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A prospective evaluation of contingent loans as a means of financing wild dog exclusion fences

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Abstract. Invasive species, such as wild dogs can be considered an externality arising from the activities of pastoral enterprises, with producers having limited responsibility for the problem and limited capacity to mitigate it. There are therefore arguments for government intervention through encouraging both individual and collective control measures. Governments are however increasingly inclined to ensure recipients of support make some contribution where there are private benefits. An example of this, in Australia, is the requirement that students repay some of the cost of their tertiary education. Using the issue of wild dog exclusion fencing in south-west Queensland as a case study, this paper considers if and how a policy instrument adopted for higher education (HECS-HELP), contingent loans, could be adapted to address problems of externalities in rural Australia. Central to the issue of exclusion fences are high upfront costs and highly variable incomes that limit the ability to recoup those costs according to a predictable timeline. Considering a range of incomes and a variety of private/government shares of the cost of the fences, we examine the effects of revenue contingent loans for the construction of these fences, using model farms developed from survey data for farm businesses in south-west Queensland. We find that contingent loans could mitigate the hardship effects of additional debt and variable incomes. Businesses with smaller properties and relatively lower incomes may however struggle to pay back larger loans. Using south-west Queensland as a case study, we show how different shares of contributions change the time to pay back loans, outline how a contingent loan scheme might be administered and note some issues with integrating personal contingent loans into a collective fence arrangement.

Additional keywords: collective action, predation on livestock, public benefit, rangelands grazing.

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Introduction

Wild dog predation on livestock has significant direct and indirect costs for landholders in the pastoral zones of Australia. 'Wild dogs' include dingoes, feral dogs native to Australia; more recently introduced breeds released, lost or fled from domesticated situations; and, hybrids of the two. Wool Producers Australia (2014) reported that in Queensland in 2009, production losses due to wild dog predation were $A16.9 million for the sheep and goat industries alone. The most significant losses are from predation on young livestock, especially in the case of sheep where lambs are particularly vulnerable. As an example of the financial effects, for a flock of 5000 meat sheep, a decrease in weaning rate, from 90% to 30% would result in ~3000 fewer lambs each year. Under prices at the time of writing, that would be an estimated annual loss to revenue of more than $300 000 after variable costs are excluded. Second, predation may contribute to livestock disturbance and stress, which then affects grazing patterns and efficiency, resulting in overall lower wool or meat production. Third, there may be an opportunity cost of predation for some landholders, as they choose, for example, to run cattle rather than sheep. Figure 1 shows a trend reduction in wool as a share of income among participants in regular sample surveys in a region of South-west Queensland (Meat & Livestock Australia 2017). With some land types, more suited to sheep than cattle, this trend may mean a reduction in income over time.

Wild dog predation on livestock is a long-standing concern, and colonial governments started constructing a major dingo 'barrier' in the 1880s, a fence that eventually ran through Queensland and South Australia, ostensibly protecting the south-eastern cropping and pastoral areas. Resourcing the maintenance of this fence decreased, notably in the 1980s in Queensland. Concern about declining sheep numbers and producer reports of dog attacks contributing to that decline increased over time, leading to a report that produced a 'conservative' estimate of annual losses of $33 million in

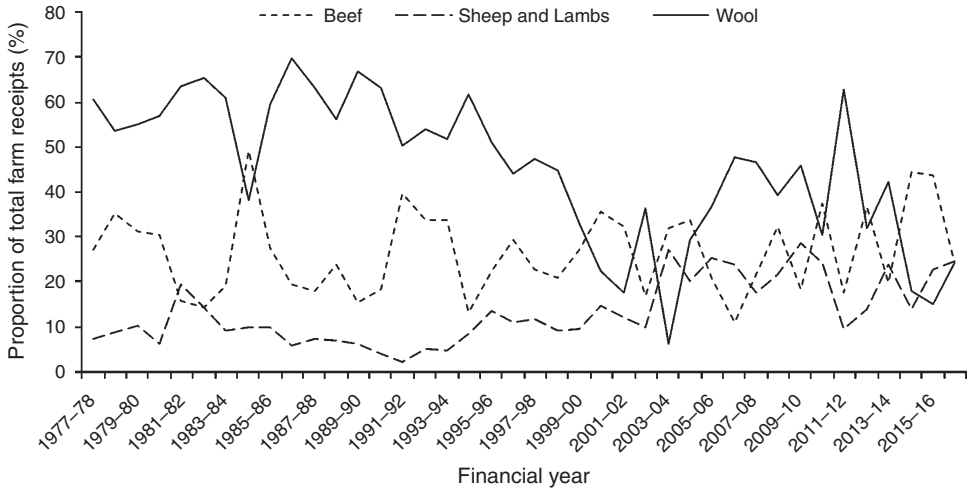

Fig. 1. Share of farm business receipts by product sales for a sample of farm businesses running some sheep in the Charleville–Longreach region. Source: MLA 2017.

Queensland, including the costs of urban wild dogs (Rural Management Partners 2004). Queensland's major agricultural industries lobby group, Agforce, then continued to lobby the State Government on this issue and was funded to commission a report focusing on impacts on the grazing industries (Agforce 2018). This report estimated a cost to those industries in Queensland of $67 million for the financial year 2008–09 (Hewitt 2009). According to a survey for that report, the primary control measures used by landholders were shooting, baiting (poisoning), use of guard animals and some exclusion fencing (Hewitt 2009). Political attention did however start to shift more towards fencing.

In 2015, the Federal Government announced a pest and weed management program as part of a drought assistance package. The Queensland Government recommended that money for the State should go to cluster fences, which would enclose a cluster or number of properties. Money from the Federal government was subsequently supplemented by the Queensland Government for additional work. Forms of financing under this program have included: grants, no interest loans and low interest loans. The aim of exclusion fencing of properties is to increase landholder production choices and effective livestock weaning and survival rates. If constructed to address total grazing pressure, fences have the potential to also reduce the grazing competition from kangaroos or goats, thereby enabling increased stocking rates for domesticated livestock. Therefore, exclusion fencing could potentially deliver significant private benefit to landholders who construct fences, whether just for their individual property or as part of a cluster. The cost of fence construction is, however, not insignificant and, for many landholders, may be prohibitive.

There are several arguments that can be made for a public contribution to exclusion fencing, as the advantages are not limited to the private benefits just described. First, the proliferation of wild dogs is a function of factors largely external to individual landholders. People who have lost or released domestic dogs, or landholders not participating in coordinated control campaigns are effectively creating or exacerbating an externality for livestock producers, but it is almost impossible to attribute the related costs to those responsible. Second, the mobility of the dogs (and kangaroos and goats) means that collective or at least coordinated action of some form will be more efficient and effective in constraining unwanted animals. Cluster fencing reduces the cost per hectare and per livestock unit and reduces the 'Swiss cheese' effect of unfenced properties providing havens for predators. Therefore, governments could provide incentives to encourage efficiency gains through collective action in a similar manner to larger collective systems, such as sugar and grain storage, transport, and marketing systems, which have in the past been subsidised and cross-subsidised.

To date the main argument evident in public and political discussions to justify government involvement is that exclusion fences could improve regional economic outcomes as a result of the increase in livestock production. This would especially be the case with an increase in the number of sheep for wool production, where the income and employment multipliers are higher than managing sheep, cattle, or goats just for meat. The Queensland Government estimated that its existing cluster fencing program, as at 2017, will result in an additional 400 000 sheep in the Longreach region, generating $5.7 million in flow-on wages in wool-related industries such as shearing (Burton 2017). There are claims that such fences could contribute to improved resource condition and even protection of endangered species (Long and Robley 2004). The evidence for this has however been disputed, or at least considered insufficient to draw a conclusion (Allen *et al*. 2013; Hayward and Marlow 2014). Another environmental argument against exclusion fences might be that wild dogs are actually limiting numbers of livestock and thereby limiting land degradation. A reduction in the number of wild dogs would however not automatically lead to an increase in available pasture and by extension ground cover, as these would then be much more a function of grazing management decisions, assuming the fence also controls kangaroo and goat numbers, as discussed below. Either way it is, beyond the scope of this paper to examine the case for, and returns from, any such benefits. We are interested in how governments

might facilitate the construction of wild dog exclusion fences rather than the justification for such intervention.

There are two related issues to address in providing government support to the financing of exclusion fencing. One concerns the most effective and efficient style of fence construction to be supported, that is, whether the fence should enclose individual properties or groups of properties through cluster fencing. The other, and main focus of this analysis, concerns the type of financing available to support fence construction. Institutional pathways for finance for fences have so far included regional NRM organisations, usually through grants to top up private investment, and a local council (Longreach) providing low-interest loans from state government finances. Even with little or no interest, loan repayments can however be difficult with highly volatile revenue flows. We begin with a discussion of a novel and innovative policy mechanism for supporting the financing of exclusion fences at the individual property level, the use of income contingent loans. To date contingent loans have only been applied in the context of higher education financing, although a range of other possible applications of the model have been discussed in the academic literature.

Contingent loans: theory, application and design

There are several ways in which governments can become involved in supporting the financing of activities seen to have at least some element of public benefit. This can be done through the direct provision of long-term low interest loans, or the provision of subsidies on the interest paid on commercial finance. Both of these forms of government involvement have been used by Australian governments to support activities in the agricultural sector, with both used in the case of drought loans and the latter also in rural adjustment schemes. Grants, whether in the form of lump sum payments or subsidies on interest payments, can be costly to the taxpayer and the public benefit can be difficult to identify.

In the absence of government intervention commercial financing is available for farms, as for other businesses, and is provided through conventional mortgage-style loans, which are generally secured against a physical asset such as a farm. This security provides the lender with some recourse to potentially reclaim funds should the borrower default. Although this form of financing is appropriate and successful across a range of applications where investors need to borrow funds to supplement their own resources, there are circumstances under which it is likely to deliver suboptimal outcomes for either or both the borrower and the lender. In the case of farm financing, farmers may be risk averse, resulting in reduced borrowing for investment in agricultural activity. One reason for this reluctance to borrow relates to the risk of defaulting on the loan in low-income years, resulting in loss of the collateral against which the loan is secured, that is, the farm itself. As the family farm is frequently also the family home – which may have been in the family for several generations – many farmers are not prepared to take this risk. There may then be some degree of 'market failure', with demand for funds for investment but the supply of funds is not attractive to the prospective borrower because of its form and conditions.

We propose an alternative approach – government-provided contingent loans – that are something of a half-way house between the provision of grants to support desirable activities and a free market approach that leaves investment decisions to individual business managers supported by commercial finance. Contingent loans are linked to capacity to pay and are not secured against an asset, in essence they are secured against future income (or revenue) streams. Contingent loans are appropriate in several circumstances, including, but not only: (i) where there are both public and private benefits associated with the activity being financed; (ii) where there is risk aversion on the part of potential borrowers resulting in economically suboptimal levels of investment in the activity; and (iii) where there is no appropriate collateral for the loan linked to the activity. The best known contingent loan system is Australia's Higher Education Contribution Scheme (HECS), which has been emulated in several countries. Contingent loans are very flexible for governments as the policy settings can be adjusted to reflect particular values and goals. For example, a contingent loan for a particular investment could be subsidised through having no or low interest rates or not seeking recovery of administration costs, if public benefit was assumed, through to adding a commercial interest rate or some other surcharge for the capital to make the scheme close to cost-neutral for public investment. Contingent loans have the advantage over grants in that repayment and even a return on funding can be built in and government can therefore expect to receive a proportion, if not all, of the expenditure back thereby freeing up resources to direct to other government priorities.

Because standard loans, whether provided commercially or low interest loans provided by government agencies, generally require a fixed, regular repayment they are insensitive to the financial circumstances of the borrower, which can be a particular problem when incomes are highly variable, as in agricultural production. A contingent loan ensures that the borrower does not experience hardship in periods of low incomes and can make substantial inroads into the debt in periods of high income. Farm incomes are notoriously volatile so a requirement to make regular repayments of a fixed amount can result in considerable hardship in very low-income years. Figure 2 illustrates the impact on farm cash flow of the two styles of loan. These figures are derived from an annual survey of samples of pastoral businesses in south-west Queensland (Meat & Livestock Australia 2017). The figure compares the proportions of revenue (farm cash income) required to service debt. A contingent loan repayment plan has a constant proportion, whereas the mortgage loan would have considerable variations in the proportion of income needed to service debt, with those variations strongly associated with seasonal conditions. This could result in considerable hardship to farmers and their families in low-income years.

Income volatility is apparent from data from a separate survey and review of farm businesses in the same region ($n = 1243$), which concluded that from 1989 to 2014, the proportion of properties where the interest : receipts ratio exceeded 15%, ranged from less than 5% to more than 40% (ABARES 2014). In 21 of 25 years, this ratio was above 20% and in 8 years more than 30%. That is, with dry conditions, especially in combination with lower prices, more farm businesses have to pay a relatively

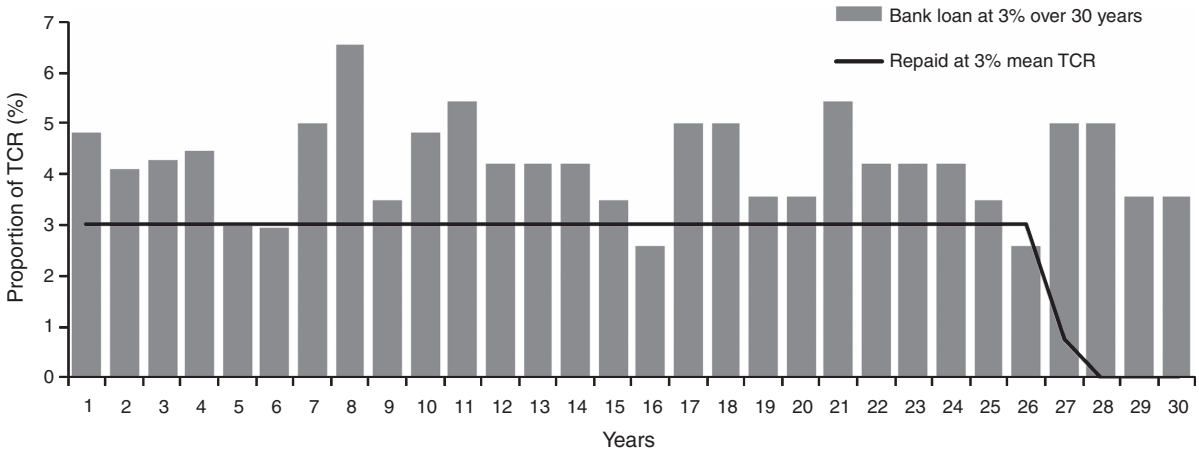

Fig. 2. Proportion of revenue used to repay a contingent loan and a mortgage-type loan by a 13 000-ha farm with mean total cash receipts. The mortgage- type loan assumes a 30-year loan of $175 000 (50% of total cost) and 3% interest.

high proportion of revenue to service debt. Some businesses are especially vulnerable. For the south-western pastoral region of Queensland, ~57% of respondents had at least 90% equity but 14% had equity of less than 70%, whereas for all of Queensland, 10% of farm businesses surveyed had less than 70% equity (ABARES 2014). From the data used as the base of the modelling below (Meat & Livestock Australia 2017), for the average of the properties ($n = 20$–30) there were 8 out of 30 years in which farm cash income (net of direct costs) was negative. Therefore, in the study region there are some properties that are likely to have relatively high debt servicing costs with many more experiencing additional costs in the frequent dry years. In addition, debt increases in dry years (ABARES 2014) with extra borrowing and perhaps an escalating inability to meet repayments.

In this sense, contingent loans play the type of consumption smoothing role familiar to farmers through schemes such as Farm Management Deposits. Farm Management Deposits are a mechanism that provides favourable taxation treatment for deposits into the scheme as an incentive for farmers to put aside money in high income years to be accessed when needed in subsequent periods of low income, for example during drought. For the contingent loans, borrowers enter into a commitment to repay a proportion of future income or revenue until the loan is repaid. The repayments are therefore explicitly linked to capacity to pay; the amount due varies as the borrower's circumstances vary. This makes this style of loan attractive for investment in the agricultural sector as it addresses the two limits on traditional forms of farm borrowing listed above by (a) not putting the farm at risk of foreclosure, and (b) responding to fluctuations in farm incomes and therefore not risking undue hardship in low-income years.

Contingent loans generally require government involvement. This form of lending is likely to be unattractive to private financial institutions looking for securities against loans and predictable repayment schedules. In addition, only government has the power to compel the financial reporting required to ensure that borrowers do not misrepresent their income in order to minimise their repayment obligations. Government also has the mechanism through the Australian Tax Office to enforce collection of repayments. Table 1 sets out the key differences between conventional loans, grants and contingent loans.

In summary, there are two key features of income contingent loans that make them appealing to policy makers and borrowers. These are:

- consumption smoothing, as debtors pay nothing when incomes are low, and proportionately more when incomes are relatively high; and
- insurance against default, which would otherwise result from low income (Chapman 2014).

Within the academic literature, the policy aspects of contingent loans have been considered from the perspectives of a range of disciplines, including economics, political science, anthropology and criminology. Policies or proposals have been associated with the financing of: higher education (the HECS-HELP Scheme); drought relief (Botterill *et al*. 2017); the payment of fines for both low level criminal offences and white-collar crime (Chapman *et al*. 2004*b*; Chapman and Denniss 2005); Indigenous land development projects (Altman and Dillon 2004); and Research and Development investments (Denniss *et al*. 2009).

Other than the HECS-HELP scheme, the proposal for the provision of drought relief through a revenue-contingent loan is the most developed and of particular relevance to the financing of other farm activities, such as the construction of exclusion fencing. The drought relief case is instructive, as the problem is unpredictable, it contributes to significant revenue volatility and it is beneficial for the farm businesses and the broader economy if post-drought reinvestment is relatively rapid. Issues of moral hazard and adverse selection, whereby land managers may arrange their affairs to minimise or avoid repayment obligations can be addressed in the policy design. Botterill *et al*. developed a policy instrument with respect to drought that addresses these and other issues (Botterill and Chapman 2004, 2006, 2009; Kelly *et al*. 2004; Botterill *et al*. 2017). These could also apply to loans for particular projects, such as a wild dog fence.

As an established, successful and relatively efficient working contingent loan scheme, the HECS-HELP model provided the basis for our study of financing wild dog fencing. We incorporated modifications for the context of farm businesses,

Table 1. Summary of benefits and limitations of financing options

Category	Mortgage-style loans	Contingent loans	Grants
Lender/grantor	Government or commercial entity	Government	Government
Linked to borrower's capacity to pay	No	Yes	n/a
Income smoothing	No	Yes	n/a
Possibility of default	Yes	No	n/a
Cost to public finance	No	Depends on policy settings	Yes
Administrative costs	Variable	Can be low	Low
Administrative commitment	Life of loan	Life of loan	Short term
Public benefits of investment	Can have	Can have	Should have

as set out by Botterill and Chapman (2009) in their consideration of contingent loans for drought relief. In the case of HECS-HELP, repayments are generated from *taxable income* and collected through the Australian Tax Office. Repayments are triggered when taxpayers reach a threshold level of taxable income. This is a relatively reliable indicator of the borrower's welfare, and the repayment rate can be determined with some precision in order to meet the public policy goal of timely repayment of loans without imposing undue hardship on the taxpayer. For the case of loans to primary producers there are however both moral hazard and capacity to pay issues. As to moral hazard, farm business managers have some scope to manipulate taxable income, given deductions for some forms of investment, and the use of Farm Management Deposits. Therefore, repayments could be delayed or minimised indefinitely with some particular arrangements. As was the case for the drought relief proposal, we therefore model based on *revenue* rather than income, and discuss how this might be administratively managed later in the article. It should be noted, however, that revenue is a poorer indicator of the borrower's capacity to repay than income as it is a gross measure and therefore insensitive to factors such as differing farm cost structures. This has implications for the level of interest or surcharge (if any) to be applied to the loan amount and the proportion of revenue that forms the basis of the repayment. Putting this aside at this stage, the first step is to explore some more fundamental scenarios around capacity to pay.

Methods

The model developed for this paper is based on the provision of revenue contingent loans to farm businesses for the purpose of constructing wild dog exclusion fences. In the first instance, we are assuming that the fencing will be for individual farm properties, not in a cluster arrangement, however the scale issues revealed by the modelling described below suggest that cluster arrangements also warrant consideration. The modelling generates net revenue for grazing enterprises that have at least some income from wool and sheep, with farm finances derived from surveys of a sample of properties in south-west Queensland (Meat & Livestock Australia 2017). The time series farm revenue and farm area data are from the Australian Agricultural and Grazing Industries Survey. The survey is conducted annually and covers farming establishments with revenues above a given threshold, which rose from $22 500 in 1991 to $40 000 since 2004. Area and financial data were downloaded for *Specialist Sheep Farms*, *Mixed Enterprise Sheep Farms*, and *All Sheep Industries Combined* in two Queensland regions – the *West* and *South-West* and the *Charleville–Longreach* regions (Meat & Livestock Australia 2017). Average revenue per hectare data from 1996–97 through 2015–16 were used to develop projected Years 1 through 20. Data from the last 10 years (2006–07 to 2015–16) were then repeated for projected Years 21 through 30. The reason for the repetition was to reflect more closely recent years' prices and conditions. This does mean however, that the effects of the 'Millennium' drought (2002–09), a very severe period of dry years, will be repeated. There might therefore be an argument that long-term production could be greater than this constructed period but against that is an argument to consider the effects of climate change. The repayments for the contingent loans are then modelled as varying proportions of that revenue and, from that, repayment schedules can be estimated.

The objectives of modelling were to examine five factors in relation to the payment schedules associated with a revenue contingent loan provided for the purpose of fence construction:

- property scale (area);
- level of revenue (farm business performance);
- productivity gains when factored into historical revenues;
- different interest rates or surcharges; and
- levels of private and public contributions.

For the scale analysis, three initial borrowing scenarios were:

- a 13 000-ha property with a $350 000 fence;
- a 26 000-ha property with a $500 000 fence; and
- a 40 000-ha property with a $620 000 fence.

These were chosen to reflect different property sizes, economies of scale, revenue levels and fencing project costs. In the initial scenarios, the full cost of the fence is included in the loan and the cost of fencing was based on simple rectangular perimeter calculations for each property by the cost of fencing ($7000/km), as advised through consultation with key informants from South-West NRM, a regional natural resources management organisation that has been involved with collaborative fencing projects. So, for example, enclosing a rectangular 13 500 ha would require ~48 km of fencing, rounded up to acknowledge that such neat symmetries would be rare. Hence, 50 km by $7000 is a $350 000 fence.

To show the effects of different levels of farm performance, as indicated by revenue, three types of farms for each of the

Table 2. Distribution of revenue for Queensland sheep farms, 2000–2015

	Percentiles								
	P10	P20	P30	P40	P50	P60	P70	P80	P90
Average 2000 to 2015[A]	–66%	–52%	–42%	–33%	–14%	+01%	+21%	+81%	+105%

[A]The percentage values shown are the mean difference between farms in that percentile and the average for each year (2000–2015).

property sizes were created: low, mean, and high revenue, represented in the figures below as Low Total Cash Receipts (TCR); Mean TCR; and High TCR. A farm with a 'low' revenue is defined as a farm with revenue equal to half the mean total cash receipts for that year. A farm with a 'high' revenue is defined as a farm with revenue equal to 1.5 times the mean total cash receipts for that year. A farm with a 'mean' revenue is defined as a farm with revenue equal to the mean total cash receipts for that year. The basis for the sub-scenarios of 0.5 and 1.5 times mean cash receipts is shown in Table 2.

Table 2 shows the average variation from the mean of revenue of Queensland sheep farms by percentile over the period 2000–2015. These distributional data were provided by ABARES for a related project (Botterill *et al*. 2017). To help explain the table, consider a farm that has revenue where half the other sheep farms in Queensland have more and half have less. This farm is on the 50th percentile (P50). This P50 farm averaged 14% less revenue than the mean over the years 2000–2015. A farm having an average revenue of 0.5 times the mean approximates to a farm at the 25 percentile, whereas a farm with 1.5 times the mean is approximately at the 75 percentile.

Exclusion fencing is justified on the basis of (potentially significant) productivity improvement. Our model therefore considered three scenarios to reflect increased revenue following fence construction: 10%, 25% or 40% increases. These are based on three potential benefits to production from an exclusion fence:

- an increase in lambing and weaning rates as a result of reducing or eliminating wild dog predation;
- a slight decrease in overall adult sheep death rates; and
- an increase in sheep stocking rates over time as kangaroo numbers inside fences decrease.

The base data for this part of the analysis were again from the MLA/ABARES farm survey price and production data for each of the Charleville–Longreach and the West and South-West regions of Queensland. Carrying capacity and lambing and death rates vary with seasonal conditions, decreasing and increasing respectively in drought years. For example, from the survey data, reported lambing rates for Charleville–Longreach over the last 30 years have varied from 40% to almost 75%. Given that some degree of variation is inevitable, we modelled proportionate changes for stocking rates, lambing rates and livestock death rates. That is, these were assumed to improve in all years, but would still vary proportionately according to historical rates.

For the kangaroo exclusion effect, we assumed a pre-fence kangaroo density of 15 dry sheep equivalent (DSE)/km^2 (0.15 DSE/ha), based on the reports from south-west Queensland from the Australian Collaborative Rangelands Information Systems (Bastin 2012). That rate is higher than reported in 2012 (11–12 DSE/km^2) but the trend was upward in this decade. Exclusion of most of these kangaroos would allow sheep flock numbers to increase, for example on a 20 000-ha property, by 1500 DSE. Tables 3 and 4 show one scenario for each of the two study regions, with the result close to the 40% one, primarily used for the modelling.

Table 3. Averages of variables by three scenarios for Charleville–Longreach region

Variable	Historical	Predation exclusion	Plus kangaroo reduction
Death rate (adult sheep) (%)	9.2	5.5	5.5
Lambing rate (%)	61[A]	85	85
Marking rate (%)	49	67	67
Increase in adult sheep no. (%)	–	0	21
Increase in revenue (%)[B]	–	11	37

[A]Lambing rates are highly seasonably variable and are also likely to be much lower on some properties.

[B]Based on historical (1985–2017) prices for wool and sheep. The actual modelling would have average prices that are slightly higher due to recent prices.

Table 4. Averages of variables by three scenarios for the West and South-West region

Variable	Historical	Predation exclusion	Plus kangaroo reduction
Death rate (adult sheep) (%)	10	5.9	5.9
Lambing rate (%)	57	83	83
Marking rate (%)	45	67	67
Increase in adult sheep no. (%)	–	0	27
Increase in revenue (%)	–	12	34

It would be a matter for policy decision as to the level of subsidy that a government might be prepared to offer for a contingent loan scheme for wild dog fencing. In order to minimise the cost to the budget, either an upfront surcharge could be added to the debt or an interest rate applied over the lifetime of the loan. Either of these measures could help cover the cost of government borrowing to finance and administer the scheme and therefore could indeed be structured to ensure that there was no net cost to the budget at all. To examine the effects of different interest rates (1% and 2%), or the application of a surcharge, we incorporated those into the modelled repayment schedules. The model also allowed for the inclusion of a farmer contribution to the cost of the fence of 0%, 25%, 50% or 75%. To date, other funding mechanisms have been based on or about a 50% landholder direct contribution.

Results

As discussed in the introduction, public funding of exclusion fences is being promoted as regional development policy but

with private benefits. Given this, the results presented below assume that half of the cost of exclusion fencing would be funded publicly and half would be borrowed by the farm. A small farm (13 000 ha) borrowing half the cost would require a $175 000 loan and a large farm (40 000 ha) would require a loan of $310 000. Other options ranging from 100% farm contributions to 0% contributions are considered later in the paper. Figure 3 shows differences based on scale and on revenue generation. In summary, larger farms will have a greater capacity to repay the loan. Second, there will be considerable differences in repayment times.

The large farm could repay the full fence cost in 6 years with the mean size repaying in 10 years, compared with the best case for the small farm being 11 years, with the mean being 16 years, and small farms with a low TCR would take more than 30 years. Increasing productivity (Fig. 4) will decrease the repayment time, but this would not necessarily offset adding either interest or a surcharge.

With productivity improvements, even a modest interest rate of 2% increases the repayments for low revenue farms beyond 30 years and in the case of small farms with low revenue would require a very long repayment period.

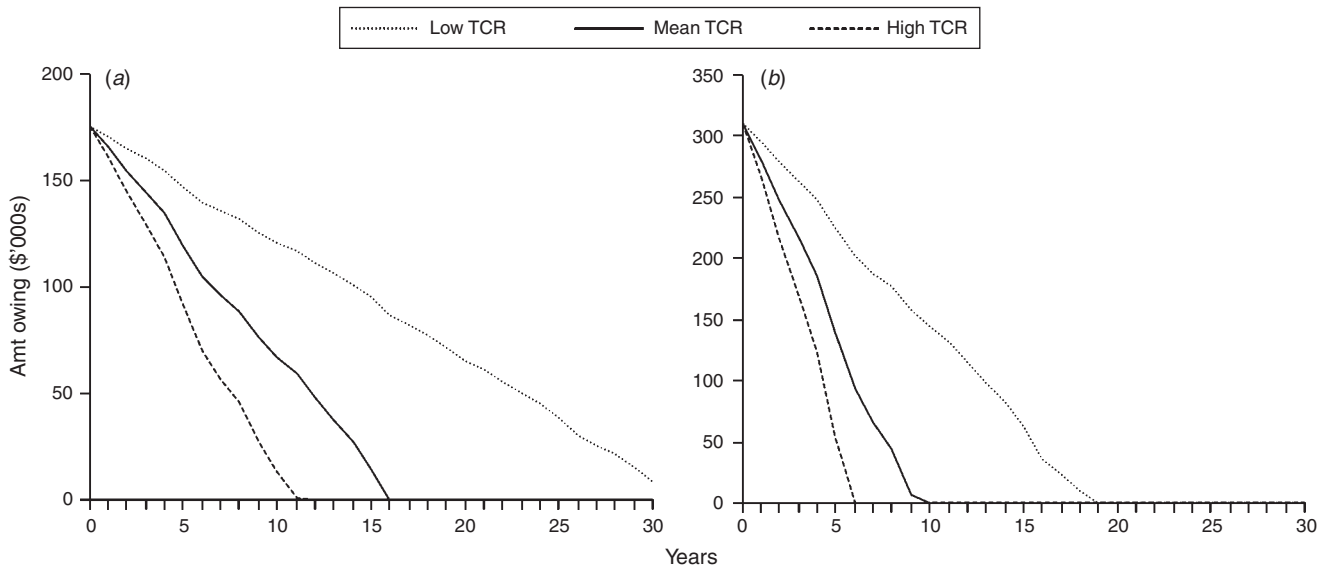

Fig. 3. Payment schedule for loan with 50% subsidy, no interest, 5% (of revenue) repayment rate and 40% improvement in total cash receipts for: (*a*) small and (*b*) large, sheep farms.

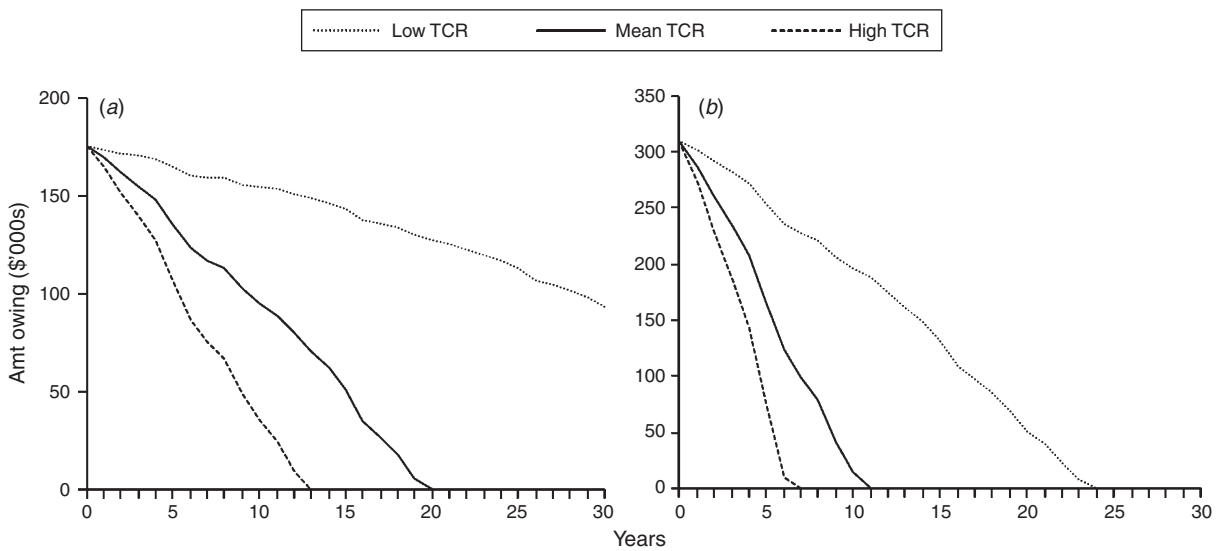

Fig. 4. Payment schedule for loan with 50% subsidy, 2% interest, and 40% improvement in Total Cash Receipts for: (*a*) small and (*b*) large, sheep farms.

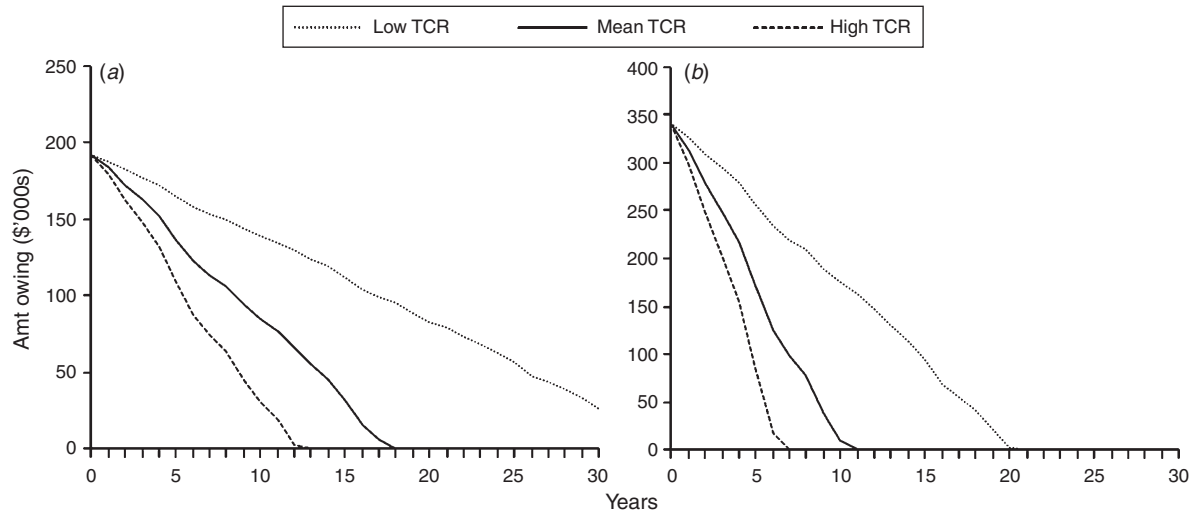

Fig. 5. Payment schedule for loan with 50% subsidy, no interest, a 10% surcharge, and 40% improvement in total cash receipts for: (*a*) small and (*b*) large, sheep farms.

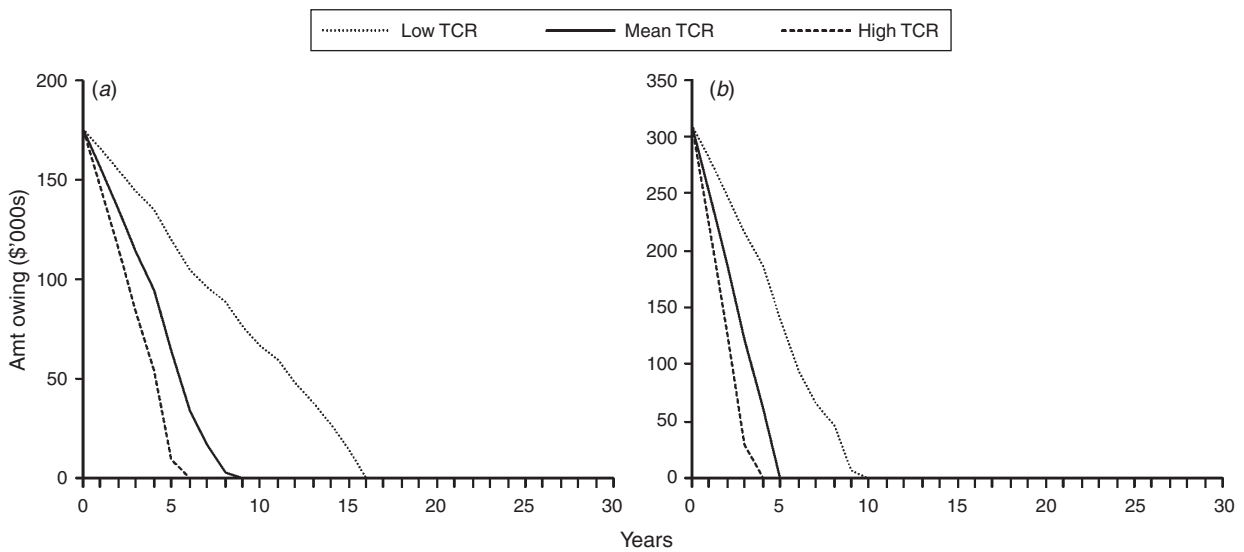

Fig. 6. Payment schedule for loan with 50% subsidy, no interest, 10% repayment rate, and 40% improvement in total cash receipts for: (*a*) small and (*b*) large sheep farms.

A surcharge seems to enable better relative outcomes from the small farm, as suggested by Fig. 5.

In order to improve repayment prospects, the repayment rate could be increased to 10% of revenue (Fig. 6), however, this could greatly increase the risk of repayment hardship given the relatively crude nature of revenue as a measure of capacity to pay, as noted above.

The repayment times for different policy settings are summarised in Table 5, including farmer contributions of 0–75% of the cost of the fence.

The surcharge reduces the repayment time for large farms on loans for the full cost of the fence, but otherwise there is little difference to applying a 2% interest rate. Recall however that low and median income small farms will be able to repay a loan more quickly with a surcharge than with 2% interest. The larger loans will significantly increase repayment times, especially for the small properties.

Discussion

Implications for policy design

As illustrated above, there are a range of policy parameters that can be adjusted in designing a contingent loan instrument. These include:

- the proportion of the cost of fencing to be borne by the lending body and the farmer;

Table 5. Repayment projections (years) under different policy options

Farmer contribution (% of total cost)	0%			25%			50%			75%		
Farm size (small, medium, large)	S	M	L	S	M	L	S	M	L	S	M	L
Interest rate												
0%	30+	24	19	26	18	15	16	12	10	9	6	5
1%	30+	26	21	28	19	16	18	13	10	9	6	5
2%	30+	30+	24	30+	22	17	20	14	11	9	6	5
Surcharge												
5%	30+	26	20	26	19	15	17	13	10	9	6	5
10%	30+	26	21	26	19	16	18	14	11	9	6	5

- the addition of a surcharge, which reduces the interest rate subsidy implicit if no interest is charged;
- the inclusion of an interest rate to cover the government's cost of borrowing; and,
- the repayment rate as a percentage of farm revenue.

Theoretically, if the government's cost of borrowing is covered in full by either the application of an interest rate or a surcharge, the length of time to repayment is irrelevant in budgetary terms. This would however, need to be weighed against the political desirability of having these loans on the government's books for the long term and the fact that, for some farms, the impact of compound interest could see the debt of some properties actually increase over time.

A government could decide to subsidise these loans on the basis of the public benefit associated with fence construction. There could even be a performance contract between borrower and government that included consideration of stocking rate (practice indicator) or post-fence land condition (outcome indicator). The payment for public benefit could then take the form for example, of the government requiring only 80% repayment. Second, if the interest rate on the debt was below the government's cost of the borrowing, there is an interest rate subsidy. For debts in which repayment takes a long time (for example, more than 10 years) interest rate subsidies can be significant and even constitute the main implicit cost to the budget of a loan scheme. Factoring in interest to cover the government's cost of borrowing would however increase the amount owed and therefore the time that would be taken to repay the loans.

Repayments would be set at a standard percentage of gross revenue, with scope to increase the repayment percentage above a given revenue level. This could be desirable in terms of reducing the time frame within which the government/funding agency could expect to receive the repayment of a reasonable proportion of the amount lent.

Administrative considerations

The general assumption underpinning both existing and proposed income/revenue contingent loan schemes is that they be set up and administered by the federal government through the Australian Taxation Office. The Australian Taxation Office has experience with the administration of HECS-HELP, which it operates at relatively low cost; the cost to the taxpayer of collecting HECS-HELP is of the order of 2% per annum of annual HECS-HELP revenue receipts (updated figure from Chapman 2014). It also has both the legal backing to require accurate reporting of personal income and established administrative processes for collecting taxes through employer withholding and requiring payment in advance from businesses or individuals where previous income has outstripped the tax liability. Should a state government decide to set up a contingent loan scheme without a national scheme being in place, the administrative arrangements would be more complex and therefore more costly, though just how costly is hard to estimate given that cross-jurisdictional repayment collection would be a new arrangement.

In order to reflect the lag time between the construction of the fence and the recovery in sheep and lamb numbers, recipients of a fencing loan might not be required to make any repayments for 12 months. In this case, policy makers could consider a discount for farmers who choose to repay the loan partially or in full during this 12-month period. This would encourage early repayment by those with the capacity to do so, thereby improving the speed at which government would recover these loans, though such rapid repayment is likely to be rare, given seasonal and market fluctuations and the range of other costs for a grazing enterprise.

Many of the issues of potential adverse selection and moral hazard associated with a revenue-contingent loan for wild dog fencing have been addressed in the development of the proposed drought loan (see Botterill and Chapman 2009). Attaching the repayment obligation to the farm's Australian Business Number, which is a form of identification in the tax system, is the starting point of measures to ensure repayment. The drought loan proposal (Chapman *et al*. 2004*a*) also included measures to address the sale of the farm property, the death of the farmer, other changes in ownership arrangements, and in the case of bankruptcy. All of these could be adopted for a wild dog fencing scheme. These measures assume a system run through the Business Activity Statement and the Australian Taxation Office. Any system that moved away from the direct involvement of the Australian Taxation Office would complicate collection in the event of change of farm ownership.

In order to minimise adverse selection, the loan scheme could be available to cover only a portion of the cost of the fence with the borrower required to cover the balance either from their own resources or from the commercial financial sector. As we understand it, most current schemes require 50–60% of private input. A commercial financial institution would be concerned to ensure that their portion of the loan would be repaid and are likely to deny finance to those they deem risky. If the farmer is

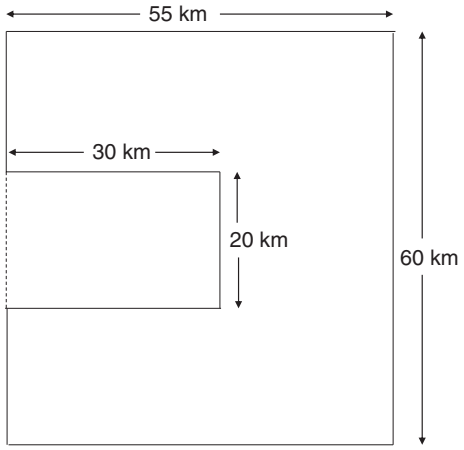

Fig. 7. A hypothetical fenced property with the potential for a later addition.

unable to raise funds to cover even a small portion of the cost of financing, this suggests that their prospects of repaying the larger loan would be poor. Alternatively, financial institutions may yet be unsure about the benefits of fencing.

Individual property versus cluster fencing arrangements

The modelling described above demonstrates the economies of scale that can be achieved through the fencing of larger properties. By extension, this implies that cluster or cell fencing, the fencing of groups of adjoining properties, is a more efficient use of both private and public funds. In addition, cluster fencing minimises the potential 'Swiss cheese' effect, which would see predators (and likely kangaroos) relocating and possibly concentrating in unfenced areas thereby exacerbating the problem for unfenced properties. Piecemeal building of individual fences also has the potential to result in the construction of fences that could be superseded if consolidation and infilling of previously unfenced areas were to occur. However, the costs of removing predators and grazing competitors from larger areas may be relatively higher, though there are no studies of that to date. Additional internal barriers may therefore make predator and competitor management easier.

Figure 7 shows a simple hypothetical case of a later addition to a cluster of properties. In this case the initial cluster enclosed 270 000 ha, perhaps 10–13 properties, but 3–4 others (60 000 ha) stayed out of the arrangement, only to join later. A Queensland Government map of cluster fencing to March 2017, shows both some similar shapes and where different projects have ended up with a shared boundary (Queensland Government 2017). For the simplified example here, the initial cost would be \$2.03 million (290 km × \$7000/ha) or \$7.5/ha enclosed. Had the other properties participated in that fencing, the total cost would have been \$1.61 million (230 km × \$7000/ha) and \$4.89/ha. This raises questions as to what might be done to encourage or facilitate 'efficient' agglomerations.

To date, proposals for contingent loan schemes have not addressed the financing of large-scale collective action. These have been focussed on providing finance to individuals or single businesses. Investment in cluster arrangements would maximise the value of investment in wild dog exclusion fencing, however, it would require innovation in the development of a contingent loan scheme. At present, participants in cluster fencing make a contribution to an incorporated entity, either from their own existing resources or with commercial finance. In principle there is no reason why participants in the incorporated fence entity could not access a contingent loan to meet their obligations as part of that entity. This would require further policy consideration, however using contingent loans to finance participation in cluster arrangements should be possible.

Conclusion

The introduction of revenue contingent loans for wild dog exclusion fencing would be a long-term investment for the funding body. Even with an interest subsidy, the best-case scenario that was modelled would not see any loans repaid in full in under 13 years at a repayment rate of 5% of revenue per annum. Doubling the rate would substantially decrease the repayment time but increases the risk of hardship for some borrowers. The inclusion of an interest rate approximating the government's cost of borrowing would result in some small farms having very long-term loans (greater than 30 years), even under the best case for improved total cash receipts from productivity gains following the construction of the fence. Requiring private contributions generally increases the rate and likelihood of a government getting all of a loan back.

Cluster fence programs to date raise significant equity issues, especially considering our analyses of capacity to repay. 'Disadvantage' factors for a business preferring sheep and wool production would include: smaller scale; isolation from other sheep properties; absentee owners as neighbours; and perhaps even poor local relationships. As shown, larger properties have a greater capacity to repay loans and cluster fencing is likely to reduce the cost per hectare enclosed. Therefore, governments could decide to accept longer repayment times from smaller, individually fenced enterprises as an equity contribution, in which case contingent loans might be particularly appropriate. They may however, also be adapted to support individual contributions to a cluster cell fence. This would need to be examined further to check for legal and management issues. Further to that, there may be an important area of research in considering how the cluster arrangements and policy settings could be used to: maximise participation so as to gain economies of scale; identify any emerging problems within collaborations, such as free-riding on maintenance obligations; and examine existing arrangements to consider the factors that contribute to the workability or otherwise of collaborative area management.

Conflicts of interest

The authors declare no conflicts of interest.

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