return on agricultural production and community-based wildlife conservation for individual districts. However, national data on communal agricultural production and community-based wildlife conservation exists for 1989-1999.[9] This national data covers all the 57 rural districts in Zimbabwe. National data on communal agricultural production was sourced from the Central Statistical Office while data on community-based wildlife conservation (i.e. CAMP-FIRE) was sourced from the Worldwide Fund for Nature Southern African Regional Programme Office (WWF SARPO). We therefore made use of this data to compute the national correlation coefficient on the rates of return on communal agricultural production and community-based wildlife conservation. Due to the highly aggregated nature of the data as shown in table 1 below, we can therefore only say whether or not community-based wildlife conservation is a feasible hedge asset at a national level rather than show the specific districts for which community-based wildlife conservation is the asset for rural farmers to offset exposure to risk associated with agricultural production.

[Insert Table 1 about here]

Before we report the results of our analysis in the next section, it should be noted that data on communal agricultural production and community-based wildlife conservation potentially suffer from at least four limitations. Firstly, wildlife in the community-based wildlife conservation framework is a unique resource that does not require the usual cash investment to acquire it as it is usually acquired freely from the parks agency and as such the rates of return on community-based wildlife conservation are likely be overstated. Also, some other kinds of investment are not taken into account in the community-based wildlife conservation data. For instance, foregoing opportunities for economically rewarding uses of land within a territory put under community-based wildlife conservation is an important kind of investment that should be captured. Damage that people put up with, guarding fields against wildlife intrusions, protecting fields with thorny-bush fences, and looking out for poachers also constitute another kind of investment that is usually omitted. All such omissions in accounting for relevant investments in community-based wildlife conservation further exaggerate the rates of return on community-based wildlife conservation.

A second potential limitation of the data on community-based wildlife conservation is that the benefits emanating from wildlife are more public such that their valuation depends on the constituency that one chooses, be it district, national or global. A related issue is that a large portion of public benefits associated with community-based wildlife conservation are non-monetised yet in

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[9]On the one hand, the data on the agricultural sector in Zimbabwe has not been released since the beginning of the so called "fast-track" land reform programme in 2000. On the other hand, data on community-based wildlife conservation only exists from 1989, when CAMPFIRE was established.

our quest to calculate the rates of return, we simply make use of the monetary values (revenues or financial profits) actually realised. These two factors could result in depressed rates of return on community-based wildlife conservation.

Thirdly, both the data on agricultural production and community-based wildlife conservation are also likely to understate physical capital investments. It is important to note that communal lands entail non-ownership rights to land except usufruct rights. As a result, there exists no market for land in these areas such that it is quite difficult to have the value of land invested in each of the enterprises. The division of land in Zimbabwe into five agro-ecological regions makes it difficult to infer the shadow value of communal land from commercial land because of differences in quality.

The final potential limitation of the data on agricultural production, and possibly community-based wildlife conservation as well, is that it ignores human capital investments. Given that the communal land farmers are predominantly subsistence farmers who use household labour and only sell surpluses to the market, the estimates of profit are likely to include the returns to labour (salaries and wages). Reliance on such data would yield abnormally high rates of return.[10]

5   Results

As we have reported in the previous section, district-level data on agricultural production and community-based wildlife conservation are not readily available in Zimbabwe. The analysis of national historical data on agricultural production and community-based wildlife conservation for the period 1989-1999, for which data exists for both activities, shows that agricultural production and community-based wildlife conservation are hedge assets. The correlation coefficient between the returns to community-based wildlife conservation and communal agricultural production is -0.56 indicating that rural farmers could use community-based wildlife conservation as a hedge asset and thereby reduce the risk they face by engaging in agricultural production only.

Figure 2 below shows the effect on the portfolio standard deviation of changing the investment weights between the agricultural production and wildlife conservation. This is obtained with the help of equation (1) (see textbooks such as Bodie *et al.,* 2002 for computational details). It should be noted that even though the investment weight of agricultural production does not appear in the graph, it is simply given by unity less the weight of wildlife conservation i.e. $1 - w_C$. Assuming that the investments made in agricultural production and wildlife conservation by rural farmers in 1999 exhausted all the capital available to them, we find that the investment weights were 97% and 3% for agricultural production and wildlife conservation respectively. The farmers were therefore facing a portfolio risk of 293. Figure 2 further shows that low investments in wildlife conservation are associated with high portfolio risk. Thus, there is room for the farmers to reduce risk by increasing investments in wildlife conservation. This is a plausible result since most of the land constituting rural areas is marginal land that is almost barren for crop production and not as suitable for livestock production as it is for wildlife conservation. Our calculations show that a 95% investment in wildlife conservation and a 5% investment in agricultural production would yield the lowest possible portfolio

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[10]The abnormally high rates of return on wildlife conservation may even be depressed because it has not been possible to judge potential wildlife income due to the difficult political conditions in Zimbabwe. It is believed that wildlife income is very sensitive to marketing and political stability. However, another school of thought suggests that the current political uncertainty has not significantly affected wildlife income going to CAMPFIRE since political uncertainty has mostly affected non-hunter tourists while CAMPFIRE derives most of its income from hunter tourists, who are relatively risk tolerant. The potential adverse impacts of political uncertainty on CAMPFIRE have also been harnessed by the fact that most safari operators to whom RDCs sell their hunting quotas are white and they have continuously been able to scout for foreign hunters, who are also predominantly white. For as long as these white safari operators have still been in Zimbabwe, and had to survive on the safari hunting business, they have done their best to encourage foreign hunters to come to Zimbabwe despite the political climate, citing their own continued existence in such a climate as an assurance. The CAMPFIRE revenue for the period 1989-2001 shows that trophy hunting revenue has been increasing steadily throughout the period while tourism revenue has fluctuated (see table A1 in the appendix).

risk, which is lower than the risk for any one asset on its own. Of course, in the end, the optimal portfolio will have to recognise the degree of risk aversion of the rural farmers.

[Insert Figure 2 about here]

As we warned in the previous section, the above results are derived from data that are highly aggregated and possibly riddled with errors of measurement with respect to investments and therefore may not be sufficiently reliable. We therefore suggest the further investigation of the empirical feasibility of using community-based wildlife conservation as a hedge asset to agricultural production for future research, especially in order to show the specific districts for which community-based wildlife conservation is a hedge asset for agricultural production and determine the optimal portfolio for each district.

6 Discussion

Our enquiry has focused on findings ways of offsetting the risk that rural farmers face from output uncertainty, emanating from uncontrollable elements such as adverse weather, pests, disease outbreaks, wildlife intrusions and other natural factors, but particularly droughts and wildlife intrusions. The two key messages from the results reported above are that (i) at a national level, community-based wildlife conservation is a feasible hedge asset to communal agricultural production, and (ii) there is currently room for rural farmers to reduce risk by increasing investments in community-based wildlife conservation. Without detailed district-level data, we cannot say which districts should be involved in community-based wildlife conservation. However, given that the community-based wildlife conservation model in Zimbabwe is centred on the creation of wildlife revenues from tourism, trophy hunting, meat cropping, live animal sales, etc., there has to be sufficient animal populations under community-based wildlife conservation to generate an adequate return. Therefore, we can speculate that highly marginal and wildlife-abundant districts such as Binga, Nyaminyami, Guruve, Hurungwe, Gokwe North, Hwange, Tsholotsho, Chipinge, Beitbridge, Bulilimamangwe, Chiredzi, and Muzarabani would potentially benefit from diversification into community-based wildlife conservation as a risk management strategy while other strategies, such as the wildlife damage insurance, could be investigated for the remaining wildlife-endowed districts.[11,12]

[Insert Figure 3 about here]

Figure 3 above illustrates our reasoning. In the more marginal Zone A, risks of drought and wildlife damage are both high but community-based wildlife conservation (CAMPFIRE) income is also large. CAMPFIRE income serves to reduce total portfolio risk since there are more opportunities for giving up some land for community-based wildlife conservation. It is most likely that it is more attractive to give up land for community-based wildlife conservation since it is likely to be more profitable than marginal agriculture, given the low land quality, high risk of drought and high risk of intrusion. While it may be conceivable that introducing wildlife alongside agricultural activities may

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[11]It should be noted that those areas without natural wildlife-abundance might have ecological constraints in managing agricultural risk through community-based wildlife conservation. The damages in these areas could still be high but rural farmers cannot use community-based wildlife conservation as a hedge asset because the animal populations will not be enough to generate an adequate return given that the Zimbabwean community-based wildlife conservation model is centred on the creation of wildlife revenues from tourism, trophy hunting, meat cropping, live animal sales, etc. For this to be applicable, there has to be a certain threshold of animals, which we reason will not be achievable in some areas due to ecological constraints, e.g., there might only be baboons which are not the typical valuable animals or there might be low population levels of the valuable species such that it would not be possible to generate wildlife revenues especially through hunting. In that case, other risk management strategies, such as wildlife damage insurance, constitutes a potential strategy for managing some of the agricultural risk especially that of wildlife intrusions in areas without wildlife-abundance. Better still, the wildlife abundant areas could benefit even more if they reinforced risk reduction through community-based wildlife conservation with yet another risk reduction strategy – wildlife damage insurance. However, this paper only focuses on the role of community-based wildlife conservation.

[12]As for the wildlife damage insurance, it has to be viable to be offered and it might only be viable in some less wildlife-abundant areas than others. Without data to assess the viability of the wildlife damage insurance, we refrain from making any serious recommendations but suggest future research in this area.

even increase the risk of their destruction it does not necessarily follow. As we said earlier, embarking on community-based wildlife conservation could entail cutting back on agricultural activities and sparing some land to act as buffer zones between agriculture and wildlife, if they are conflict-ridden, thereby insulating agriculture from the risk of wildlife intrusions.

In Zone B, CAMPFIRE income is low owing to the relatively lower density of wildlife, which nevertheless perpetrates damage. It would not be of much use if CAMPFIRE income is divided evenly. Instead, it could be used to support other risk management strategies such as electric fences to separate agricultural production and wildlife activities, and the wildlife damage insurance. If wildlife damage insurance were viable, then it could easily be implemented because damage is very rare in Zone B and could for that reason be monitored more easily.

To summarise, figure 4 below shows that Zone A may initially benefit from diversification through community-based wildlife conservation by moving from land-use alternative A to E and subsequently benefit from the wildlife damage insurance by moving from land-use alternative E to F. Zone B benefits from the wildlife damage insurance by moving from land-use alternative A to G. Land-use alternatives E, F and G depict lower levels of risk than the starting land-use alternative A. *[Insert figure 4 about here]*

7   Conclusion and implications

This paper focused on risk in agricultural production. Rural farmers' production activities are characterised by uncertainty due to unpredictable climatic conditions and wildlife intrusions into agricultural production, which is particularly serious in areas with high wildlife populations. Risk faced by rural farmers in agricultural production could potentially be managed by adding wildlife conservation as a land-use in the framework of CAMPFIRE. This could diversify and consequently reduce risk, particularly where evidence suggests that community-based wildlife conservation is a feasible hedge asset. National historical data for Zimbabwe suggests that community-based wildlife conservation is a feasible hedge asset for communal agricultural production and that there currently exists room for expanding investments in community-based wildlife conservation to reduce agricultural risk. Risk management through diversification into community-based wildlife conservation could help farmers deal with risks such as the risk of drought but it could also help efforts to conserve wildlife. Naturally this strategy does little to reduce the risk of wildlife damage, which is something the communities living adjacent to the game reserves have to learn to live with. In view of this, other risk management strategies such as wildlife damage insurance have been suggested for further investigation.

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APPENDIX

Table A1: Rural District Councils' Annual Income from CAMPFIRE Activities (US$)

Year	Sport Hunting	Tourism	PAC Hides & Ivory	Other	TOTAL
1989	326,798	28	5,294	17,690	349,811
1990	453,424	2,865	42,847	57,297	556,433
1991	638,153	15,904	20,859	101,105	776,021
1992	1,154,082	18,951	9,429	34,216	1,216,678
1993	1,394,060	21,095	14,988	53,730	1,483,873
1994	1,553,543	39,985	2,770	46,373	1,642,671
1995	1,476,812	54,866	11,685	48,204	1,591,567
1996	1,656,338	23,275	39,869	36,429	1,755,912
1997	1,708,234	71,258	44,331	13,615	1,837,438
1998	1,787,977	40,871	25,205	37,713	1,891,766
1999	1,940,366	78,709	720,440	14,442	2,753,958
2000	1,919,980	55,668	116,075	13,482	2,105,204
2001	2,142,306	41,439	111,914	32,793	2,328,452
TOTAL	**18,152,074**	**464,915**	**1,165,706**	**507,090**	**20,289,784**

Source: WWF SARPO, Harare

Notes:
1. Sport hunting - income earned from lease and trophy fees paid by safari operators.
2. Tourism - income earned from the lease of wild areas for non-consumptive tourism.
3. PAC Hides & Ivory - income from the sale of animal products primarily from problem animal control.
4. Other - income from the sale of live animals, collection of ostrich eggs and crocodile eggs, etc.
5. Mean annual exchange rate based on RBZ end of month exchange rates.

TABLES AND FIGURES

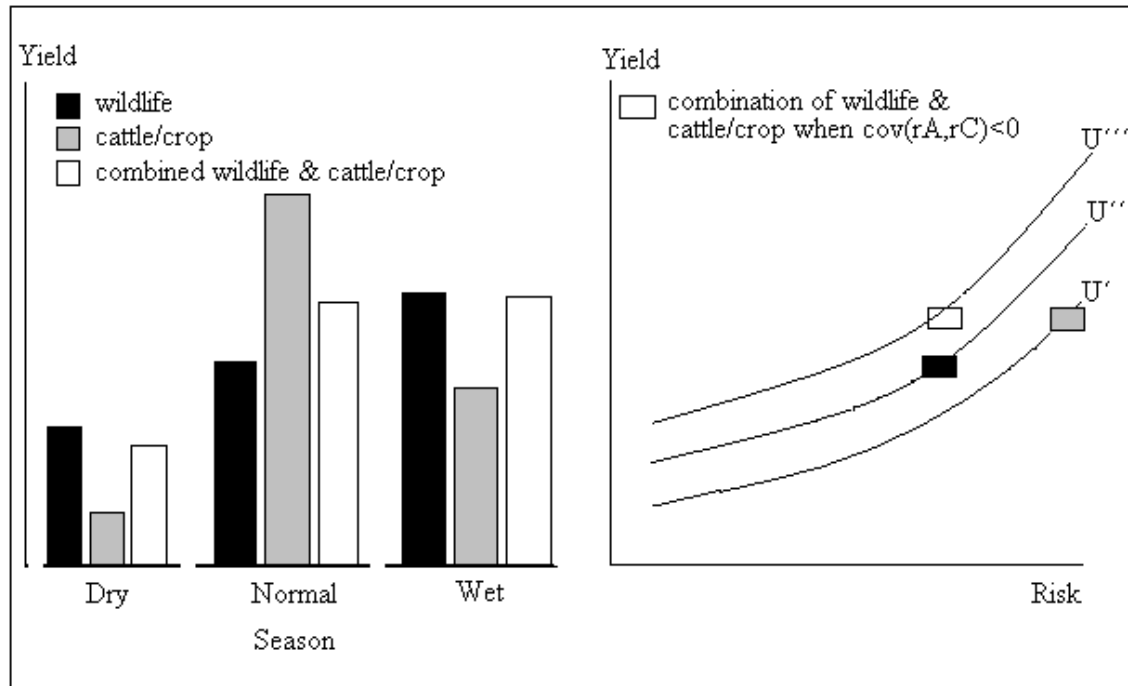**Figure 1: Farmers' benefits of diversification into community-based wildlife conservation**

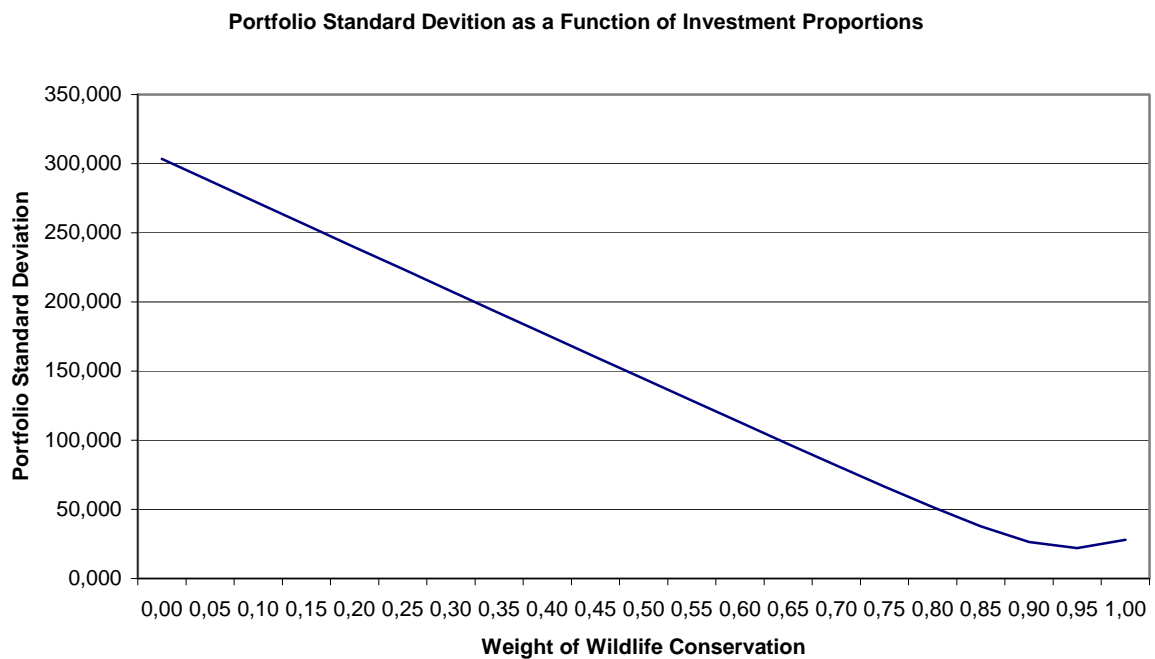**Figure 2: Portfolio standard deviation as a function of investment proportions**

Portfolio Standard Devition as a Function of Investment Proportions
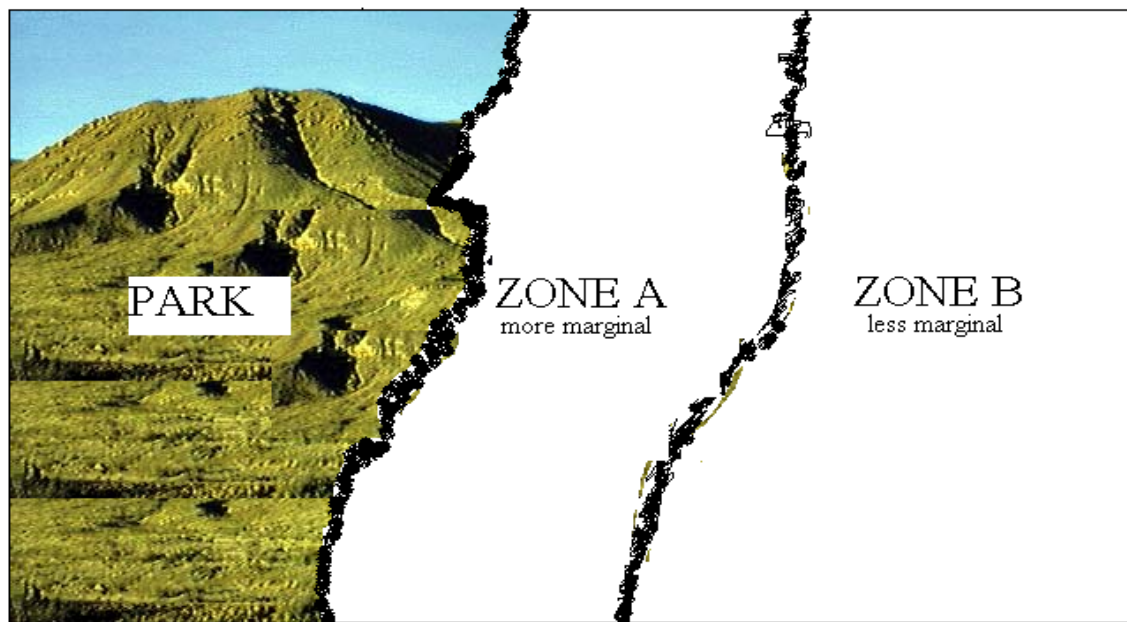
Figure 3: Zoning of risk management strategies

PARK

ZONE A
more marginal

ZONE B
less marginal

Figure 4: Risks associated with agriculture, wildlife conservation and wildlife insurance

Outcome

LAND USE ALTERNATIVES
A=marginal agriculture
B=game ranching
C=game hunting
D=marginal agriculture & game ranching
E=marginal agriculture & game ranching & game hunting
F=marginal agriculture & game ranching & game hunting & wildlife damage insurance
G=marginal agriculture & wildlife damage insurance
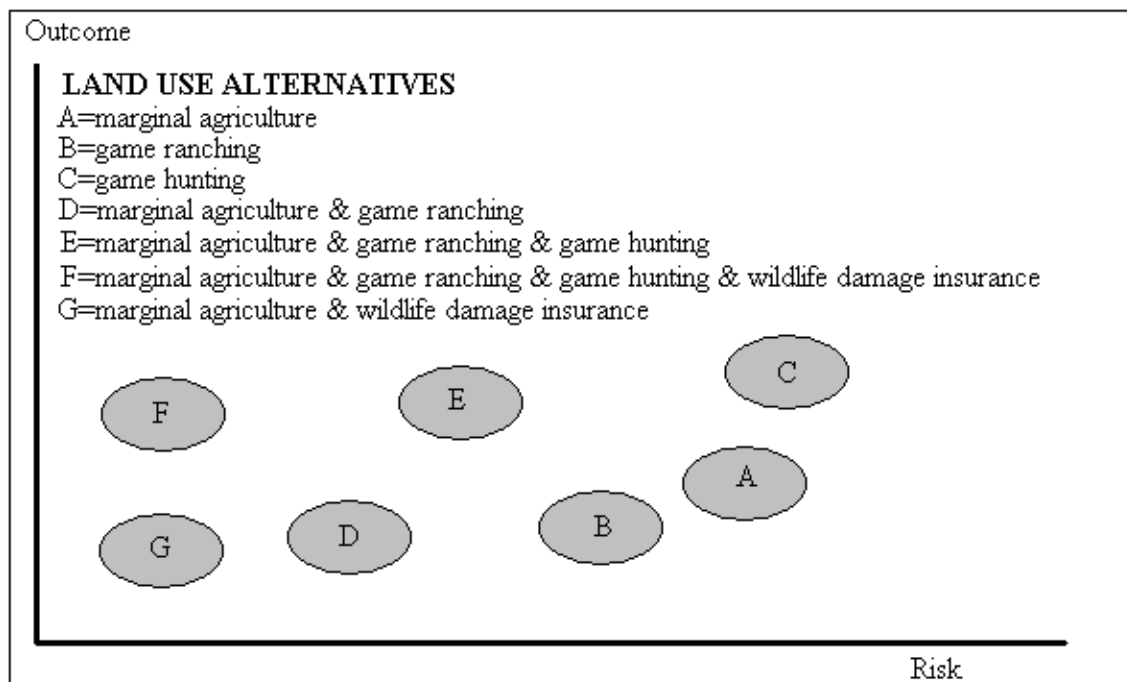
C

E

F

A

B

G   D

Risk

Table 1: Data on communal agricultural production and community-based wildlife conservation in Zimbabwe

Year	COMMUNAL AGRICULTURE (Z$000s)				COMMUNITY-BASED WILDLIFE (Z$000s)			
	Investment in Agriculture (inputs)	Gross Agricultural Output§	Total Agricultural Value Added	Rate of Return from Agriculture (%)§§	Investment in Wildlife (inputs)[1]	Total CAMPFIRE Income	Income Disbursed to Communities	Rate of Return from Wildlife (%)§§
1989	104,092	697,567	593,475	570	348	744	396	114
1990	95,178	1,060,741	965,563	1,014	866	1,376	510	59
1991	140,755	1,029,717	888,962	632	1,707	2,911	1,204	71
1992	200,961	396,359	195,398	97	3,145	6,220	3,074	98
1993	308,030	1,358,877	1,050,847	341	4,127	9,688	5,561	135
1994	427,816	3,195,059	2,767,243	647	5,695	13,490	7,795	137
1995	493,102	1,244,317	751,215	152	5,625	13,885	8,260	147
1996	914,062	4,062,724	3,148,662	344	9,293	17,682	8,389	90
1997	623,291	5,459,542	4,836,251	776	12,184	22,865	10,681	88
1998	982,231	8,759,214	7,776,983	792	23,925	46,110	22,185	93
1999	1,673,128	17,027,713	15,354,585	918	54,137	105,581	51,444	95

Sources: Central Statistical Office & WWF SARPO, Harare

§ Includes crops sales, production for own consumption, livestock sales and livestock herd changes

§§ own calculations

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[1] Under CAMPFIRE, almost 50% of wildlife revenues are distributed to rural communities with the remaining undisbursed revenues being channelled towards (i) wildlife and programme management in the area, and (ii) general district council administration and development. We therefore assume that the proceeds from wildlife that are not disbursed to the rural communities are their financial investment on wildlife since these are the funds that are currently used to carry out wildlife management functions on behalf of the rural communities.