Economic Dimensions of the Tanaea Livestock Facility of the Government of Kiribati

Anna Rios Wilks

Technical Report 201

September 2013

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Author:	Anna Rios Wilks
Published by:	SPC Applied Geoscience and Technology Division (AGTD) 2014
Layout & design by:	Sailesh Kumar Sen (SPC-AGTD)
Cover Photo credits:	Nichol Nonga (AHP/LRD)
Available from:	SPC Applied Geoscience and Technology Division (AGTD) Private Mail Bag, GPO Suva, Fiji Telephone: (679) 338 1377 Fax: (679) 337 0040 E-mail: paulah@spc.int www.spc.int|sopac

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ACKNOWLEDGEMENTS

The Secretariat of the Pacific Community acknowledges the contribution of assistance of the following individuals in preparing this analysis:

- Nichol Nonga for his extensive knowledge of livestock and for facilitating consultations with the Department of Livestock, Kiribati.
- Paula Holland for her technical advice and detailed review.
- Anterea Nautonga, Tianeti Beenna, Teaaro Otiuea and Erati Teremeti of the Agriculture & Livestock Department, Kiribati.
- Tuake Teema and staff from the Department of Fisheries, Kiribati.
- Reenate Willie of the Ministry of Water and Public Utilities, Kiribati.
- Nenenteiti Teariki Ruatu of the Ministry of Environment, Kiribati.
- Kiriati Birita and Itienang Timona of the Public Utilities Board, Kiribati.
- Mr. Takuia Uakeia, Deputy Secretary, Ministry of Finance and Economic Development, Kiribati.
- Mr. Michael Fong, Office of te Beretitenti (OB), Kiribati.

This analysis was supported by the:

- *Vegetation and land cover mapping and improving food security for building resilience to a changing climate in Pacific island communities" project - implemented in partnership with the Secretariat of the Pacific Community (SPC) and the United Stated Agency for International Development (USAID)*
- *SPC/ Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH "Coping with Climate Change in the Pacific Islands Region" Programme (SPC/GIZ CCCPIR) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ)*

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List of Acronyms

AI	Artificial insemination
ADB	Asian Development Bank
ALD	Agriculture & Livestock Department, Kiribati
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EIA	Environmental Impact Analysis
MELAD	Land management Division, Kiribati
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
OI	Outer islands
PIC	Pacific Island Country
SPC	Secretariat of the Pacific Community
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

This document considers the feasibility of one of the components of the Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013 – 2015 (Nonga 2013). Nonga (2013) proposes that the four components of the Agriculture & Livestock Department (ALD) Tanaea Breeding facility could be improved to enable the community of Kiribati to have enhanced access to food resources in the future. Nonga (2013) suggests that a regeneration project could be conducted over two interdependent steps:

- Step 1: Renovate and/or extend the current centre.

  A) Repair/rebuild the chicken, feed and water sections.

  B) Rebuild and extend the pig section.
- Step 2: Increase the production of pig stock in the facility.

A preliminary feasibility assessment of enhancing the ALD livestock facility and extending production to pigs, in addition to the current production of chickens is conducted, using a cost benefit framework. The costs of enhancing the pig facility and extending to pig production are compared to the benefits these activities would be expected to generate in order to assess whether or not they are worthwhile.

This analysis evaluates the project from two perspectives: the Kiribati national perspective and the development donor perspective.

National Perspective

In order to increase food security for Kiribati, using the current assets (land and expertise) offered by the Government-owned Tanaea livestock facility (run by the ALD), the facility must determine their optimal way forward; whether they focus on producing chicken produce only or whether they expand to also produce pig stock. The increased demand for chickens has already prompted the facility to increase the production of chicken and eggs in recent years. This analysis focuses on analysing the costs and benefits associated with expanding also to pig production.

Optimal method of producing pigs if the facility expands to produce chickens and pigs

Section 4 looks at how the facility would undertake the pig expansion suggested in Step 2 of the project: it analyses the least costly way to initially increase the number of pigs, the least costly way to replace pig stock over time, and also the optimal method to produce pigs (to use Artificial insemination (AI) or keep boars in the facility. The analysis shows that, if there was to be breeding of pigs at Tanaea, it should employ the following methods:

- Boars should be kept at the facility for breeding purposes rather than using AI.
- The initial increase in pig stock should be done by importation.
- The replacement of pig stock over time should be done by importation[1].

[1] This assumes that, over time, the cost of importation of livestock does not undergo significant increase and that there are no significant improvements to the efficiency of AI technologies. Also, the Government might wish to further consider AI training if cross-breeding programs will be implemented in Tanaea in the future.

The expected costs and benefits of expanding to produce pigs

Section 5 conducts an analysis, comparing the costs and benefits (revenue) the facility would expect in two cases: in the case that they continue to focus on producing chickens only and in the case that they undertake Step 2 and expand the facility to include the breeding of pigs, as well as the breeding of chickens. This analysis shows that, by keeping pigs as well as chickens, the facility would see estimated annual reductions in profit of about AUD 16,000 in nominal terms. The benefit to cost ratio of Step 2 is 0.66, which means that for every AUD 1 spent on keeping pigs (excluding the initial costs of Step 1, which must be done before pig production can go ahead), the facility would only recoup 0.66 cents.

Nevertheless, it is financially feasible to expand production to pigs if chicken production remains unchanged (keeping 800 parent chicken stock as well as the pigs) due to the fact that the profits made in producing chickens and eggs are able to subsidise the losses made in producing pigs.

Although this means that the facility is able to produce an overall profit in either case, the benefit expected if the Government focuses on producing chickens only is consistently higher than expanding to produce pigs. In addition, this analysis presents the "best case scenario" for pigs. If any costs of environmental impacts and the necessary Environmental Impact Assessment itself were to be included, it is likely that losses made through investing in pig production would further increase.

Development Perspective

The donor community are likely to require an analysis of whether the implementation of a project will produce overall benefits. In order to provide an indication of which parts of the suggested project are likely to have a beneficial effect, an overall analysis of the costs and benefits expected in two scenarios are estimated.

The "chicken only" scenario evaluates the total cost of first repairing the facility so that chicken production can continue and then running the chicken facility over a 40-year time frame, and compares them to the total benefits that are expected to be produced over these 40 years. The overall benefit to cost ratio would be approximately 1.52 compared to not running the facility at all.

The "chicken and pig" scenario evaluates the total cost of first repairing the facility so that both chicken and pigs can be produced and then running the chicken and pig facility over a 40-year time frame, and compares them to the total benefits that are expected to be produced over these 40 years. The overall benefit to cost ratio would be 1.28 compared to not running the facility at all.

This means that both scenarios are feasible in that overall benefits would be produced if the alternative was for the facility to not run at all.

Nevertheless, the benefits associated with the "chicken and pig" scenario are lower than those associated with the "chicken only" scenario. In fact, this analysis demonstrates that any investments in pig-related activities will produce overall losses. It is estimated that about 39 per cent of the total investments made in extending and running the pig facility will be lost.

This indicates that the development partner should focus on renovating the facility for chicken only. This entails the repairing of the chicken sheds, the rebuilding of the feed storage shed and the installation of water storage facilities.

Policy Implications

Government of Kiribati

- Analysis suggests that rearing chicken is a far more efficient and profitable method of supplying society with meat and protein products than the production of pigs, based on the scenarios provided.
- Focusing on both chicken and pig production would be expected to generate profits. However, a focus solely on chicken production would be expected to generate consistently higher profits, with pig production effectively only being feasible where chicken production subsidises it.
- Losses produced in the production of pigs would further increase if there was any environmental harm caused or if environmental impact assessments or waste management facilities needed to be established.
- The Government of Kiribati has stated a clear desire to invest in pig production under the Secretariat of the Pacific Community (SPC), United States Agency for International Development (USAID) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) climate change projects. In light of the analysis, the Government of Kiribati must now consider whether the value of achieving pig production for sale to the public is worth reducing the profit made by the facility by about AUD 16,000 per year in nominal terms, considering that these higher profits could be used to increase other food production or access to imports.

Development Partner

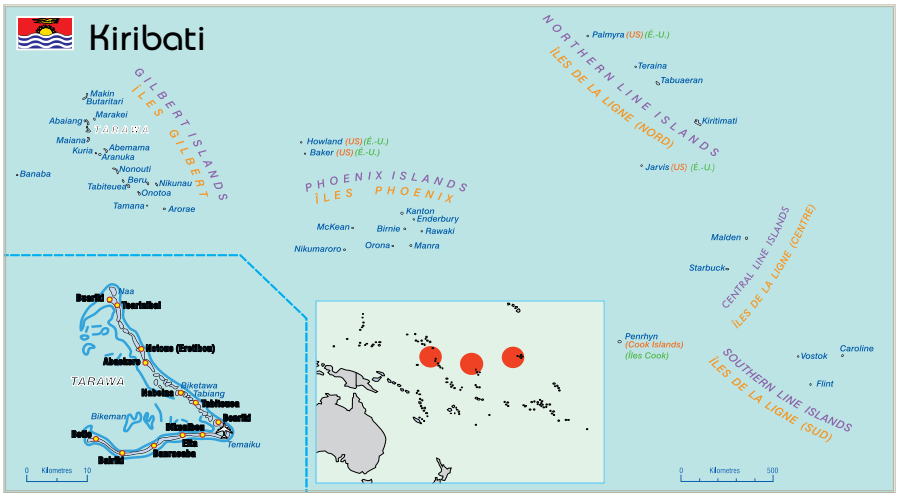
- The extension of the facility to include pigs relies on an investment to be made in the facility infrastructure and an investment in an Environmental Impact Analysis (EIA) which may or may not allow the project to obtain permission by the Department of Environment.
- Even without accounting for the costs of the EIA, this analysis shows that the investment in pig-related activities (enhancement of the pig facility infrastructure and running of the facility with pigs) produces overall losses of about 39 per cent of the value invested.
- Investments in chicken-related activities produce overall benefits. For every AUD 1 invested in these activities, it is expected for it to generate AUD 1.52 in benefits.
- Consequently, the development partner may wish to proceed with the following activities, which will allow the facility to continue producing chicken products:
    - investing in the repair of the chicken facility;
    - rebuilding of the feed storage shed; and
    - the implementation of water tanks.
- It is clear from this analysis that the continued production of chicken and eggs has multiple benefits:
    - it produces profit for the government facility;
    - it will help reduce the excess of demand for produce currently experienced in the area; and
    - it aids food security.
- In addition, because there is already a large number of chickens at the facility, investment in chicken-related activities is unlikely to cause additional environmental effects.

SECTION 1: THE REGENERATION PROJECT

Background

The Republic of Kiribati stretches over vast spaces of ocean between latitudes 170º E and 150º W and longitudes 5º N and 11º S (see figure 1). It is composed of 33 low-lying coral atolls with a total land area of 811 km2 (Encyclopædia Britannica Online, 2013). The 2010 census, reported the total human population to be 103,058, having experienced a growth rate of 2.28% since 2005. South Tarawa is the most densely populated island with 58,182 people - 48.7% of the total population of Kiribati (Republic of Kiribati, 2012).

Figure 1: Kiribati Map.



Source: SPC.

Kiribati has a relatively stable economy with a strong reliance on fisheries, which makes up a large proportion of the Gross Domestic Product (GDP) (35 per cent in 2001) (Food and Agriculture Organisation of the UN, 2004). Nevertheless, as a least developed country, it faces a number of development challenges in the future. Many of these may be exacerbated in the face of climate change. These include access to sufficient clean water resources, coastal defences and adequate food crop development (Republic of Kiribati, 2007).

To address such development issues, the Government of Kiribati is engaged in numerous programmes and projects to enhance its resilience. Among these is the Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013–2015. This concept is supported by the Secretariat of the Pacific Community's (SPC) Land Resources Division and the SPC USAID and GIZ Climate Change programs. Under the concept, the Government seeks to address food security by increasing national capacity in the pig and chicken production. The concept stems from an invitation from the Land management Division, Kiribati (MELAD) to the SPC/USAID project and the SPC/GIZ Coping with Climate Change in the Pacific Island Region project to develop a plan on climate change adaptation activities for the country. The resulting

plan identifies vulnerabilities and impacts of climate change and provides numerous agriculture-related adaptation and intervention options that could be adopted to increase sustainable livestock production for food security (Nonga, 2013).

Purpose

This document considers the feasibility of one of the components of the Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013-2015 – improvement of the ALD Tanaea Breeding Centre Facilities[2] and the increase in production capacity through greater stock of pigs in the facility.

This document details an economic screening exercise designed to inform the potential value, risks and possible design of this project. It summarises the relevant information available, and provides guidance as to what might be an optimal way to implement such a project, the likely impact of this regeneration project, as well as other data and information needed before further development might be undertaken.

Introduction to the Facility and its Current State

The ALD Tanaea Breeding Centre on Tarawa is a government-owned and operated facility aimed at providing for sale live chickens and pigs, as well as eggs to the population on Tarawa and in the outer islands (OI).

The facility comprises four components, which are studied in the Kiribati Livestock Production Concept (Nonga, 2013): the pig facility, the chicken facility, the food storage facility and the water supply.

According to Nonga (2013), the present status of each is as follows:

- Pig facility: the pig facility is presently run down and rearing of pigs is at a minimum. Existing poor facilities are associated with a high (50 per cent) mortality rate of piglets. The facility presently holds eight sows and one boar used for breeding, all of which are reaching the end of their reproductive lives and will soon need to be on-sold or slaughtered.
- Chicken facility: this comprises two chicken sheds currently in need of minor repairs, to stop pests entering and killing livestock through disease and hunting. Due to increased demand for chickens, the facility has focused on and expanded the rearing of layer and broiler chicks, which are then on-sold to local households and farmers.
- Feed storage: the feed storage shed is dilapidated and no longer usable. It needs replacement so that feed can be safely stored.
- Water supply: water supply is erratic with regular shortages, especially during drought season.

Proposed Two-Step Process for Regeneration of the Facility

Nonga (2013) proposes that the four components of the ALD Tanaea Breeding facility could be improved to enable the community of Kiribati to have enhanced access to food resources in the future. Nonga (2013) suggests that a regeneration project could be conducted over two interdependent steps:

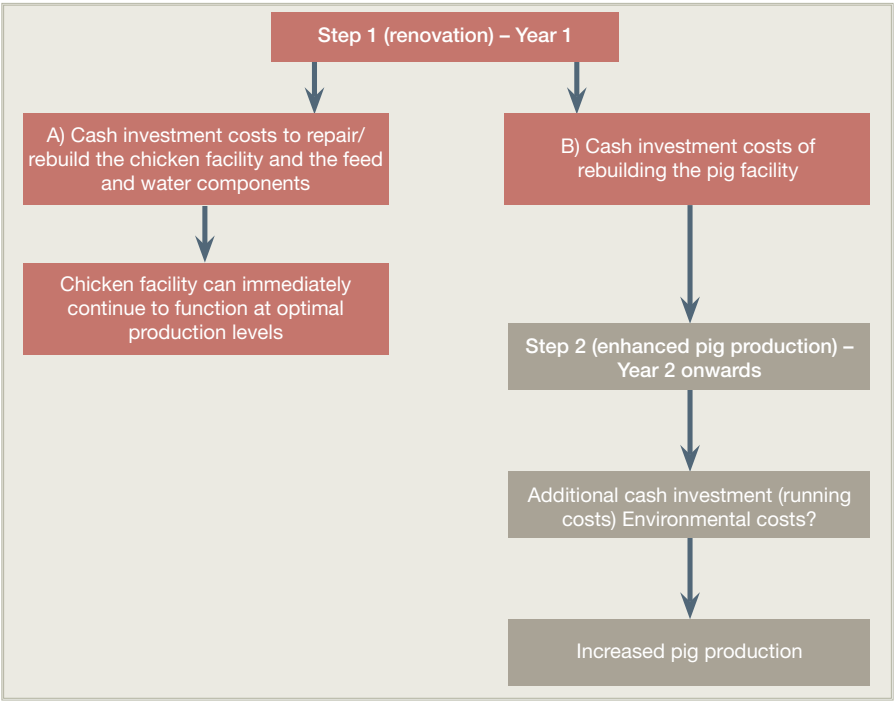
[2] All back ground and project details have been directly sourced from the livestock expert report, see (Nonga, 2013) for further details.

- Step 1: Renovate and or extend the current centre.
  A) Repair/rebuild the chicken, feed and water sections; and/or
  B) Rebuild and extend the pig section.
- Step 2: Increase the production of pig stock in the facility.

Step 1 reflects the regeneration of the infrastructure of the facility in the first year of the project. This involves the construction of new sections of the livestock facility and repairs of the old sections. Step 1A incurs fairly small investment costs and will immediately allow the chicken facility to continue functioning at optimal production levels. Step 1B incurs large investment costs and provides no benefits until Step 2 is implemented in the second year of the project.

At the end of Step 2, benefits are intended to take the form of enhanced food availability in the community. Costs associated with Step 2 would reflect facility running costs, although it is possible that some environmental costs may also arise, which would need to be considered.

Figure 2: Two-step implementation process.



Affected Stakeholders

The Government of Kiribati presently envisages that investment for the two steps of facility enhancement would come from different sources. They anticipate investment for Step 1 to come from the SPC USAID and GIZ Climate Change programs, while the investment for Step 2 would be the responsibility of the Kiribati Ministry of Agriculture and Livestock.

SECTION 2: METHODOLOGY FOR THIS SCREENING EXERCISE

A preliminary feasibility assessment of enhancing the ALD livestock facility and targeting pig production can be conducted using a cost benefit framework – that is, identifying and comparing the costs of enhancing the facility with the benefits enhancement that it would be expected to generate, and using this information to assess whether or not the activity is worthwhile.

Identifying the benefits and cost of enhancing the facility involves comparing the wellbeing or wealth in the community if the facility was not enhanced to the wellbeing or wealth they would experience without it. In economic jargon, this is termed 'with and without analysis'.

Without scenario

As indicated in Section 1, the livestock facility is presently extremely run down and basic repairs and maintenance are required to maintain even the simplest level of operations. Since the pigs at the facility are presently reaching the end of their productive lives, only chicken production would likely occur at the facility if no major investment is made. Nevertheless, the condition of the chicken-rearing facilities is presently poor and production of chicken is suffering due to pests, poor feed storage and sporadic water access. As a result, basic maintenance from Step 1A (Figure 2) is required to ensure continued chicken and egg production. Such maintenance includes, for example, repair to mesh to prevent the entry of pests that kill stock through disease and hunting. These enhancements will need to be conducted with or without the assistance of the SPC USAID and GIZ climate change projects. Nevertheless, the Government of Kiribati anticipates that these projects will assist in the work. Consequently, Step 1A effectively represents the 'without' scenario for this feasibility assessment.

With scenario

If the facility was to be enhanced to include pig production, maintenance of the facility would need to occur on a larger scale, as represented by Step 1B in Figure 2. For example, old pig sections would need to be repaired and new sections constructed to accommodate a revised and expanded pig production (the demolition, rebuilding and extension of the two current pig sheds). Having prepared this foundation, Step 2 could then be implemented to deliver and extend pig production beyond previous levels. These investment costs of enhanced production should then lead to benefits to the community in of improved food security (Table 1).

Table 1: With and without scenarios for the ADL livestock facility.

	Without scenario	With scenario
Description	Produce chickens only	Produce chickens and pigs
Costs	- Investment in fixed costs to ensure chicken production (year 1). - Investment in variable costs to run the facility with chickens (year 2 to year 40).	- Investment in fixed costs to ensure chicken and pig production (year 1). - Investment in variable costs to run the facility with chickens and pigs (year 2 to year 40). - Environmental costs?

Benefits	- Revenue for government facility from sales of chicken produce. - Benefit to community of being able to buy more live chicken and eggs. - Benefit to economy of less meat imports?	- Revenue for government facility from sales of chicken and pig produce. - Benefit to community of being able to buy more live chicken, pigs and eggs. - Benefit to economy of less meat imports?

Perspectives for assessment

The payoffs from enhancing the facility depend partly on who is responsible for the investment. The Government of Kiribati anticipates that costs associated with Step 1 would be met by development partners (preferably the SPC USAID and GIZ climate change projects). This leaves the Government of Kiribati with the responsibility to cover only the day-to-day running of the facility. An assessment of the feasibility of the enhancement activity from the perspective of the Government of Kiribati would then require only assessment of Step 2 running costs compared to the value of benefits. (In financial analysis, this is sometimes called gross margin analysis).

By comparison, if the activity was to be replicated in the future, all costs (Steps 1A and 1B and Step 2) would need to be covered before benefits could be achieved. Future government decisions and/or donors' decisions to support replicate activities would benefit from an understanding of the likely pay off of the activity compared to all investment costs.

In light of this, two assessments will be made:

- Assessment of the potential gross margin from enhancing the facility for pig production versus continuing to function with chickens only for the Government of Kiribati.
- Consideration of the broader pay off on all investment for the benefit of development partners and future replication.

Time Frame

For each scenario, the benefits of improved food security are compared to the costs over a 40-year time period. It is assumed that Step 1 would be undertaken during the first year of the project. Step 2 would subsequently be implemented as soon as possible after Step 1 to benefit from the capital investment made during reconstruction and extension of the facility. Consequently, it is assumed Step 2 begins to be implemented in the second year of the project.[3]

This screening analysis spans a 40-year time period in order to provide a long-term evaluation of the project. This means that annual costs and benefits expected to be produced from this project are estimated from the year of the project commencement until the 40th year of the project.

The Use of Time Discounting

In projects where costs and benefits will be incurred at different points in time (some in the first year of the project, some in the future), time discounting is used in order to make values comparable across different years. Social time discounting accounts for three main elements when considering future values: catastrophic risk, pure time preference and the decreasing marginal utility of consumption (HM Treasury, 2003).

[3] A 40-year time period is chosen as the project usually spans the lifetime of the longest lasting component of the project (which in this case are the new buildings built in Step 1).

The decision as to which discount rate to use, is a much disputed topic (see Holland, 2008) for a discussion on discount rates in the Pacific Island countries (PICs). Environment and development projects still use highly variable discount rates; these can range between 3 and 12 per cent per annum. Due to the high level of uncertainty in the Pacific environment, a discount rate of 10 per cent seems to be the most common value used in Pacific development projects and this figure is also consistent with the Asian Development Bank guidelines (ADB, 2006) and a review of discount rates used elsewhere in the region (Holland, 2008).

All values included in this screening analysis will be measured, using constant prices in order to reflect real, not nominal values.

Summary of Costs and Benefits Included in Analysis

Only financial costs are included in this preliminary screening analysis. Environmental impacts and impacts on society are not valued but are discussed. The analysis calculates the total costs, the benefits (revenue from sales) and net benefits (profits) from the facility in two scenarios, if no adverse events impact the facility (or in the "best case of the world").

Assumptions

- All values used in the analysis concerning the livestock are displayed in Annex 1.
- There is assumed to be a demand from households and farmers for all eggs, chicks and pigs produced.[4]
- It is assumed that appropriate waste management technologies have already been put into place in the facility. This consists of the use dry waste management, in order to minimise the use of water for cleaning purposes. If this is not put into place then costs of running the pig facility would increase.
- Pig production conventionally requires medication (e.g. vaccination of new-borns). The only available data for medication costs are those incurred in the past by the facility when they were rearing very few pigs. These are approximately AUD 5,000. In this analysis, in the case when the new larger pig facility has been set up, no change is made to these medication costs because it is uncertain by how much they will increase. Nevertheless, as it is expected that medication costs would increase with the number of pigs, the profitability of running the facility with an increased number of pigs given in this analysis will be a maximum estimate. In reality, profitability may be smaller depending, on how much more the medication costs are.
- It is assumed that no extra labour would be needed if the facility was to increase pig production and that the cost of labour is the same in both cases (with and without the production of pigs). If this is not the case and the number of staff needed must increase, then this would need to be taken into account.
- It is assumed that the cost of electricity would not change by increasing the number of pigs, because minimal lighting is needed in the pig facility. The majority of the electricity used at the Tanaea facility is due to the running of the incubators and hatcher of chicken eggs.

[4] Although this seems to be the current case, if this demand reduces then this would have a major impact on the profit of running the facility. Nevertheless, the value of imported bovine animal cuts (pork or beef) per annum in Kiribati has averaged AUD 250,000 over the last three years between 2010-2012 (Ministry of Statistics, personal communication, June 2012). In addition, given the constant increase in population and few other suppliers of such goods, it is likely that demand will continue.

- This analysis assumes that there are no adverse events which might impact the production of the facility (such as extreme weather events or epidemics in the livestock). This means that this analysis shows the "best case scenarios".
- This analysis excludes the valuation of any environmental effects that pig breeding might have on the surrounding area.

Outline of this Document

Section 3 identifies the costs to repair/rebuild components of the facility (Step 1). Section 4 analyses how the facility might be run 'with' Step 2. Section 5 describes a preliminary feasibility assessment of facility enhancement from the perspective of the Government. Section 6 provides an analysis of investing in enhanced pig production from a social or development partner perspective. Section 7 comments on some policy implications.

SECTION 3: COST ANALYSIS OF STEP 1

Description of the Current State of the Facility Infrastructure

The current facility is comprised of 4 sections:

- The pig facility: currently has a 15-sow unit shed. This contains only one poorly functioning farrowing crate . The lack of sufficient crates produces a high mortality rate for piglets, averaging 50 per cent, mainly due to crushing (Nonga, 2013).
- The chicken facility: currently comprises two sheds for raising chickens, Shed 1 is used for keeping layer and broiler parent flocks and Shed 2 is used as a rearing shed for broiler and layer chicks.
- Feed facility: The Feed Storage Shed that was once used to store feed for the pig and chicken stock at Tanaea is no longer used to store feed since the whole building is deemed no longer safe (Nonga, 2013). Feed stock is temporarily stored at the ALD training room. As detailed in the livestock report, the maintenance of feed in good conditions is highly important for the nutrition and productivity of livestock.
- Water supply: A good source of fresh water is essential for the successful operation of this livestock breeding and distribution facilities. The underground water lens in the area around ALD Tanaea breeding station is not suitable for drinking for both humans and livestock. The current water supply comes from the Water Authority public supply. This supply, however, is limited (running for 48 hours and then being turned off for 48 hours). The water supply is also negatively affected during the dry season, which is usually quite long in Kiribati. At times, there has been no water supply for a month on end, and facility staff have had to collect water from nearby villages in order to allow the facility to keep running. The facility does have two water tanks at present, which can be filled to store some water for use when the supply is shut off at 48-hour intervals. Nevertheless, these are not enough to ensure a good supply can be held as a reserve during droughts. There is no other rainwater collection undertaken at the facility.

Description of Step 1

Step 1A involves the maintenance of existing facilities to ensure continued chicken production as follows:

- Chicken facility: Repairs to the walls of both sheds, as well as the installation of wire mesh nettings to keep out pests.
- Feed facility: Replacement of the old feed storage building with a new one.
- Water supply: Introduction of rainwater harvesting facilities to counter the present erratic water supplies. Rainwater tanks would be established on the roofing of all buildings for consumption by livestock and humans. Tanks would be purchased from a local company (Rotamould Co.) in Tarawa, which produces tanks of various volumes and sizes. Although the amount of water bought from the water authority will not change, the rainwater harvesting and new storage tanks are intended to reduce the shortages faced by the facility by allowing for the facility to store its own water and to store water from other sources which have not had the water cut off. Altogether, it is proposed that four new tanks be installed. Two of the tanks will hold 10,000 litres each and two will hold 5,000 litres each. A higher capacity of water storage will help to provide water during the initial stage of drought (remove some problems) and tanks can also be filled with local supply for

storage before drought. Although the Commonwealth Scientific and Industrial Research Organisation (CSIRO 2011) has predicted that the risk of drought is expected to decrease in this area of the Pacific, given the high frequency of droughts at present, improved storage would aid the facility to continue normal functioning on the days when the water supply is turned off.

Step 1B involves the addition of more extensive maintenance that specially addresses the capacity of the facility to support pig production. This would require:

- the extension of the current 15-sow unit shed to a 25-sow unit shed;
- The building of a pig rearing shed and the installation of six new farrowing crates (Nonga, Personal communication June 2013).

Analysis of the Costs of Step 1

The calculations of the costs of building each section are detailed below. These estimates have been taken from the livestock specialist report (Nonga 2013).

Labour for carpentry work for renovations and refurbishments of the buildings and installation of rain water harvesting facilities are expected to be carried out by the current staff of the facility (who, during this time, would have less work than normal due to the fact that there would no longer be any pigs in the facility) and by employing unskilled labour. The cost of employing the additional unskilled labour during construction work is included in the costs whereas the salaries will not be included in any of the analysis of Step 1 as this will not be paid by the development partner and would be paid by the Ministry, whether the project is implemented or not. The three unskilled labourers will be paid AUD 3 per hour, working days of approximately 7.25 hours. Each building will take different lengths of time to build, so labour costs will vary between buildings.

Maintenance costs of the new facility for Step 1 are described in the following sections, which detail the costs for each new building, but on-going maintenance is expected to be paid by the facility as part of its running functionality in the future. For this reason, these maintenance costs, which are needed in later years, will only be of interest in the analysis of Step 2.

Step 1A

Chicken shed renovations

The material costs of the renovations are displayed in table 2. In addition to this, extra labour is needed: 3 unskilled labourers for 1 month. Total labour would cost AUD 1,305.

Maintenance is estimated to be AUD 300 per year.

Table 2: Estimated fixed cost of renovations of 2 chickens sheds.

Description	Quantity	Rate (AUD)	Total (AUD)
Timber (4x2) frame/plat form	40	28.00	1,120.00
Timber (2x2) platform	20	16.00	320.00
Plywood (for nests) (1/2)	5	60.00	300.00
Plastic coated wire mesh	4	85.00	255.00
Hinges (6")	10	5.50	55.00

Description	Quantity	Rate (AUD)	Total (AUD)
Cement bags	10	19.00	190.00
Nails (4") (kg)	10	7.50	75.00
Nails (2") (kg)	10	7.50	75.00
Down pipes	4	78.00	
Elbow	4	22.00	
PVC Glue	3	5.00	
Other materials		300.00	300.00
Total			**2,690.00**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Feed storage shed

Table 3 displays the material costs of constructing the new shed. In addition, extra labour would be needed: three unskilled labourers for one month. Total labour would cost AUD 1,305.

Maintenance is estimated to be AUD 250 per year.

Table 3: Estimated fixed cost of building feed storage shed.

Materials	Description	Quantity	Unit cost (AUD)	Total (AUD)
Brick (6x8)	Wall	2400	1.90	4,560.00
Cement 40 kg	Foundation	20	19.00	380.00
Cement 40 kg	Floor	50	19.00	950.00
Cement 40 kg	Mortar	10	19.00	190.00
Cement 40 kg	Plaster	15	19.00	285.00
Timber (3x2)	Perlin	20	18.00	360.00
Timber (4x2)	Rafter	45	28.00	1,260.00
Timber (4x2)	Door	4	28.00	112.00
Timber (6x2)	Frame/Platform	40	38.00	1,520.00
Timber (6x1)	Fascia Board	12	28.00	336.00
Timber (2x2)	Platform	20	16.00	320.00
Plywood (3/8)	Door	2	38.00	76.00
Plywood (3/8)	Form Work	6	38.00	228.00
Iron Roofing Sheets (10 ft)	Form Work	64	42.00	2,688.00
Ridge Cap (6 ft)	Form Work	7	20.00	140.00
Roofing Nails (4")	Form Work	15	7.50	112.50
Nails (4")	Form Work	10 kg	7.50	75.00
Nails (6")	Form Work	10 kg	7.50	75.00

Materials	Description	Quantity	Unit cost (AUD)	Total (AUD)
Nails (2")	Form Work	5 kg	7.50	37.50
Security Wire	Window	1 roll	360.00	360.00
Hinges Pairs (6")	Door	2	5.50	11.00
Total				**14,076.00**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Rainwater harvesting

Table 4 displays the material costs that would be incurred. In addition, extra labour is expected to consist of only one week with two unskilled labourers, costing AUD 218.

Maintenance is expected to be minimal and the tanks are expected to last 10 years.

Table 4: Estimated fixed cost of rainwater harvesting.

Description	Quantity	Size	Unit Price (AUD)	Total (AUD)
Water tanks	2	10,000 litre	2,200.00	4,400.00
	2	5,000 litre	1,100.00	2,200.00
Guttering	20	lengths	17.50	350.00
Down pipes	4	lengths	25.00	100.00
Taps	4	½ inch	15.00	60.00
PVC pipes	5	Lengths	15.00	75.00
Tee-joints	8	pieces	3.00	24.00
PVC glue	2		5.00	10.00
Total				**7,219.00**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Step 1B

25 sow unit breeding pen

Table 5 shows the material costs expected. In addition to this extra labour is also needed: three unskilled labourers for two months. This means that total labour for construction would cost AUD 2,610.

Maintenance per year is estimated to cost AUD 1,000.

Table 5: Estimated fixed cost of a 25 sow unit breeding pens.

Materials	Description	Quantity	Unit cost (AUD)	Total (AUD)
Brick (8x8)	Wall	2380	1.90	4,522.00
Cement 40 kg	Foundation	32	19.50	624.00
Cement 40 kg	Floor	112	19.50	2,184.00
Cement 40 kg	Mortar	32	19.50	624.00
Cement 40 kg	Post	44	19.50	858.00
Timber (3x2)	Perlin	30	19.00	585.00
Timber (6x2)	Rafter	45	38.00	1,710.00
Timber (6x2)	Door	16	38.00	608.00
Timber (6x2)	Door	16	38.00	608.00
Timber (2x2)	Door	16	16.00	256.00
Timber (6x1)	Fascia Board	14	28.00	392.00
Iron Roofing Sheets (10 ft)	Form Work	104	42.00	4,368.00
Ridge Cap (6 ft)	Form Work	12	22.00	264.00
Roofing Nails (4”)	Form Work	15 kg	7.50	112.50
Rods(12 mm)	Post	60	20.00	1,200.00
PVC Pipes (6”)	Formwork	6	80.00	480.00
Elbow (6”)	Form Work	6	19.50	117
Tee (6”)	Drain Out	4	25.00	100.00
Hinges Pairs (4”)	Door	18	5.50	99.00
Pad-Bolt (6”)	Door	18	5.50	99.00
Nails (4”)	Formwork	40 kg	7.50	300.00
Nails (6”)	Formwork	20 kg	7.50	150.00
Nails (2”)	Formwork	10 kg	7.50	75.00
Gravel	Formwork	500 bags	1.00	500.00
Sand	Formwork	500	1.00	500.00
Water Pump		1	1,050.00	1,050.00
Total				**22,385**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Pig rearing shed

Table 6 displays the material costs incurred in building the shed. In addition to this this extra labour is also needed: three unskilled labourers for two months. Total labour would cost AUD 2,610.

The farrowing crates would also need to be purchased. Six farrowing crates are needed for 25 sows. A local company can provide the crates for AUD 2,000 per crate, or AUD 12,000 in total.

Maintenance per year is estimated to cost AUD 1,000.

Table 6: Estimated fixed cost of a farrowing, wiener and grower shed without farrowing crates.

Materials	Description	Quantity	Unit cost (AUD)	Total (AUD)
Brick (6x8)	Wall	1500	1.90	2,850.00
Cement 40 kg	Foundation	54	19.00	1,026.00
Cement 40 kg	Floor	84	19.00	1,596.00
Cement 40 kg	Mortar	20	19.00	380.00
Cement 40 kg	Plaster	30	19.00	570.00
Cement 40 kg	Post	60	19.00	1,140.00
Timber (3x2)	Perlin	30	18.00	540.00
Timber (6x2)	Rafter	45	42.00	1,890.00
Timber (6x2)	Door	16	42.00	672.00
Timber (6x2)	Door	16	28.00	448.00
Timber (2x2)	Door	16	15.50	248.00
Iron Roofing Sheets (12 ft)	Form Work	76	42.00	3,192.00
Ridge Cap (6 ft)	Form Work	15	22.00	330.00
Roofing Nails (4”)	Form Work	15 kg	7.50	112.50
Rods(12mm)	Post	40	25.00	1,000.00
PVC Pipes (150 mm)	Drain-Out	7	78.00	546.00
Elbow (150 mm)	Drain-Out	10	22.00	220.00
Tee (150 mm)	Drain Out	4	25.00	100.00
PVC Glue	PVC Pipe	3	5.00	15.00
Hinges Pairs (6”)	Door	36	4.50	162.00
Pod-Bolt (6”)	Door	36	5.50	198.00
Nails (4”)	Formwork	10 kg	7.50	75.00
Nails (6”)	Formwork	10 kg	7.50	75.00
Nails (2”)	Formwork	10 kg	7.50	75.00
Iron Nail (4”)	Formwork	10 kg	7.50	75.00
Plywood (3/8)	Post	8	58.00	464.00
Gravel	Formwork	700 bags	1.00	700.00
Sand	Formwork	700	1.00	700.00
Drinking Nipples		40	12.50	500.00
Water Pump		1	1,050.00	1,050.00
Galvanized Pipe		30	19.50	585.00
Total				**21,534.00**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Summary of Regeneration Costs

Table 7 summarizes the fixed costs of constructing each component of the facility. It also includes their annual maintenance costs, which will be used in section 5.

Table 7: Summary of regeneration costs.

	Component	Fixed cost (cost of construction) (AUD)	Annual maintenance cost (AUD)
Step 1 A	Chicken sheds	3,995	300
	Feed storage shed	15,381	250
	Rainwater harvesting	7,437	-
Step 1 B	25 sow breeding pens	24,995	1,000
	Pig rearing shed (farrowing, wiener and grower shed with farrowing crates)	36,144	1,000

Table 8: Total investment in fixed costs for scenarios.

Scenario	Total fixed cost (AUD)
Without (chicken production only)	26,813
With (chicken and pig production)	87,952

Life time of the infrastructure

Buildings are expected to be constructed in order to last approximately 40 years if maintenance is carried out. Rainwater harvesting equipment is replaced approximately every 10 years.

SECTION 4: ANALYSIS OF STEP 2

In Step 2 of the project, ALD aims to produce piglets to serve the needs of Kiribati society, both on the mainland of Tarawa and the OI. At present, it is unclear whether the government should target this be keeping a number of boars or simply using AI to breed pigs.

After describing current livestock at the facility and the stock planned if Step 2 is implemented, this section goes on to identify the least cost method of running the facility in order to reach the levels of production planned. It addresses three questions: first, whether the facility might use live boars or AI in its breeding, then what the least cost method of initially increasing the pig stock, and finally what the least costly method of replacing the parent stock at the end of their reproductive lives. The findings of this section will be used in Section 5 when comparing the costs and benefits of the two main options open to the government: running the facility with chicken only or running it with chicken and pigs.

Description of the Current Running of the Facility

The pig facility: The pig shed currently has eight sows and one boar, all of which will soon be culled or sold due to their age and low reproductive capacity. This means that there will be no pigs at the facility (Nonga, 2013).

The chicken facility:

- Currently, there are 400 new parent flock layer chickens at the facility and 400 new parent flock broiler chickens. The layers produce chickens to be sold on to local farmers at four weeks old for AUD 3. The broilers produce chicks sold at one day old for AUD 0.75.
- On average, 680 (85 per cent production rate) eggs are laid each day. Tanaea has two incubators at a capacity of 3,276 eggs each, meaning that up to 6,552 eggs can be processed at any one time. If there is a surplus of eggs laid, then they are sold (half as one day-old broiler chicks and half as four-week old layer chicks).
- Each egg is kept in the incubator between 1819 days and moved to the hatching machine for the last two-to-three days (21 days total). This means that it takes up to 25 days (including three-to-four days for cleaning) for this process to occur and the process commences again.
- Every 18 months the parent stock of 800 chickens must be replaced. The facility does this by importing fertile eggs suitable for parent stock and rearing these in the facility. This means that space in the incubator and hatcher is taken up for these eggs and will reduce the number of chicks sold every 18 months by about 889 eggs (10 per cent mortality rate means more eggs need to be hatched in order to obtain 800 chickens).

Labour employed: Currently, the labour used in the facility comprises eight staff paid an average annual salary of AUD 4,600.

Electricity: The price of electricity is 70 cents/kilowatt. With 800 parent flock, the facility will need to use both of its incubators and its hatcher full time. During the last year, the electricity bills per month for the facility ranged between AUD 400 to AUD 1,200, depending on how many machines were in use. Because 800 chickens will require maximum capacity, the maximum AUD 1,200 per month is used in this analysis as an estimation of the cost of electricity per month.

Description of the Running of the Facility with Both Chickens and Pigs (Step 2)

The pig facility: The number of pigs is envisaged to increase to 25 sows and 3 boars. All of this parent stock of pigs would be of Duroc breed (Nonga, 2013). This breed of sows produces on average 1.8 litters of 10 piglets per year. Once minimum mortality rates are included, on average, 8.5 piglets per litter are weaned for sale, therefore, annual sales of 383 wieners are expected.

The chicken facility: The number of chickens would remain unchanged with the only increase in stock being that of the pigs.

Labour employed: Because the facility is currently running below capacity given the number staff currently working at the facility (8 staff), the livestock facility proposes that no extra labour would be needed if the facility was to increase pig production (Teaaro Otiuea – personal communication 2013).

Electricity: Minimal lighting is needed in the pig facility. The majority of the electricity used the Tanaea facility is due to the running of the incubators and hatcher of chicken eggs (Nonga, personal communication June 2013). It is expected that any increase in electricity use once the facility holds pigs as well as chicken is to be minimal. Nevertheless, the cost of running the facility with pigs, which is estimated in section 5, is taken as a minimum estimate.

Uncertainty Concerning Increasing Pig Stock

A number of issues affecting the production of pigs will require consideration before the feasibility of enhancing the ALD facility can be fully analysed.

Environmental impacts

The Tanaea facility is located on an islet surrounded by channels going between the sea and the lagoon. One of these channels is used by the Government Fisheries Department to grow clams and milk fish (Tuake Teema of the Government Fisheries Department, Kiribati – personal communication 2013). It is possible that pollution from wash-off of heavy rain from the facility into the lagoon would have negative impacts on this. There may also be a risk of seepage of waste down into the water lens beneath the facility. Nevertheless, this water is only used for cleaning purposes and the lens is isolated, meaning that the water of other lenses in the area would not be contaminated (Water, Sanitation and Hygiene Unit, SOPAC SPC – personal communication 2013).

With the use of new waste management technologies, such as dry manure collection and possibly a biogas digester, and the new facilities that will have concrete floors, the contamination of the surroundings should be kept to a minimum. Nevertheless, it may be required to carry out an EIA before Step 2 could proceed (Nenenteiti Teariki Ruatu, Ministry of Environment, Kiribati – personal communication 2013). The length of the application process for permission is not known, nor the costs of undertaking the assessment. Consequently, no costs have been imputed for this activity in the analysis.

Climate change and water supply

Enhancement of the facility to achieve extended pig production at the ALD facility is presently considering using the exotic Duroc breed of pig. This breed is considered to be more productive than the local breeds found in Kiribati and would also be more suitable for the climate, coping relatively better in high temperatures and in high intensity sun (Nonga, 2013).

A key factor in the success of breeding will be access to feed and water. Using the water requirement data (tables A3 and A4 Annex 1) the water requirements for different numbers of chicken and pigs are calculated. The supply of livestock drinking water required by the facility when it is producing with only chicken (800 parent stock) is calculated to be approximately 545 litres per day. Once pigs are kept, this water requirement will increase to approximately 1,220 litres per day. These are minimum requirements and do not take into account increases in temperature, wastage/ spillage of water due to animals knocking water containers in their facilities or the use of water for any other purpose.

Droughts are common in Tarawa and, in the past, the facility has experienced a lack of access to sufficient water supply. Although it has been predicted that the risk of drought is expected to decrease with climate change, it has also been predicted that the average air temperature will increase (CSIRO, 2011) which will, in turn, increase the water demanded by the livestock.

Water supply is a problem in the facility, but with the new water storage units installed in Step 1, which should hold a total of 30,000 litres and can be filled every two days from the main water supply, there should, in theory, be no issues unless the water is cut for many days.

Running the Facility

At present, the details of how an enhanced ALD facility would operate in practice have not been widely discussed. The facility might be run in a variety of ways yet to be decided. For example, pig breeding might be conducted conventionally, using imported boars to impregnate sows, or through AI. Theoretically, it would be possible to achieve production of pigs, using sows and AI practices only. This would mean that rather than funding the upkeep of boars for reproductive purposes, experts would be trained in AI to inseminate the sows. Nevertheless, in the case of the Kiribati Government livestock facility, it is probable that some boars would need to be retained to ensure an on-going supply of quality breed (Duroc) semen. Relying solely on the importation of semen from abroad would not only be costly but would be risky.

Similarly, replacement of parent stock might be achieved through on-going importation of exotic stock or AI. Although these decisions have not yet been made, the costs associated with both options vary (see Annex 2) and it is reasonable to assume that the cheapest option would be adopted. In this case, it is assumed that both establishing a core pig stock and replacing parent stock over time would be achieved through importation since these options appear to be cheapest (Annexes 2 and 3).

SECTION 5: FEASIBILITY FROM A NATIONAL PERSPECTIVE

This analysis will compare the expected financial costs and benefits for the facility:

- if the facility continues to maintain chicken stock only; and
- if the facility implements Step 2 to produce both chicken and pigs.

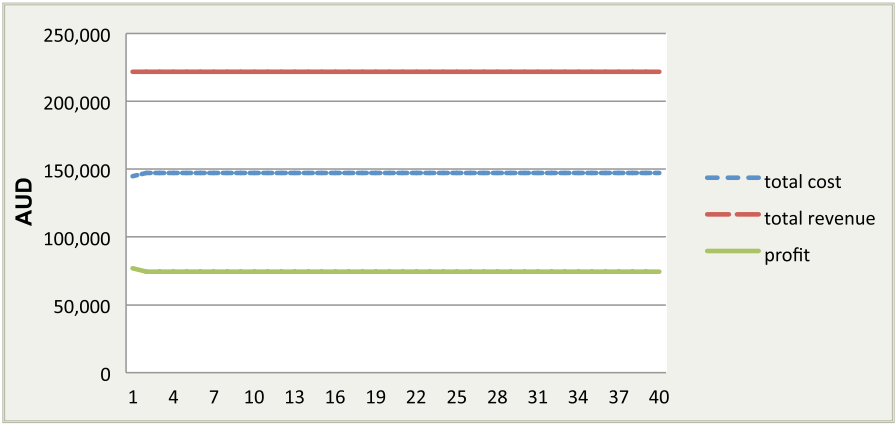
Tables detailing the lifecycles of livestock, the feed and water requirements and the costs of feed and water can be found in Annex 1.

Results

Running costs, sales revenues and profits[6]

Figures 3 and 5 display the nominal (undiscounted) costs (running costs), benefits (expected sales revenue) and net benefits (profits), which the facility could expect to see each year if chickens only are produced (Figure 3) and chickens and pigs are produced (Figure 5). It can be seen that chicken production generates a consistent flow of benefits and costs over time (Figure 3) due to the gradual replacement of parent chicken stock. By comparison, the inclusion of pig production (Figure 5) would be expected to result in continuous spikes in costs, benefits and net benefits over time since parent stock replacement would need to be done via imports every four years.

Figure 3: Undiscounted costs, revenue and profit over time – chickens only.



[6] Here, the term "profit" refers the revenue produced by the facility minus the variable costs of the facility per annum. This is because in the project, the capital investments are expected to be paid by the development partner, leaving only the day-to-day running and maintenance costs to be paid by the Government of Kiribati.

Figure 4: Costs, revenue and profit over time with chickens only (10% discount rate).

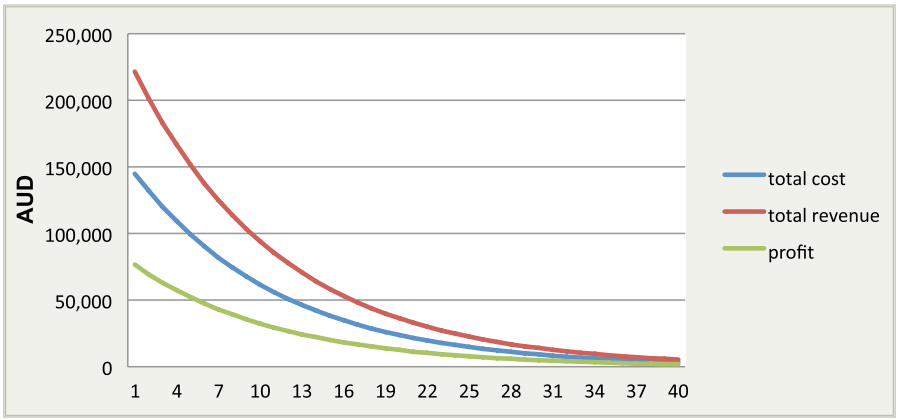


Figure 5: Undiscounted costs, revenue and profit over time – chicken and pigs.

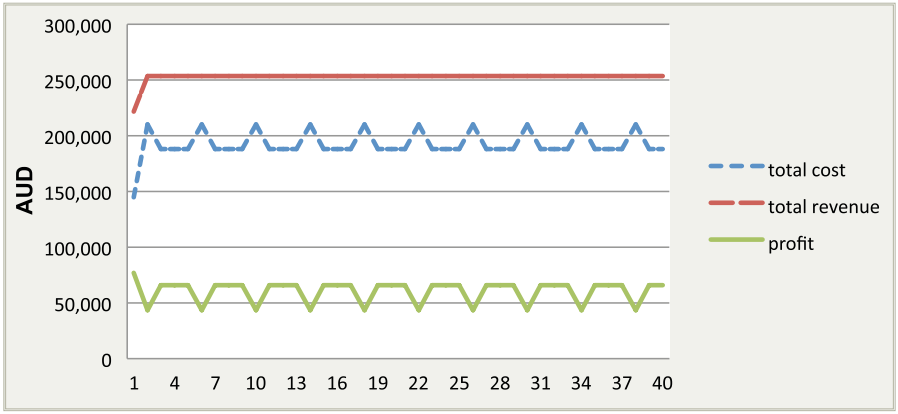
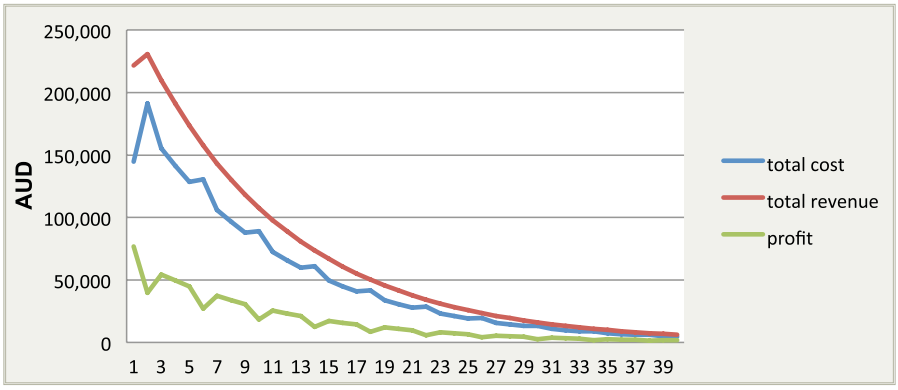


Figure 6: Costs, revenue and profit over time – chicken and pigs (10% discount rate).



Comparison of the with and without scenarios

Both with and without pig production, the expected net benefit of investment (profit) is expected to be positive, meaning that the revenue obtained from selling chicken or pigs is higher than the running cost of the facility (Figures 7 and 8). Where both pigs and chicken are kept in the facility, the running costs are higher, but the gain in revenue from producing pigs does not increase as much as the costs. This means that if the facility expands to produce pigs as well as chicken, a decrease in net benefits – profit – would be expected, although their profit would still be positive overall.

Figure 7: Expected profit from keeping chicken and pigs rather than chickens only.

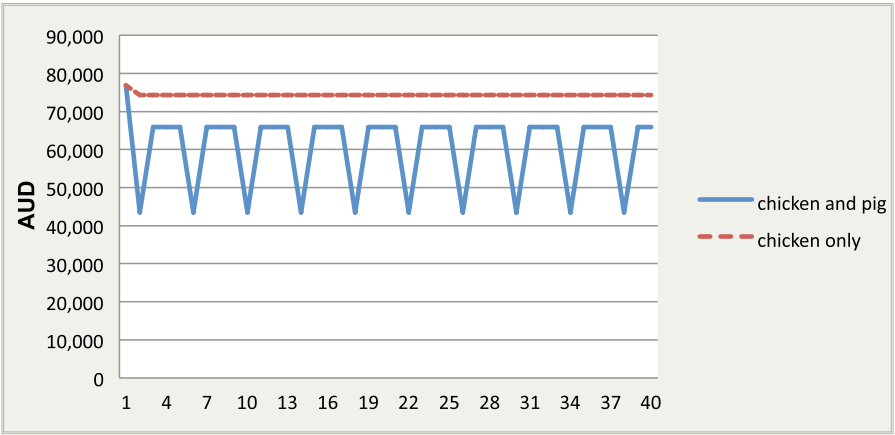
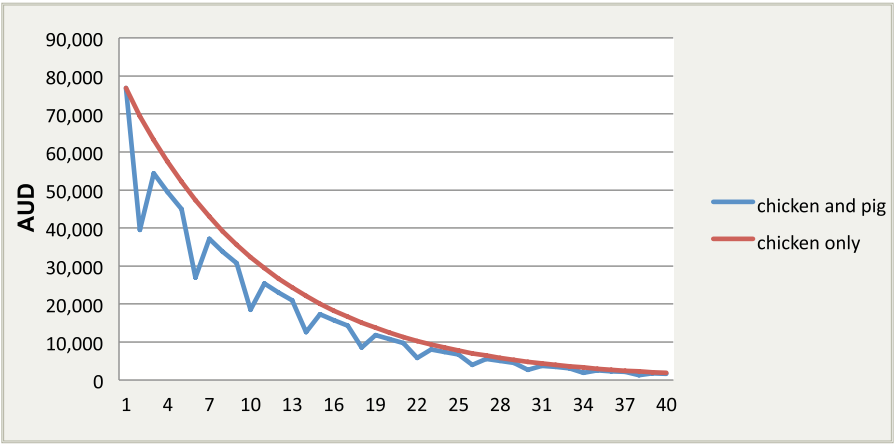


Figure 8: Profits from keeping chickens and pigs rather than chickens only (10 per cent discount rate).



From Figures 7 and 8, it can be seen that the expected profit of keeping both chicken and pigs is always below that of just keeping chickens. This means that the overall effect of expanding the facility to include pigs has a negative impact on the facilities profit.

Figure 9: Cumulative losses over time incurred from Step 2 (non-discounted).

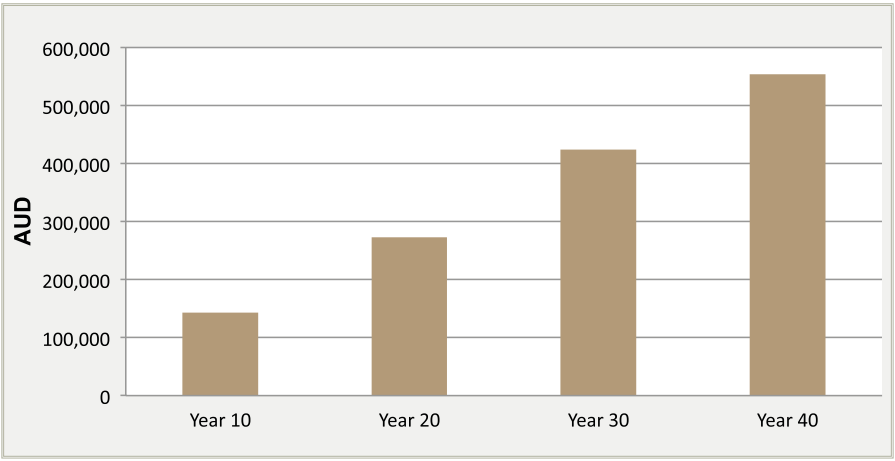
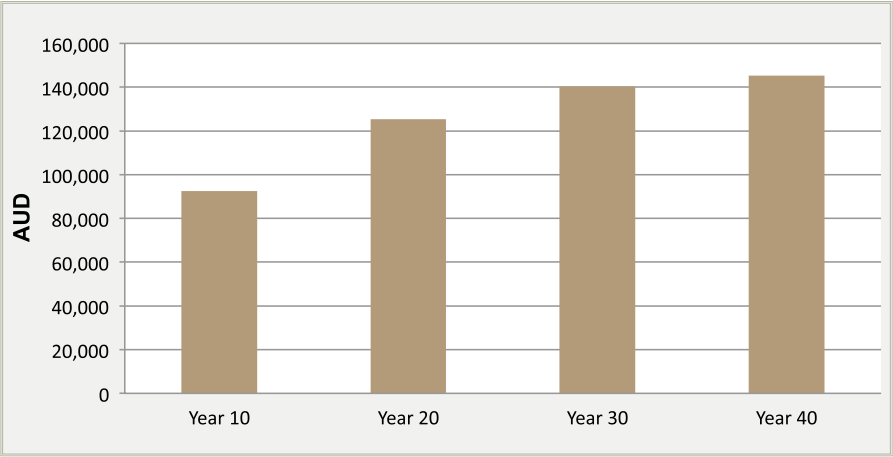


Figure 10: Cumulative losses over time from implementing Step 2 (discounted).



The scale of the lost profit from implementing Step 2 can be seen in Figure 9 where profits associated with chicken and pigs are subtracted to profits associated with chicken production only. In this case, it can be seen that the losses accumulate over time, such that Step 2 would reduce the profit the facility could make by over AUD 500,000 over 40 years. In fact, it would be infeasible for the facility to run producing only pigs. When discounted, the loss in profits over 40 years amounts to around AUD 140,000 (Figure 10). Pig production is only possible because the profits from chicken production subsidize it. A focus on chicken production only would allow higher profits of AUD 140,000 over 40 years in present day value terms.

Although the ALD facility would still be expected to generate profits if it produces both chicken and pigs, this would appear to be the least efficient investment plan, based on information provided.

Table 9 summarises the results of Section 5 thus far.

Table 9: Summary of discounted annual costs, revenue and profit of facility.

Option	Average discounted annual costs (AUD)	Average discounted annual revenue (AUD)	Average discounted annual profit (AUD)
Produce chickens only	39,079	59,615	20,536
Produce chickens and pigs	51,037	67,452	16,415
Effect of implementing Step 2 (expanding to produce pigs as well)	+11,958	+7,837	-4,124

The benefit cost ratio of implementing Step 2

Since profits with Step 2 would be expected to be lower than without Step 2, the overall effect of investing in Step 2, specifically (the 'marginal cost' of Step 2), is negative in terms of the profitability of the facility, causing the benefit (revenue) to cost ratio of Step 2 to be below 1. This benefit cost ratio is 0.66 (both with and without time discounting at 10 per cent[7]). This means that for every AUD 1 invested in expanding the stock of the facility to include pigs, the revenue they expect to benefit from is only 66 cents.

This does not mean that there is not an overall benefit in running the facility with chicken and pigs (implementing Step 2) compared to the facility not running at all. Even if the facility runs with chickens and pigs, there are overall benefits to be made compared to the facility not running at all. This can be seen in table 10 below.

Table 10: Benefit to cost ratios of running the facility.

With option	Without option	Cost benefit ratio (10 per cent time discounting)
Run the facility with chickens only for 40 years	Not running the facility	1.53
Run the facility with chickens and pigs for 40 years	Not running the facility	1.32

Nevertheless, there will always be higher benefits compared to costs if the facility chooses not to produce pigs and just focus on chicken only. In conclusion, for every AUD 1 the Government invests in producing pigs, only AUD 0.66 is regained; AUD 0.34 is lost.

Sensitivity analysis

Although the implementation of Step 2 could be seen as successful in that it allows the facility to supply pigs without causing the facility to make overall losses (it is a feasible project), this depends on two main assumptions: firstly that the facility continues to produce chicken as it is at present in order to offset the losses made in the financial losses incurred in the production of weaners, and secondly that there are no adverse events, such as extreme weather or livestock epidemics (Kiribati is relatively free of major livestock diseases). It is not possible to tell by how much profit would decrease given a specific event, but if, for example, production of chicken-based produce was to decrease by approximately 25 per cent, the facility would incur overall losses.

[7] Although it is unusual for the discount rate to make no difference to the benefit-cost ratio, in this case the small variability in costs and benefits expected over time has created this characteristic.

SECTION 6: FEASIBILITY ASSESSMENT FROM A DEVELOPMENT PERSPECTIVE

The analysis in section 5 only analyses the costs and benefits to the Government of running the facility, ignoring the investment costs that would need to be spent beforehand in Step 1 to renovate/reconstruct the facilities. This section aggregates the costs and benefits from Step 1 and 2 to give an overall indication of the expected costs and benefits that would be experienced for the two options open to the facility.

Table 8, Section 3 indicated the potential costs incurred in year 1 associated with investing in the facility to enable continued chicken production (AUD 26,813) or the expansion to support pig production as well (AUD 87,952). Table 9, section 5 showed the discounted costs and benefits of running the facility over time. When all of the benefits and costs are aggregated, the return on investment can be identified through a benefit-cost ratio. In this case, it becomes evident that:

- Either option is expected to produce more financial benefits than costs over a 40-year period compared to not running the facility at all (Table 11).
- Higher benefits compared to costs can always be expected if chickens only are targeted. The overall benefits of investing in the regeneration and running of the pig facility are lower than the overall costs (Table 12).

Table 11: Expected ratios of total financial costs to total financial benefits of regenerating and running the facility.

With option	Regenerate and run the facility with chickens only for 40 years	Regenerate and run the facility with chickens and pigs for 40 years
Without option	No running of the facility	No running of the facility
Investment costs incurred in year 1 (Step 1)	AUD 26,813	AUD 87,952
Present value of costs of running facility	AUD 1,563,145	AUD 2,041,475
Total present value of costs	AUD 1,589,958	AUD 2,129,427
Total present value of benefits	AUD 2,384,582	AUD 2,698,073
Cost benefit ratio (10 per cent time discounting)	1.50	1.27
Comment	For every A$1 spent, this option is expected to produce about AUD 1.52	For every A$1 spent, this option is expected to produce about AUD 1.28

Table 12: Benefit to cost ratios of extending and running the facility for chicken and pigs compared to chicken only.

With option	Regenerate and run the facility with chickens and pigs for 40 years
Without option	Regenerate and run the facility with chickens only for 40 years
Extra investment incurred in year 1 (step 1B)	AUD 61,139
Present value of extra costs of running facility with pigs	AUD 478,330
Total present value of extra costs associated with pig activities	AUD 539,469
Total present value of benefits associated with pig activities	AUD 313,491
Cost benefit ratio (10 % time discounting)	0.58
Comment	For every AUD 1 invested in the pig related activities, only AUD 0.61 is expected in return. About 39% of the funds invested in pig related projects will be lost.

This means that, on average, the pig-related activities (extending the pig facility and producing pigs) generate lower benefits than costs. Overall, approximately 39 per cent of the total amount invested in any pig-related activity will be lost.

SECTION 7: POLICY IMPLICATIONS

Analysis suggests that investing in increased pig production is less efficient than focusing solely on chicken production, based on the scenarios provided. Both focusing on chickens only and including pig production would be expected to generate profits. However, a focus solely on chicken production would be expected to generate consistently higher profits, with pig production effectively only being feasible where chicken production subsidises it.

This situation would be exacerbated if the cost associated with pig production were to increase – say because of environmental harm or because environmental impact assessments or waste management facilities needed to be established.

The Government of Kiribati has stated a clear desire to invest in pig production under the SPC USAID and GIZ climate change projects. In light of the analysis, the Government of Kiribati must now consider whether the value of achieving pig production for sale to the public is worth reducing the profit made by the facility by about AUD 16,000 per year in nominal terms, considering that these higher profits could be used to increase other food production or access to imports.

While it ponders this issue, investment in Step 1A is expected to be an efficient use of funds and, the government or development partner may, therefore, wish to proceed with the following activities:

- investing in the repair of the chicken facility;
- rebuilding of the feed storage shed; and
- the implementation of water tanks.

These activities will allow the facility to continue producing chicken products. It is clear from this analysis that the continued production of chicken and eggs has multiple benefits:

- it produces profit for the government facility;
- it will help reduce the excess of demand for produce currently experienced in the area; and
- it aids food security.

In addition, because there is already a large number of chickens at the facility, any investment in chicken-related activities is unlikely to cause additional environmental effects.

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ANNEX 1: DATA TABLES

Table A1: Time spent in each age group - pigs.

	Duroc breed		Local breed	
	Weeks	Days	weeks	Days
Piglets	6	42	7	49
Weaners 6 - 13 weeks	8	56	12	84
Grower	15	105	18	126
Finisher	20	140	30	210
Dry sow	2	14	4	28
Lactating sow	6	42	7	49
Pregnant sow	16	114	16	114

Table A2: Time spent in each age group - chickens.

Layer and broiler chickens	Days
Parent	800-1200
Chicks	
1–5 week	35
6–12 weeks	49
13–18 weeks	42

Table A3: Pig feed and water requirement[8].

Age group	Piglet	Weaner	Grower	Finisher	Gilt	Dry sow	Lactating sow	Pregnant sow	Boar
Exotic breed (Duroc)									
Feed (kg/day)	0.1	0.5	1.8	2.5	2	2	4	3	2
Water (litre/day)	0.75	4	8.5	13.5	13.5	13.5	25	17.5	13.5
Local breed									
Feed (kg/day)	0.05	0.2	1	1.5	1.2	1.2	2.5	2	1
Water (litre/day)	0.5	3	5	8	8	8	12	10	10

[8] Source: Nichol Nonga, livestock expert and the Kiribati Livestock Facility – personal communication 2013.

Table A4: Chicken feed and water requirement.

	Feed/chicken/day (g)	Water/chicken/day (litre)
Parent	110	0.250
Chicks		
1–5 week	40	0.105
6–12 weeks	60	0.150
13–18 weeks	100	0.200

Table A5: Running costs.

	Cost per unit (AUD)
Pig feed (kg)	1.04
Chicken feed (kg)	1.04
Water (litre)	0.005
Electricity (kilowatt)	0.7
Purchase (import) of 1 fertile egg	20

Table A6 Growth rate of pigs.

Growth rate	Average weight
Av. Weight @ birth	>1.2 kg
Av. Weight weaning (4–7weeks)	6 – 8 kg
Av. Weight at 8-9 weeks	8 – 10 kg
Av. weight @16 weeks	50 kg
Av. Weight @ 22 weeks	80 kg
Av. Weight @ 24 weeks	90 kg
Av. Weight @ 28 weeks (mating age)	100 kg

Table A7 Prices of livestock sold

	Price per unit (AUD)
20 kg weaner (approx. 11 weeks old)	84
1 day old broiler chicks	0.75
4 week old layer chicks	3

ANNEX 2: THE INITIAL INCREASE IN PIG STOCK

At present, there are eight sows in the facility and one boar. These are all over four years old and will soon be culled or sold on because their reproductive capacity is low.

An extended facility would have the capacity to hold up to 25 sows and three boars. The government anticipated these to be of exotic (Duroc) breed, which are highly productive and which could also later be used for cross-breeding purposes to create more climate resilient but productive breeds for use in Kiribati (Nonga, 2103). As these parent stock must be bred from specific bloodlines, it would be necessary to either import all parent stock from abroad, or to import some of the sows and use AI with the semen from the specific bloodline (also sourced abroad) to build up to full capacity.

To assess which approach would be most optimal for the stock increase, a costing of potential stock has been conducted.

Option a) Use AI on Pure Breed Sows

Using table B1 below, it is possible to see that from one sow successfully inseminated, 10 would be the average number of piglets born. The mortality rate indicates that from these only eight will be successfully reared if best practice is undertaken (the use of well-functioning farrowing crates is essential). On average, four of these will be sows and four will be boars.

Table B1: Productivity of Duroc breed pigs.

	Exotic Breeds (Duroc)
Parameter	Average
Number sows in facility	25
Number boars in facility	3
Average number of litters/sow/year	1.8
Average number of pigs born/litter (total)	10
Average number of pigs born/litter (alive)	9.5
Average number of pigs weaned/litter	8.5
Average number of pigs reared/litter	8

Source: Nonga, 2013.

Nevertheless, AI is generally less successful than normal breeding methods because sows must be in heat in order to successfully be inseminated. The expected success rate of carrying out AI at the facility was estimated to be 50 per cent on average, which means that from the insemination of one sow, the expected number of pigs reared would be 4:2 sows and two boars (Nichol Nonga, SPC livestock expert - personal communication 2013). Consequently, to increase the stock of sows to 25 within the shortest time span using AI, eight sows would first need to be imported from abroad. These would then be inseminated to produce an average of two sow piglets each, which would, in turn, be reared to make up the remainder of the sow stock to an estimated 24 sows in total. Nevertheless, the number of sows produced could be higher or lower, depending on how many sows are actually reared successfully through this process). If any more sows are needed to make up the numbers then they would either need to be imported or bred.

It is assumed that from the eight imported sows, 16 sows would be reared successfully using AI, meaning that one more sow should be imported to make up the full 25 proposed.

The cost of importing nine sows is shown below. These estimated costs of importing pigs have been taken from the report written by Nonga 2013, after consultations with the livestock facility on the costs they incur when usually importing pigs. A crate is needed per two pigs, meaning that, in this case, five crates would be needed.

Table B2: Estimated cost of importing nine sows.

Description	Quantity	Unit price (AUD)	Total (AUD)
Females prices (imported)	9	500	4,500
Vet treatment supply pack		500	500
Crates consignment preparation costs	5	100	500
Stock person (travel, DSA, etc.) to accompany stock on boats	1	2,000	2,000
Feed, water other requirements (transportation)	3 bags feed		250
Freight charges	5 crates	100	500
Quarantine in Tarawa		500	500
Total cost			**8,750**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

The cost of AI is displayed in table B3 below.

Table B3: Estimated cost of importing chilled semen for AI of up to 25 sows.

Description	Quantity	Unit price (AUD)
Cost of AI equipment / tools		1000
Cost of chilled semen	1 shipment	2500
Cost of transport (freight)		300
Expert from Fiji MPI (travel, DSA)	1	3,500
Total cost		**7,300**

Source: Nonga 2013.

Aside from the cost of AI, the costs incurred in rearing the pigs to reproductive age would also need to be incurred and, during this time, they would not be producing any piglets for the facility to sell.

The cost of rearing one piglet to maturity has been calculated to be AUD 610 if only feed and water costs are considered. To rear the 16 sows and three boars needed, the cost of feed and water alone is estimated to be AUD 11,576.

Finally, it can be estimated that 16 boars would be produced from AI of eight sows, as only three are required to make up the parent stock on the facility; there would be 13 extra boars left. These would be sold on once they reach 20 kg (at 11 weeks of age on average), for AUD 84

(4.2 AUD/kg). The cost of rearing these extra boars to 20 kg is estimated to be AUD 23.5 for feed and water alone. This means that the profit (AUD 787) of rearing and selling the extra boars can be subtracted from the total cost of the AI option.

Consequently, as a minimum estimate, the cost of using AI methods in the initial build-up of pig stock to 25 sows and three boars would be AUD 26,840.

Of course, it would be possible to import less sows to begin with and do multiple courses of AI to gradually build up numbers, but this would take even longer than the 49 weeks (almost one year) needed to rear the one set of piglets from one course of AI. Given that this is costly to the facility in both rearing costs and in time, during which no piglets would be produced to sell, these more gradual options are not analysed here as it would simply take too long to generate the parent stock needed.

Option b) Import Pure Breed Pigs from Abroad

Table B4 demonstrates the estimated cost of importing 25 sows and three boars in total.

Table B4: Estimated cost of livestock for importation.

Description	Quantity	Unit Price (AUD)	Total (AUD)
Price of females	25	500	12,500
Price of boars	3	500	1,500
Vet treatment supplies	23	100/animal	2,300
Crates consignment preparation costs	10	100	1,000
Stock person (travel, DSA, etc.) to accompany stock on boat	1	2,500	2,500
Feed, water other requirement (boat transportation) (Fiji prices - 28 pigs x 1.5kg/pig/day x10 days)	17 bags feed	17/25 kg bag	289
Freight charges	10 crates	100	1,000
Quarantine Tarawa (Feed 28 pigs x 1.5kg/pig/day x 30days x)	50 bags	26/bag	1,300
Total cost			**22,389**

Source: Livestock Sector, Agriculture Livestock Division, summarized in Nonga 2013.

Results

Not only is the cost of importing pigs directly from abroad cheaper than AI, but these imported stock will be ready to begin producing piglets for the facility to sell.

ANNEX 3: THE REPLACEMENT OF PARENT STOCK OVER TIME

Once sows and boars reach four years of age, their reproductive capacities decline. Every four years, there is a need to replace the 25 sows and three boars with new parent stock.

Because this process would be repeated every four years or less, it is potentially more cost effective to train staff in AI. This will enable the replacement of parent stock to be achieved by importing semen.

An assessment of whether it is more economical to simply import new parent stock from abroad or train staff and use AI is presented.

Option a) Import Replacement Parent Stock from Abroad

Using table C1, the cost of replacing the 25 sows and three boars is estimated to be AUD 22,389. If it is assumed that the price in real terms would stay stable over the next 40 years, then it is possible to use this value to estimate the cost of importing replacement stock.

The total cost after 40 years with no time discounting is AUD 223,890 and with a 10 per cent time discount is AUD 62,791.

Option b) Train Two Staff on AI and Use Imported Semen

The cost of training two staff is detailed below.

Table C1 Costs to train staff.

Description	Quantity	Rate (AUD)	Total (AUD)
2 Staff attachment training (Airfares, DSA, accommodation etc.)	2	4,000	8,000
Purchase of tools & equipment	1	1000	1,000
Freezer	1	1500	1,500
Preparation of dummy boar	1	100	100
Maintenance of tools and equipment	1 year	800	800

Assumptions:

- It is possible to assume that these two staff would pass on their expert knowledge and train other staff, so that there are always staff available to implement AI at the facility and that as AI would be carried out regularly, that further attachment trainings will not be required.[9]
- The freezer will need replacing every 10 years.[10]

[8] Nevertheless, it is also possible that refresher trainings may be required, in which case this option would be more costly.

[10] Research found that freezers should be expected to last at least 6 years (see http://www.whitegoodstradeassociation.org) and an average of 11 years (see http://www.appliance.net/2007/home-appliance-life-span-102) for home white good appliances. As the freezer may be subject to more extreme conditions in the livestock facility, an estimate of 10 years is used in this analysis.

From Annex 2, it has been estimated that the AI of one sow will have an expected production of two sows and two boars. In order to achieve the 25 sows needed to replace the parent stock, 12-13 sows would need to undergo AI every four years. Table B3 shows that the cost of importing one shipment of semen, which could be used for AI of all 12-13 sows is AUD 3,800.

The total cost after 40 years with no time discounting is AUD 233,228 and with a 10 per cent time discount is AUD 61,012. In addition to this cost, using the 12-13 sows for producing the replacement parent stock would mean that during this time, these sows are not producing pigs to be sold on.

Results

It seems that the total cost of importing replacement stock from abroad is approximately AUD 9,330 cheaper than that of using AI over the lifespan of the analysis. With time discounting, the results change and the importation of replacement stock becomes approximately AUD 1,780 more expensive. Nevertheless, the costs of using AI are a minimum estimation; they ignore the medical costs of rearing the replacement stock and also the loss of sales profit that would be incurred if the 12-13 sows used in the AI process were to continue producing for sale as normal. They also ignore the possibility of having to provide refresher courses for the AI staff over this 40-year period. Once these other costs are included, it is highly likely that even if the discount rate was set at 10 per cent, the importation of replacement stock would be the cheapest option.

From this, it is reasonable to assume that importing replacement stock would be the preferred option.

Further Consideration for AI

Although in this specific analysis AI is found to be more costly than using normal breeding methods, AI has other uses, which the Government may wish to consider:

- In other projects under the Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013–2015 (Nonga 2013), the cross breeding of local and exotic pigs has been put forward in order to produce breeds that have both the climate resilience of local breeds and the high productivity of exotic breeds. It is likely that this would require AI to be used by Tanaea staff in order to more successfully carry out the cross breeding initiative (Nonga 2013).
- If the Government is also concerned with increasing the knowledge assets of the staff, they may wish to provide AI training which could, in turn, be passed on to new staff through hands-on experience.
- Once these knowledge and resilience benefits are considered, it may be reasonable to invest in the training of two staff from Tanaea who would be expected to continue working at the facility and to pass their knowledge on to others.

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