Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013 - 2015

Department of Agriculture and Livestock

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Acronyms

AH&P	-	Animal Health & Production Thematic Group of SPC
AH&P	-	Animal Health & Production Division - Fiji
ALD	-	Agriculture and Livestock Department of MELAD - Kiribati
MELAD	-	Ministry of Environment, Lands and Agriculture Development
SPC	-	Secretariat of the Pacific Community
GIZ	-	Deutsche Gesellschaft fuer Internationale Zusammenarbeit
BMZ	-	German Federal Ministry for Economic Cooperation & Development.
OI	-	Outer Islands of Kiribati
AI	-	Artificial Insemination
MPI	-	Ministry of Primary Industries – Fiji
OB	-	Office of te Beretitenti
CCCPIR	-	Coping with Climate Change in the Island Region
SPCZ	-	South Pacific Convergence Zone
ICZ	-	International Convergence Zone
AnGR	-	Animal Genetic Resources
TTM	-	Taiwan Technical Mission
ECD	-	Environment, Conservation Department, MELAD
MFMRD	-	Ministry of Fisheries, Marine Resources Development
MPWU	-	Ministry of Public Works and Utilities, MPWU

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Executive Summary

The report was prepared following an invitation from the Ministry of Environment, Lands and Agriculture Development (MELAD), Kiribati to SPC/GIZ Coping with Climate Change for the Pacific Island Region (CCCPIR) project and the SPC/ USAID project, for a livestock specialist to develop a livestock implementation plan on climate change adaptation options for the country. The aim is to identify vulnerabilities and impacts of climate change and provide adaptation and intervention options that could be adopted in the short to medium livestock planning. These projected climate variabilities puts the agriculture sector (livestock included) and the food security to be among the most vulnerable to be affected. Climate change will have pronounced impacts on Agriculture and food security in Kiribati already exacerbated with limited crops and livestock diversity that can be grown and raised in Kiribati. The overall impact of these climate variations or changes will have a big impact on the individual performance of animals and production in Kiribati.

Livestock plays an important role in the lives of the people and although livestock are rarely slaughtered for daily meals, they become important for meeting social and cultural obligations such as weddings, birthdays and funerals. The pig and poultry sectors are dominated by the subsistence production system and a growing semi-commercial production system. Demands for livestock products in Kiribati is expected to increase further in the future driven by changing dietary habits, increases in human populations and migration to urban areas, increase in the numbers of families and the requirement for families to keep pigs to meet their social and cultural obligations, and increases in disposable incomes.

The objective of the report is to have sustainable small livestock production systems developed and promoted in Kiribati for Food Security and livelihood. The report provides a list of climate change hazards that are likely to affect livestock, climate change adaptation / intervention options and cost estimates to establishing these activities. A SWOT analysis of the livestock industry in Kiribati was conducted and included in the report. A Cost Benefit Analysis (CBA) of some of the concepts has also been compiled and is included as an annex (Annex I) to this report. It is anticipated that the report acts as a guide and a tool for decision making for the Agriculture & Livestock Department, Ministry of Environment, Lands and Agriculture Development (MELAD) and stakeholders.

Cost Benefit Analysis Report(Annex III)

A Cost Benefit Analysis Report has been included as an annex to this document of which part of the executive summary is hereby included. The full Executive summary of the analysis to the activities can be accessed on the document (annex III).

Step 1: Renovate and or extend of 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 2 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 Agriculture and Livestock Department (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 to also produce pigs.

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 AI or keep boars in the facility was undertaken. 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].

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 2 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

[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.

chicken. This analysis shows that by keeping pigs as well as chickens the facility would see estimated annual *reductions* in profit of about A$16,000 in nominal terms. The benefit to cost ratio of Step 2 is 0.66, which means that for every A$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 0.66cents.

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 chicken 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 chicken 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 the 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.

- 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.

- 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 SPXC 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 A$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 A$1 invested in these activities is expected to generate A$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
- it aids food security.

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

1.0 Background.

The Republic of Kiribati consists of 33 low-lying coral atolls scattered over 3,600,000 square kilometres of ocean stretching between latitudes 170º E and 150 º W and longitudes 5 º N and 11 º S. The total land area is 74,940 hectares (Department of Lands) with Kiritimati Island accounting for 38,840 hectares. In the 2010 census, it determined the total human population to be 103,058, an increase of 10,525 persons from the 2005 census (92,533) and a growth rate of 2.28% with South Tarawa being the most densely populated island with 58,182 (48.7%) people.

Food security is a major challenge for the 103,058 people living in Kiribati, and with the impacts of Climate Change threatening many resources vital for food security and livelihood, this challenge will become even greater. The 'Kiribati Livestock Production Concept to Support Climate Change Adaptation and Food Security 2013 – 2015' paper was undertaken to support the Agriculture & Livestock Department (ALD), Ministry of Environment, Lands and Agricultural Development (MELAD) to identify livestock adaptation /interventions options that could be adopted to increase livestock production for food security.

The report was prepared following an invitation from MELAD to SPC/ USAID project and the SPC/GIZ CCCPIR project, for a livestock specialist to develop a livestock implementation plan on climate change adaptation options for the country. The aim is to identify vulnerabilities and impacts of climate change and provide adaptation and intervention options that could be adopted in the short to medium livestock planning.

2.0 Objective

The objective of this report is to have sustainable small livestock production systems developed and promoted in Kiribati for Food Security and livelihood.

3.0 Livestock production and management systems in Kiribati

Livestock plays an important role in the lives of the people and although livestock are rarely slaughtered for daily meals, they become important for meeting social and cultural obligations such as weddings, birthdays and funerals. Traditionally almost all households raise livestock, with the majority of families and households raising both pigs and chickens mostly on a subsistence level.

Livestock production in Kiribati can be put into 3 categories and these are National level, Outer Islands and Tarawa and Kiritimati.

3.1 National level

Livestock development in Kiribati has been focused on pigs and poultry as the choice of diversification of livestock is limited to small animals such as pigs, chickens and ducks as compared to the larger island countries which could also include ruminants (cattle, goats, and sheep). However, there have been some Anglo-Nubian goats introduced in the past from Fiji in 1997 but these were exterminated in 2002 due to the environmental damage they caused and no taste for goat meat from the local population (AnGR Report, 2003). A national livestock census was conducted in 2012 with the results yet to be released but early estimates put the pigs population to be around 48,800 and chicken population at 63,950, a significant increase from the 2001 figures (Table 3).

Animal Disease Status

Kiribati appears to be free of the major exotic, economic and public health important diseases of chicken and pig (livestock) and there is no evidence to suggest that any of the OIE List A diseases are present (Saville, Peter H. 1996) although some of the OIE List B and OIE List C diseases are present and some are endemic. Therefore, it is important that future importations should seek to maintain this major disease free status.

Livestock products

The national animal products imports for the year 2010, 2011 and 2012 were valued at $6.4 m, $8.6 m and $7.8m respectively (table 1.) and is expected to increase in the coming years. The imports made up a large proportion of the national food imports and although the volumes and values have dropped in 2005, 2006 and 2007 respectively it increases again in 2010 – 2012 which indicate increases in consumption. There is a need to increase local production to reduce imports. It is difficult though to estimate the local livestock production of pig and chicken meat due to the absence of a central abattoir for slaughter of livestock as most of the livestock is slaughtered backyard.

Table 1. Imported livestock products

Animal products Imports	Year	Quantity (t)	$AUD (millions)
Meat & Meat products	2005	1,110	$3.9
Meat & Meat products	2006	1,058	$3.4
Meat & Meat products	2007	1,062	$2.8
Meat & Meat products	2010	1,230	$6.4
Meat & Meat products	2011	1,635	$8.6
Meat & Meat products	2012	1,561	$7.8

Source: Ministry of Statistics – 2011

Animal Genetic Resources

Animal Genetic Resources (AnGR) is an important national asset for food and agriculture and although the extent of the AnGR is unknown it is believed that Kiribati has some valuable animal genetic resources that have adaptated to the local environment / climate over time. Some of these valuable traditional or indigenous / adaptated breeds or genetic resources may have been lost or at the risk of being lost due to culling of superior animals for social /cultural obligations and unchecked husbandry practices. Urgent attention is needed to maintain these resources for development, conservation and utilization for food security and livelihood.

Production systems

The pig and poultry sectors are dominated by subsistence production system based on the use of adapted local breeds fed on locally available feeds. Subsistence production system is a low input system characterised by free-ranging, tethering or small confined pens and feed is based largely on kitchen scraps (leftovers), coconuts, breadfruits, fish offal, fish bones and fish soup and other marine products. This is the main production system used by farmers and smallholders throughout the country and especially in the Outer Islands (OI).

However, there is a dynamic growing smallholder semi-commercial pig and chicken production industry especially in the urban South Tarawa raising pigs with sow unit sizes ranging from 2 – 15 sows, broiler (meat birds) units of 50 – 200 birds and layer units of 50 – 1000 layers. Farmers are aiming to cash in on the growing demand for livestock products for social and cultural events. Smallholder semi-commercial system can be described as having medium to high inputs for production with majority of feed based on imported balanced feed imported from overseas countries such as Fiji, Australia and New Zealand.

The semi-commercial industry depends on the 15-sow pig unit, 250 parent layer and broiler chicken units at the ALD livestock breeding, multiplication and distribution centre for the supply of pig and poultry stock to farmers both in the urban Tarawa and the Outer Islands.

Feed stuff

Feed, water, husbandry care and management of livestock in these systems is done by owners, assisted by women and children doing this daily duty. The most common feed used in the subsistence system in the rural areas are kitchen scraps (leftovers), coconuts, pawpaw, breadfruit, fish offal, fish bones, fish soup and other marine products supplemented by locally adapted edible plants and weeds such as *temtea* or *teboi* (pig weed - *Portulaca spp*.), *te noni* and other plants. These plants are used mainly during the rainy/wet seasons when these are growing in abundance. An urgent need is to identify local feed ingredients for livestock in Kiribati.

Pig Production

Pig production is based on 3 breed lines; local breeds, exotic breeds and cross-breeds or improved breeds with the majority of pigs raised in subsistence and semi-commercial production systems.

Breeds

The local pig breed is characterised by a smaller body size, with a coat commonly black, red or brown, with white spots or red stripes along the whole body. It is a hardy type of breed which has adapted well to the local environment and have many desirable traits such as tolerant to high temperature, droughts, high rainfall events and resistant to diseases and pests and performs well under limited feed and water conditions. The disadvantages include slow growth rate, low litter size of 4-6 piglets and low litter number per year and high piglet mortality.

The only exotic pure breed currently maintained at the Tanaea breeding facility is the Duroc breed although Large White, Landrace, Tamworth and Berkshire (Table 2.) have been introduced in the past. Exotic breed is characterised by a large body, colour is dependent on the breed (white, red, black with white belt across the shoulders), faster growth rate which means it can reach mating age early, has a high litter size (av. 9-12 piglets), low piglet mortality and high feed conversion rate. The disadvantages of the exotic breed include vulnerable to high temperature, droughts, perform poorly under limited feed and water conditions and vulnerable to diseases and pests. These exotic breeds were introduced in Kiribati for the purpose of crossbreeding with local breeds to upgrade the local herds for adaptability, resilience and productivity. The Duroc breed was selected by the Agriculture and Livestock Department for its better performance as compared to the other exotic breeds kept at the Tanaea piggery (AnGR Report for the Republic of Kiribati, 2003). It was selected according to its higher growth rate, better tolerance to heat and high temperatures, tolerant to sun burn because of its colour and its high feed conversion rate.

Crossbreeds are products of crosses between exotic breeds and local breeds and the off-springs are commonly used by local farmers for to their desirable traits. Crossbreeds have a wide range of characteristics. Many of these characteristics resemble the parents and they could have coat colours such as white, red, white with black spots, black with white spots and so on. Some of these crosses have higher resistance to high temperatures, droughts, perform well under limited feed and water and resistant to diseases and pests. The main reason for crossbreeding is to capture the preferred traits from the

parents. These breeds can be used in both the subsistence and semi-commercial production systems.

In the subsistence production system, pigs are largely tethered to trees or stakes or penned in small pens made of timbers, sticks, coconut trunks, wire mesh and other available materials. These are usually located at the back of the houses or along the seashores. All pigs are raised in these two types of systems regardless of the breeds.

It is difficult to estimate the local production of pig meat (pork) due to the absence of an abattoir where such local productions can be measured. But it is evident that the local production of pig meat has increased dramatically driven by the increasing populations and the increase of disposal incomes.

Table 2. Shows livestock species and breeds raised in Kiribati

Pig Breeds	Available / not available	Chicken Breeds	Available/ Not available
Local pig	Endemic	Local breeds	Endemic
Exotic Breed		*Hi-breeds*	
Duroc	Pure breed available	Ross Meat	Available
Large white	Cross breed only	Hyline Brown parent	Available
Land race	Cross breed only	Hyline Brown layers	Available
Tamworth	Cross breed only		
Berkshire	Cross breed only		
Cross breeds (crosses of the above exotic breeds)	Present (LW x local, LR x local, TW x local, BS x local, D x local)		

Source: Agriculture Livestock Department, MELAD, 2012

Chicken production

Chicken production is done on two main systems and these are subsistence and semi-commercial production systems. Indigenous chickens are predominantly raised on subsistence or free-range system whereby chickens are left to roam within the villages and surrounding bushes fending for themselves, eating anything from coconuts, insects, leaves, crabs, crustaceans and occasionally supplemented by leftover foods from owners' kitchens. They are hardy type of livestock and can survive the harshest conditions. Indigenous chickens are smaller in size with roosters weighing around 1.5 – 1.8 kg and hens around 900 g – 1.0kg live-weight with multi-coloured feathers, with red, black and brown being the dominant colours. Production is low with hens only rearing 10-15 chickens annually. Hens lay eggs wherever they can make a nest ranging from houses, kitchens and bushes where eggs are not safe as they are eaten by dogs, rats and birds. Chick mortalities are usually high due to bad management and threats from predators such as dogs, cats, birds and rats.

Layers and broiler birds are raised in the semi-commercial system by farmers both in the Tarawa and in

the villages of the Outer Islands fed on imported compound feed from Australia, New Zealand and Fiji. The commercial hybrids used include Ross Meat (Broilers) and Hyline Brown Parents and Hyline Brown Layers (Table 2.) produced at the Tanaea ALD Breeding facility. These commercial layer and broiler parent flocks were imported from the Bromley Park Hatcheries Ltd, New Zealand. The aim of the parent flocks are to produce fertile eggs for hatching in the 2 new 3500 hen egg capacity incubators and one 1000 egg capacity hatching machine to supply to the farmers. Broilers chicks are sold as day-olds at $0.75 /chick/ week and layers are sold as 4 weeks old pullets at $0.75 /pullet /week to farmers in Tarawa as well as to farmers in the OIs. About 75% of table eggs are produced by smallholder layer farmers in Tarawa and also some broiler chicken meat is supplied locally by broiler farmers, both sectors making an impact on the supply of chicken meat and eggs. The majority of chicken shipments especially young broilers and layers and are normally transported to the Outer Islands by planes, these are organised and freighted by MELAD (govt) as a form of government subsidy to assist livestock farmers.

3.2 Outer Islands

There are two significant types of islands in the Outer Islands (table 3.), the first are those islands which are smaller in size (< 1,000 ha) and the second category are the much larger islands with more land mass (> 1,000 ha). These are all low lying islands and are all vulnerable to sea level rise and other climatic threats and human population pressures. Except for Kritimati Islands (38,839 ha), all the other islands are small. The main livestock species are pigs, chickens and ducks of which subsistence production system is the predominant system. Majority of pigs are most commonly allowed to free-range with some enclosed in pens and some are tethered, whilst local chickens are mostly allowed to free-range. These pens and pigs tethered can be moved from place to place depending on the condition of the sites.

The average number of pigs kept per household in the OIs range from 2-7 pigs with free - range chickens. How many pigs and chickens a house-hold can keep is not dependent on the size of the islands but rather on the reliable availability of feed, water and management commitment of the households. Livestock keeping and population is closely related to household numbers and human populations as shown in **table 3**. Majority of livestock keeping is done per household and as such the islands with high households and human populations also have the highest livestock population.

Common pig breeds used in the rural areas are predominantly local breeds, cross breeds and Duroc stock supplied by the Agriculture Livestock Department. The ALD pig breeding facility at Tanaea is distributing male and female Duroc breeding stock to local farmers to promote the crossbreeding programme to upgrade the local herds, for example in 2012, 12 males and 12 females were supplied to the communities of Tamana Island for their cross-breeding upgrading programme. Off-springs from the breeding stock will then be passed on to other households for breeding and fattening. Feed is based largely on kitchen scraps, surplus breadfruit, coconuts, fish bones and other available feeds and water, this dictates the numbers of pigs each household can keep. Pigs are kept mainly for social, cultural and religious obligations and are rarely slaughtered for daily family meals.

Table 3. Human and livestock numbers and distribution 2003

Island	Area (ha)	No. of Households	Av. size (ha)	Human population	Total Pigs	Total Chickens	Total Ducks
Tarawa	3,103	5,222	0.6	41,194	14,689	8,474	726
Abaiang	1,748	843	2.1	5,794	2,249	5,336	226
Tabiteuea	3,763	829	4.5	4,582	2,355	4,885	160
Butaritari	1,349	592	2.3	3,464	2,634	5,134	26
Abemama	2,737	533	5.1	3,142	1,755	3,377	195
Nonouti	1,985	508	3.9	3,176	1,991	3,141	368
Kritimati	38,839	458	84.8	3,431	2,787	2,157	228
Beru	1,765	492	3.6	2,732	1,339	1,989	136
Marakei	1,413	429	3.3	2,544	1,231	1,982	236
Maiana	1,672	376	4.4	2,048	1,012	1,303	190
Onotoa	1,562	354	4.4	1,668	1,467	1,650	13
Nikunau	1,908	333	5.7	1,733	1,230	1,430	87
Makin	789	292	2.7	1,691	1,040	1,681	26
Tabuaeran	3,373	282	12	1,757	1,069	2,357	58
Arorae	948	244	3.9	1,225	969	1,414	82
Tamana	473	214	2.2	962	1,103	1,423	95
Aranuka	1,161	194	6	966	779	1,052	41
Kuria	1,548	182	8.5	961	329	245	24
Teeraina	955	169	5.7	1,087	635	1,770	162
Banaba	625	54	11.6	276	62	447	7
Kanton	915	9	101.7	61	58	139	9
Total	**72,631**	**12,609**	**286**	**84,494**	**40,783**	**51,386**	**3,095**

Source: Animal Genetic Resources for the Republic of Kiribati report, 2003

Commercial layer and meat (broiler) birds are also raised in the Outer Islands sourced from the ALD breeding, multiplication and distribution centre, Tanaea. Operations are smaller with live meat, 'spent layers' birds and eggs are sold to the public.

3.3 Tarawa /Kirimati

Livestock keeping in Tarawa is slightly different to the rest of the country because of its high human population density (South Tarawa, 58,142). This is also where most of the semi-commercial livestock farming is taking place. There is a total of thirteen (13) 2-37 sow units pig producers and one (1) fattening unit in South Tarawa, using the Duroc breed and feeding their stock on imported compounded feed. The largest is a 37- sow unit which is owned by the Taiwan Technical Mission (TTM) producing about 450 pigs annually distributing weaners free to local selected farmers. The rest are producing pigs for the local market. The main focus is to produce meat for the local market and also to further produce improved stock to pass on to their neighbours and relatives in the villages as part of the on-going cross-breeding upgrading and distribution programme.

For chickens, there is a total of 35 local egg producers (table 4.) ranging from 50 – 1000 layers producing eggs for the local market. There are 10 local broiler (meat) producers ranging from 50 – 250

birds, selling live chickens due to the absence of a central abattoir to slaughter the chickens.

Most of these establishments rely on the Agriculture & Livestock Department, MELAD's breeding facilities at Tanaea for the supply of replacement stock.

Table 4. Number of pig and chicken establishments in Tarawa, 2013

Pig operations	No	Chicken operations	No
		Egg producers	
2 –sow units	3	50 -100 layers	15
3 sow unit	5	100 -150 layers	10
3 – 6 sow unit	3	150 – 200	5
6 – 15 sow unit	1	200 – 1000	5
15 – 40 sow unit	1	**Broiler operations**	
Fatteners (mainly buying in weaners and fattening them for sale)	1	50 -100 birds	5
		100 – 250 birds	5
Total	**14**		**45**

Source: Agriculture and Livestock Department, MELAD, 2013

Kiritimati Island

Kritimati Island has a total of 38,839 hectares (Table 3.) of land and accounts for about 53.5% of the land mass in the country and has a very high potential for livestock production. There is high potential to establish larger operations with bigger numbers of livestock in Kritimati since it has a bigger land area, potential to better availability of local feed and water for production. The human population on Kritimati Island is comparatively low as to the other islands, this could be an advantage to livestock production.

3.4 Pig and chicken breeding, multiplication and distribution centre, ALD, Tanaea.

The Agriculture Livestock Department Breeding, Multiplication and Distribution Centre was built by the government purposely to breed, multiply and distribute improved pig and chicken stock to farmers for breeding and fattening to increase livestock production for food security and livelihood. This purpose is still maintained today with the centre continuing to fulfil this purpose and for many more years to come. It is important to note that this breeding facility distributes pure-breed stock of pigs, hybrid layers and broilers and is therefore a vital link to the reliable supply of pig and chicken stock to farmers throughout the nation. The facility produced and distributed annually 25,000 broiler birds, 44,350 layers and 100 pigs (table 5) to farmers. It will continue to play this major role in supplying stock to farmers in the foreseeable future until some other establishments could take over this important breeding and distribution role.

The main pig breed used for the purpose of breeding and distribution to local farmers is the Duroc breed which is a brownish/red type of exotic pig breed (plate 1.). The Duroc breed was selected from among other exotic breeds based on the results of the production performances of these exotic breeds kept at the centre in the early 1980/90s and also from performance results from other countries. The Duroc breed has some of these resilient preferred traits such as high growth, heat and high temperature tolerance, tolerant to sun burn because of its colour, high feed conversion rate and high production rate.

Hybrid chicken layers and broiler parent flocks are kept at this facility for the production of fertile eggs which are collected, set and hatched for supply of day-old broiler chicks and layer pullets to farmers. The parent stock for both layers and broilers were brought in as fertile eggs which were incubated and hatched to produce parent stock chicks. The majority of the eggs produced are hatched to supply day-old broiler chicks and pullet layers to farmers and the rest of the eggs are sold for consumption as table eggs. At the time of the visit, there were 250 parent stock (150 layer and 100 broiler) at the facility and production was at about 80% per annum.

The government annual expenditure budget to this breeding facility for production and maintenance is AUD $147,550 per annum (Table 3). The annual income from the sales of livestock and livestock products (pigs, meat and eggs,) and sales of imported feed totalled to AUD$149,860 showing a profit off AUD$2,310. All income raised from the sales is deposited directly into the government's general revenue and is not revolved into the operation.

Plate 1: Duroc breed, boar and sow

Duroc boar

Duroc sow

Source: Pig Husbandry 1, study book, The University of Queensland, Australia, 1993

Table 5. Government Expenditure /Income annual budget for Tanaea

Expenses	No	Cost/unit	Amount(AUD)
Livestock feed (pigs / chickens)	4 containers	27,000	108,000
Parent stock replacement(Layer fertile eggs)	300	20.00	5,000
Parent stock replacement (broiler fertile eggs)	300	20.00	5,000
Maintenance	Annual	13,750	13,750
Utilities (water , electricity etc)	12 months	900/month	10,800
Medicines/drugs		5,000	5,000
Total annual expenditure			**147,550**
Income (from Sales)			
Sale of livestock (broilers)	25,000 birds	0.75	18,750
Sale of chickens (layers, 4 wks)	30,000	3.00	90,000
Sale of livestock (pigs)	100 (20kg)	4.20/kg	8,400
Sale of livestock feed	100 bags	26.00	26,000
Eggs	3,650	0.40/egg	1,460
Roosters (reject)	1500	3.50	5,250
Total annual income			**149,860**
Expenditure less income (profit)			**2,310**

Source: Agriculture Livestock Department, MELAD, Tarawa

4.0 Climate Trends & Sector Vulnerabilities

The climate of Kiribati is best described as tropical marine with annual temperatures range from 26^{o}C to 32^{o}C (mean: 29^{o}C). Annual rainfall is very variable and ranges from 1,000 mm near the equator to 3,000 mm in the North (Washington Island). The country is very susceptible to the El Nino effect causing prolonged droughts that are a common occurrence. Strong winds often occur during the period November to May, fortunately, Kiribati lies outside the cyclone region of the Pacific.

4.1 Observed and expected climate trends

The observed climate of Kiribati is hot, humid tropical climate, with air temperatures very closely related to the sea-surface temperature of the surrounding ocean. The wet season and the dry season is influenced by the South Pacific Convergence Zone (SPCZ) and the International Convergence Zone (ICZ). Variability of rainfall is high impacted by El Nino-Southern Oscillation (ENSO). Warming trends of annual and seasonal air temperatures in Tarawa is evident recorded from 1950 -2009. Sea level rise near Kiribati measured to have risen as well. Droughts recorded in association with La Nina have been very severe for example in the 2007 – 2009 droughts in the Southern part of Kiribati, underground water lens turned brackish and leaves of plants turned yellow including coconuts, (PCCSP report, 2011). There is a strong trend towards increase in annual and seasonal minimum air temperatures. There is a positive significant annual rainfall trend for Kritimati Island during the period from 1952 – 2009 but the seasonal and annual rainfall for both Kiritimati and Tarawa are not significant. Kiribati does not experience cyclones. There are trends for water surface temperatures, ocean acidification, and sea level rise be increasing around the waters of Kiribati over the past decades.

4.2 Future predictions

The future climate projections for Kiribati are that the Surface air temperature and Sea surface temperatures are projected to continue to increase with *very high* confidence. The Annual and seasonal mean rainfall is also projected to increase (*high* confidence). The intensity and frequency of days of extreme heat are projected to increase (*very high* confidence). The intensity and frequency of days of extreme rainfall are projected to increase (*high* confidence). The incidence of drought is projected to decrease (*moderate* confidence). Ocean acidification is projected to continue (*very high* confidence). Mean sea-level rise is projected to continue (*very high* confidence) (PCCSP, Country Reports, 2011).

These projected climate variabilities puts the agriculture sector (livestock included) and the food security to be among the most vulnerable to be affected. Climate change will have pronounced impacts on Agriculture and food security in Kiribati already exacerbated with limited crops and livestock that can be grown and raised in Kiribati. The overall impact of these climate variations or changes will have a big impact on the individual performance of animals and production in Kiribati.

4.3 Vulnerabilities of the livestock production sector

To analyse and demonstrate the current status and specific vulnerabilities of the livestock production sector in Kiribati a Strength-Weaknesses-Opportunities and Threat (SWOT) Analysis of the livestock breeding and distribution system of the Department of Agriculture was undertaken. The SWOT analysis looks at the current livestock varieties, breeding stock, husbandry care (water, feed, housing, etc.) and maintenance and the sustainability of existing distribution mechanism of livestock to outer islands for food security.

Strengths

- A national network of 92 Livestock and Agriculture Extension staff of the ministry with 39 based at Agriculture HQ in Tarawa and 53 in the Outer Islands.
- Existing facilities, networks, skills and knowledge and human resources that have experience in animal production and distribution of stock to local farmers.
- A dynamic semi-commercial livestock industry present in the country that supplies part of the country's supply of livestock products with the capacity to breed, produce and distribute stock to farmers (table 6.)

Table 6: Existing assets, stock and items at the Tanaea facility – strength

Items	No.	No. Pens	Purpose	General condition
Pig sheds	5 sheds (1 new shed need to be completed)	4 mating pens 6 weaner pens 10 dry sow pens 2 farrowing pens.	Sheds / pens major producer to pig stock for distribution to farmers. Vital for livestock production.	Majority are old and need repairs / renovations
Stock (Duroc breed)	9 sows 2 boars 4 weaners		Main breed is Duroc. Advantage over white pigs due to resistant to sunburn.	Sows and boars need to be replaced as they are old and in-bred
Chicken sheds	3 sheds	8 Layer / broiler parent flock pens 7 Rearing pens	Main layer and broiler production parent flocks for the whole country	Fair. Changes needed for repairs to walls and netting
Hatchery shed	1 Shed	1 room	Hatchery produce chicks /stock for farmers	Fair. A separate room for sorting, vaccinations and other works for hygiene is needed
Hen Egg Incubators	2 Incubators	Capacity 3276 eggs	Incubators capacity can produce at least 25% of the country's need	New and operating well
Egg Hatcher	1 Hatcher	Capacity 1,008 eggs	Hatcher to hatch young chicks	New and operating

Feed Storage shed	1 shed		Store imported livestock feed for pig and chicken stock	Unused for storage - rundown

Weaknesses

- Large amounts of foreign reserves (AUD 3,971,814, Ministry of Statistics, 2006), is spent on imports of livestock products annually into the country.
- The choices of livestock species for production is limited to smaller animals such as pigs, chickens and ducks and honey bees as compared to larger island countries whereby ruminant livestock such as cattle, goats and sheep can be raised.
- Indigenous local /traditional breeds of livestock (animal genetic resources) potential for future breeding of climate resilient animals are eroding due to many threats including slaughtering of superior animals for social obligations and unchecked husbandry practices.
- Animal waste is a pressing issue in Kiribati atolls especially from pigs of all breeds causing pollution to coastal land, contamination of underground water, transmission of diseases and parasites to humans. However, it should be noted that the size of animals will also have an impact on the amount of waste produced, the bigger the breed the more waste it will produce.
- Livestock staff with limited professional training on agriculture and livestock production.
- Limited resources such as transport logistics, finance, fuel, tools, medicines and human resources to support livestock production and distribution from Tarawa to Outer Islands.
- Dependency on imported livestock feed from Australia and Fiji and limited availability of locally produced feed as food crops and coconuts are needed for human consumption.
- Limited water resources available for human, agricultural use and livestock consumption. Major sources of water are from the underground fresh water lenses and rainwater. However, with population increasing, water consumption and salt contamination putting extra pressure on underground fresh water lenses.
- Underground water source at ALD breeding facility, Tanaea is brackish and unfit for human or livestock consumption. The current water supply to the chickens and pig sheds comes from the public water supply system which creates additional costs and at times is limited especially during the dry months.
- The conditions of pig, chicken and feed storage sheds at the ALD Tanaea are deteriorating. Immediate repairs and renovations to the floors, walls and roofs are needed; otherwise the supply of stock will be seriously affected.

Opportunities

- Identify and adopt proven appropriate sustainable production systems that could increase livestock production for food security and livelihood.
- Opportunities in utilising ALD staff posted in every OI to coordinate and implement activities and improve livestock production.
- Opportunities for farmers to increase livestock production using appropriate locally adapted plants and crops for livestock feed.

- Opportunities to increase the use of locally available by-products of copra meal and fish meal with the opening of the tuna fish loining (it is said that fish meal will soon be available).
- Opportunities in identifying, conservation and utilisation of adapted indigenous pigs and chicken breeds for food security.

Threats

- The major threats to the livestock industry are the negative impacts of climate change affecting livestock production.
- The competition for scarce resources such as land, feed and water with higher priorities given to human activities and development over livestock.
- The trend of rural drift of people to urban areas increases human population poses a threat to livestock keeping due to shortage of resources e.g. land and feed resources.
- The high human population density increases contacts between animals and humans and therefore increases the potential spread of animal diseases to humans and vice versa.
- Animal wastes pose threats to public health, contamination of underground water-lens and pollution to the environment.

4.4 Likely climate change impacts on livestock and food security in Kiribati

Climate change will impact on all areas of the Pacific Islands region, on oceans, land and forest resources including agriculture of which livestock play an important role in agriculture and food security. Livestock farmers of all sizes, including backyard, smallholder and commercial producers, are all at risk.

Demands for livestock products in Kiribati is expected to increase driven by changing dietary habits, increases in human populations and migration to urban areas, increase in the numbers of families and the requirement for families to keep pigs to meet their social and cultural obligations, and increases in disposable incomes. However, the future of the livestock sector in Kiribati is under threat due to the possible long term climate change impacts. Some potential impacts of climate change on livestock production in Kiribati include:

Increased daily minimum and maximum temperatures - Heat stress on livestock resulting in reduced productivity due to poor production and reproduction, increased mortalities and losses, increased disease susceptibility, decreased nutritional performance and behavioural changes. Potential livestock feed plants /crops and water resources will be affected as well.

Increased rainfall variability and extreme rainfall events – Increased variability and extreme rainfall events will cause livestock stress from poor housing conditions such as muddy enclosures. Nutritional performance will decrease. Diseases will spread more easily, and new diseases may emerge. Fresh water quality will be affected by pollutants and water-borne diseases.

Increased frequency and duration of droughts – Water availability and quality will be highly affected with underground fresh water lens in danger of being contaminated by salt. Potential plants growth and production e.g. coconuts and other local feed ingredients for livestock will be impacted by lack of water and feed availability decrease. Direct mortality in livestock will occur from lack of feed and water. Pests will increase.

Increased intensity and frequency of wind gusts – Livestock infrastructures will be damaged, trees and plants will be damaged resulting in reduced shade for scavenging animals and birds, and water contamination from pollutants and water-borne diseases will occur.

Storm surge, salt water intrusion and salt spray resulting from sea level rise – Inundation of coastal areas resulting in a reduction in land areas available for agricultural activity, increased livestock densities and increased animal-human contact. Water availability and quality will decrease as salt contamination of fresh water in underground lens will occur and cost of fresh water will increase. Stress levels in livestock will increase. Infrastructure will suffer from rust and damage, loss of land increases. Spoilage of feeds in storage will occur, and costs will rise.

Diseases will interact with climate hazards to manifest in different ways. Some current disease problems will be exacerbated due to stress and nutrition related immune challenges. Shifts in vector populations will cause changes in prevalence in different areas.

High priority mechanisms for adapting the livestock sector to climate change include:

Housing – For subsistence / smallholders and semi-commercial producers, climate adapted housing will include shade, plentiful fresh water and good ventilation. Housing should be climate change designed for protection against the elements. It would be helpful to plant trees and shrubs close to livestock pens for shade.

Breeding – Need to identify indigenous livestock breeds adapted to local conditions and future climate changes. Valuable indigenous pigs and chickens, ducks and other livestock (such as honey bees) should be selected for breeding in Kiribati. Farmers should select offspring that show good temperature /heat tolerance in terms of production and reproduction for further breeding.

Feeding -Resilient fodder / local edible plants species need to be identified, and integrate them into local farming systems for livestock feed. Locally available by-products such as copra meal and fish meal (available soon) must be used for local formulations should also be prioritized to counter rising costs of imported feedstuffs. New feeding programs need to be developed that take into account the increased nutritional needs of heat stressed animals.

Watering - Fresh water should always be available to livestock. Rainwater harvesting and storage need to be increased /developed, such as increasing number of tanks /drums for livestock use.

Waste management – The threats posed by animal waste to the environment and public health is a major concern in Kiribati. Pens, sheds and enclosures should be cleaned frequently, with composting of waste for use as organic fertilizer and biogas digester for energy.

5.0 Agriculture and Livestock Department Development Strategy, MELAD - 2012 – 2015

The Department of Agriculture and Livestock, MELAD recently made a draft development strategy for the country based on the impacts of Climate Change and focussing on improving agriculture production including livestock for food security. In this strategy, Objective 2, states "Sustainable small livestock production systems developed and promoted" with four main outputs, 2.1 – 2.4 focussing on Livestock Production Systems as listed below:

Objective 2.0 - Sustainable small livestock production systems developed and promoted

- ***Output 2.1 - Appropriate livestock management practices developed and promoted***
- ***Output 2.2 - Livestock diversity improved, conserved and utilized***
- ***Output 2.3 - Livestock feeds with local ingredients developed***
- ***Output 2.4 - Solid waste management***

Livestock Climate Change adaptations and activities developed in this concept paper are grouped into four (4) project groups for ease of implementing and these are listed in order of priorities with references to the relevant goals, outputs, indicators and costs in section 6.0 (Outputs 2.1 – 2.4).

PROJECT GROUP 1

5.1 Priority activity 1. Improving piggery, poultry and feed storage sheds with rain water harvesting at ALD Tanaea Breeding Centre (Output 2.1).

The Agriculture and Livestock Department, MELAD in Tarawa is the only local government agency that provides a pig and poultry breeding, multiplication and distribution service in Kiribati, supplying local farmers with stock. Farmers throughout the country depend on this service for pig and chicken stocks for breeding, meat and eggs. It is believed that this service will remain with the department for a long time yet until a reliable private operator can take over the service.

However, the current conditions of the facilities (piggeries, chicken and feed sheds) are not conducive to support this vital service as the majority of them are in need of renovations to improve this supporting role to farmers. Maintenance and modifications to the structures are needed urgently if they are to increase production and meet the demands for stock. This service is a vital link to the availability and supply of stock to farmers for food security and livelihood. With Climate Change impacts, population growth and other pressures threatening food security and livelihood to these atolls, it is vital that this service to farmers continue. Failure to support this facility would have a discontinuation to the reliable supply of pig and chicken to the growing livestock industry in Kiribati which is making an impact on import substitution. In the face of climate change impacts and food security threats it should therefore be given priority to maintain and improve the facility to increase the current supply of stock. The main sheds for improvements are;

a) Pig sheds

A total 6 pig sheds, 5 old ones and 1 new uncompleted shed (photo 2.) with a total of 22 pens (4 mating pens, 6 weaner /grower pens, 10 dry sow pens and 2 farrowing pens) exists at the station. These sheds and pens need to be divided properly for specific operations such as mating, farrowing, weaners, dry sows, replacement /growers and boars. Currently there are only 13 pigs in the piggery (9 sows, 2 boars and 2 weaners), a full capacity would hold 300 – 400 pigs at any one time. This is supposed to be a 15-sow unit but at the time of the visit there were only 9 sows present, 5 sows were pregnant and 4 empty, there were no piglets as most of the weaners had been sold and distributed to farmers. It was also reported that piglet mortalities is very high averaging at about 30 - 40% due mainly to sows crushing the piglets as a result of the aging farrowing crates not functioning properly.

Production could increase significantly if the conditions are improved and thus a reliable supply of resilient /adapted pigs to farmers. The department aims to increase the current stock to 25-sow unit and eventually to 50-sow unit. This mortality problem occurs due to the farrowing crates being old and not serving the purpose well. This justifies the need to build new pig sheds and install new pens and farrowing crates in the piggery to decrease this mortality rate, increase production and to cater for the increase of sows. Two new sheds are recommended to be built at the Tanaea piggery facility to increase production and these are;

Plate 1. Part of existing pig sheds at Tanaea

Plate 2. An un-completed pig shed

Table 7. Estimated cost of a 25 sow unit breeding pens

Materials	Description	Qty	Unit cost (AUD)	Total (AUD)
Brick (8x8)	Wall	2380	1.90	4,522.00
Cement 40kg	Foundation	32	19.50	624.00
Cement 40kg	Floor	112	19.50	2,184.00
Cement 40kg	Mortar	32	19.50	624.00
Cement 40kg	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 (10ft)	Form work	104	42.00	4,368.00
Ridge cap (6ft)	Form work	12	22.00	264.00
Roofing nails (4”)	Form work	15kg	7.50	112.50
Rods(12mm)	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	40kg	7.50	300.00
Nails (6”)	Formwork	20kg	7.50	150.00
Nails (2”)	Formwork	10kg	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
Labour	3 months	3 person	435.00	3,915.00
Maintenance		1	1,000.00	1,000.00
Subtotal				**27,300.50**

Source of information: Livestock Sector, Agriculture Livestock Department, 2013

Shed 1 1 x 20 sow unit shed measuring 12m x 17.8m having 16 pens measuring 2m x 4m each, and walkway (1m) in the middle with 8 pens on either side of the shed (see sketch design Annex 5). The wider sheds design is expected to give more ventilation and cooler environment to the pigs. The total cost of this new shed is estimated to be AUD $25,855 (Table 7.)

Table 8. Estimated cost of a farrowing, weaner and grower shed

Materials	Description	Qty	Unit price (AUD)	Total (AUD)
Brick (6x8)	Wall	1500	1.90	2,850.00
Cement 40kg	Foundation	54	19.00	1,026.00
Cement 40kg	Floor	84	19.00	1,596.00
Cement 40kg	Mortar	20	19.00	380.00
Cement 40kg	Plaster	30	19.00	570.00
Cement 40kg	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 (12ft)	Form work	76	42.00	3,192.00
Ridge cap (6ft)	Form work	15	22.00	330.00
Roofing nails (4”)	Form work	15kg	7.50	112.50
Rods(12mm)	Post	40	25.00	1,000.00
PVC pipes (150mm)	Drain-out	7	78.00	546.00
Elbow (150mm)	Drain-out	10	22.00	220.00
Tee (150mm)	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	10kg	7.50	75.00
Nails (6”)	Formwork	10kg	7.50	75.00
Nails (2”)	Formwork	10kg	7.50	75.00
Iron nail (4”)	Formwork	10kg	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
Labour	3 months	3 persons	435.00	3,915.00
Maintenance (years)		1	1,000.00	1000.00
Subtotal				**26,499.50**

Source of information: Livestock Sector, Agriculture Livestock Department

Shed 2 1 x farrowing, weaning and grower shed measuring 14m x 12m having 8 weaner and grower pens and 4 farrowing pens. Each weaner /grower pen measuring 4.5m x 2m and each farrowing crate measuring 1.52m x 2.12m (see sketch design Annex 6.). The total cost to this shed is estimated to AUD$25,634.00 (table 8.)

Timeframe (Pig Shed 1 & 2):

Year 1. Recommended activities in September 2013 - January 2014.

b) Chicken sheds renovations

There are currently 2 sheds being used 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. Both sheds need minor repairs to the walls, wire mesh nettings to keep rats, birds and other predators and other general improvement. Production is expected to increase with new renovations completed.

Timeframe:

Year 1. Renovations is recommended to be to done within Nov. 2013 – Jan 2014.

Plate 3. Broiler parent layer flock

Plate 4. Rearing shed for rearing pullets

Table 9. Estimated cost of 2 chickens sheds renovations

Description	Qty	Unit Price (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
Cement bags	10	19.00	190.00
Nails (4") (kg)	10	7.50	75.00
Nails (2") (kg)	10	7.50	75.00
Gutter (pvc)	10	78.00	780.00
Down pipes	4	78.00	312.00
Elbow	4	22.00	88.00
PVC Glue	3	5.00	15.00
Other materials	Assorted	300.00	300.00
Labour (per month)	3	435.00	1305.00
Maintenance	3 years	300.00	900.00
Subtotal			**6,090.00**

Source of information: Livestock Sector, Agriculture Livestock Division

c) Feed Storage shed

Feed is an important component to livestock production which caters for about 70 – 75 % of the total operational expenses of any piggery or poultry operations. The current feed storage shed used to store feed for the pig and chicken stock at Tanaea is no longer used since the building is not safe for feed storage. The shed will need to be demolished for a new one. Stock feed is temporarily stored at the ALD training room.

Feed storage is important to maintain the physical quality and the nutritive quality of the feed needed to give good nutrition to pigs and chickens for increased production. Feed need to be kept in good storage conditions that will avoid feed deterioration and losing its quality. Storage shed should have a solid floor, good roof, walls and windows and the building should be insect and rodent proof and draught-free. It is recommended that a new feed storage shed should be built and a sketch design with estimated costing is included (see sketch design Annex7) and the estimated costing is as per table 10. The total cost is estimated at AUD$15,826.00 (table 10).

Table 10. Estimated cost of feed storage shed building

Materials	Description	Qty	Unit price (AUD)	Total (AUD)
Brick (6x8)	Wall	2400	1.90	4,560.00
Cement 40kg	Foundation	20	19.00	380.00
Cement 40kg	Floor	50	19.00	950.00
Cement 40kg	Mortar	10	19.00	190.00
Cement 40kg	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/platfrom	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 (10ft)	Form work	64	42.00	2,688.00
Ridge cap (6ft)	Form work	7	20.00	140.00
Roofing nails (4")	Form work	15	7.50	112.50
Nails (4")	Form work	10kg	7.50	75.00
Nails (6")	Form work	10kg	7.50	75.00
Nails (2")	Form work	5kg	7.50	37.50
Security wire	Window	1 roll	360.00	360.00
Hinges pairs (6")	Door	2	5.50	11.00
Labour	1 month	3	435.00	1305.00
Maintenance (years)	3	3	300.00	900.00
Subtotal				**16,281.00**

Source of information: Livestock Sector, Agriculture Livestock Division

Timeframe: Year 1. Feed storage September 2013 – December 2013.

d) Installation of rainwater water harvesting and storage capacity

Water is an essential nutrient for all animals and the single nutrient required in the greatest quantity by animals. Pigs require water for a variety of reasons, including most metabolic functions, adjustment of body temperature, movement of nutrients into the body tissues, removal of metabolic waste, production of milk, and for growth and reproduction. In fact, 80% of the empty body weight of the newborn pig and about 53% of a market hog is water. The requirements for water is affected by many factors such as temperature of the environment, the humidity of the environment, the type of feed (dry feed or wet feed), the breed of the pig the age of the pig, the stage of production of the sow.

The underground water lens in the area around ALD Tanaea breeding station is known to be brackish and not suitable for drinking for both humans and livestock. A good source of fresh water is essential for the successful operation of this livestock breeding and distribution facilities. Thus, it is important to look into alternative sources of water for livestock. The current water supply comes from the Water

Authority public supply. This supply, however, is limited and the supply is affected during the dry season and drought times.

At Tarawa the driest six-month period (known as *Aumaiaki*) begins in June until November with October being the driest month, the wet season (known as *Aumeang*) is from November – April peaking in January with a mean rainfall of 268 mm (PCCS, 2011). It is also projected with high confidence that rainfall will increase in the next 50 years and drought will decrease. In view of the increase in rainfall, there is need to utilise rainwater harvesting (PCCS, 2011) option.

Rainwater harvesting is the most appropriate alternative source of fresh water for the livestock facility. It is therefore important to provide resources to explore this rain water harvesting option from roof tops of the buildings within the facility. Rainwater harvesting can be done during the wet seasonThere are 8 pig and chicken sheds at Tanaea that are ideal for rain water harvesting, collection and storage by installing tanks to collect rainwater runoff. Each building should be equipped to collect water and store for livestock as well as for humans. Tanks can be purchased from a local company (Rotamould Co.) in Tarawa which is producing tanks of various volumes and sizes. Table 11. shows the daily water requirement for various pig age groups.

Table 11: Daily water requirements for pigs

Stage of life	Amount of water needed daily
Lactating sow	20–30 litres (5.5–8 gallons)
young grower	3–5 litres (0.8–1.3 gallons)
Grower	5–12 litres (1.3–3 gallons)
dry stock	12–15 litres (3–4 gallons)
pregnant sow	12–20 litres (3–5.5 gallons)
Nursery pigs (piglets)	2.8 litres

Labour and carpentry work for construction, renovations and refurbishments of the buildings and installations of rain water harvesting facilities are expected to be carried out by the current maintenance staff of the Ministry. Maintenance of these buildings is included in budget for donors to meet in the first 3 years but after that period should be included in the annual expenditure budget allocation of the Ministry.

The details of goals, indicators, verifications, assumptions and timelines for these activities can be found in section 6.0 (refer to 6.0)

Timeframe: Year 1. September – December 2013

Table 12. Estimated cost of rainwater harvesting

Description	Qty	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 of information: Livestock Sector, Agriculture Livestock Division

5.2 Priority activity 2. Importing improved pig breeding stock and semen for herd improvement (Output 2.1)

The objective of increasing livestock production and distribution of stock to the Outer Islands farmers can be achieved through the use of quality genetic breeders (pigs and poultry). There is an urgent need to import new genetic blood lines into the herd to improve its productivity. Sources of breeding stock should be identified and importations made overseas. The importation will bring in improved stock of new blood lines to inject into the breeding herd which have now been inbred after many years of unavailability of new stock. There are two approaches to addressing the need to improve the breeding herd at the ALD Tanaea piggery. The first option is to import live breeding stock (gilts and boars) to incorporate into the herd; the second option is to import quality semen to artificially inseminate sows.

a) Option 1. Importing live stock

The pig breeding stock is to be selected and purchased from pig commercial operations in Fiji. Fiji is the closest country with good sources of good genetic breeds and has direct transportation link to Kiribati. Duroc is the preferred breed. A total of 28 Duroc breeding stock (25 gilts, 3 boars) is recommended to be imported for breeding. With these new improved breeding stock coming into production and with good management, it will increase production. It is recommended that all the existing sows be culled as they are now old and have peaked their productivity period. The newly imported stock will now form the basis of the breeding herd of 25 sow unit. This new herd should increase production of stock for distribution to the OI farmers. The off-springs (F1) from the herd can either be sent directly to farmers or they can be crossed with the local breeds for hardiness and adaptability to the environment before being distributed. Table 13 shows the estimated cost of importing live pig stock. Assumptions below show what difference new stock would bring;

Production assumption:.

Current production performance at Tanaea:

No. of sows - 9
Litters/sow/year; - 1.8
Av. Piglets/sow/litter - 8

Production performance:
(9 sows @ 1.8 litters/sow/yr @ 8 Av. Piglets/sow/litter) = 130 piglets**.**
Mortality rate of 40% (current) = 78 weaned pigs

With the importation of higher performance stock and the inclusion of the current stock, the likely estimated production will be;

Assumptions:

No. sows - 25 (5 old sows + 20 new gilts)
Litters/sow/year - 1.8
Av. Piglets/sow/year - 9

Production estimates / year:
(25 sows @ 1.8 litters/sow/year @ 9 piglets/sow/litter) = 405 piglets
Mortality rate of 5% per year
Total weaned pigs **= 385 pigs**
An increase of = 307 weaners per year

Timelines: Year 1. November 2013 - March 2014 (Stocking the newly built piggery)

Table 13. Estimated cost of live stock for importation

Description	Qty	Unit Price (AUD$)	Total (AUD)
Females prices (imported)	25	500	12,500
Boars prices (imported)	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			**22,389**

b) Option 2 - Import chilled Duroc semen for AI herd improvement (Output 2.1)

Artificial Insemination

Artificial Insemination (AI) is a technology highly recommended for livestock production with many advantages. Artificial insemination is used widely in pigs and other livestock and could greatly improve pig production in Kiribati. The main advantages of AI include; reduce risks in spreading animal diseases, utilising limited number of quality boars for semen for insemination, quality semen can be transported easily compared to live boars and reduce costs, semen from a single boar can service many sows. Option 2 will have two activities to it:

Activity 1. Technical Training on Pig Artificial Insemination (AI)

To be able to confidently practise this technology, the project need to train at least 2 staff from ALD in AI. Staff selected can do a training attachment for a period of 1month learning and practising the technique with the Fiji's Animal Health & Production Division (AH&P), Ministry of Primary Industries (MPI). AH&P of Fiji have been utilising this technology to service their farmers and has proved to increase production. Trained staff from ALD, on return can set up the equipment and tools needed and also train other staff within the department on this technique.

Training of staff in the department will address two important areas; the first is that the trained staff will have acquired the technical skills to be able to inseminate sows with the imported quality semen and the second is to use this technique to AI pigs in rural farms making use of limited quality breeding materials.

ALD will keep and maintain quality boars at the Tanaea piggery centre and the trained persons can conduct the collection, quality check, dilution of boar semen, distribution and AI of sows. Diluted semen can then be easily transported to the OI and AI can be conducted on sows by trained staff. Advanced farmers can also be trained to do the AI in their own herd at later stages. Tools and equipment would be acquired under the project and the estimated cost is presented in table 14.

Timeframe: Year 2. January – March 2014

Table 14. Estimated cost of materials required

Description	Qty	Unit Price (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
Semen collection and preparation		100	100
Implementation (collection, transport, insemination, etc)	1	500	500
Staff training of ALD staff (outer Islands)	1	3000	3,000
Maintenance of tools and equipment	2years	800	1,600
Total			**15,800**

Activity 2. Importation of semen

This activity recommends the importations of quality Duroc semen from Pig AI Centres at the Wacol A.B AI centre, Australia, or New Zealand. The Wacol A.B centre, Brisbane is licensed to export chilled semen to most South East Asian and Pacific Island countries within 24 hours. The semen importations would inject new quality blood lines to upgrade the breeding herds. AI is a highly skilled technique and needs some specific capacity inputs to ensure the pregnancy success rate is high. The infusion of the quality semen needs to be done at the right time (oestrus) and the right place for success. The main advantages of importing semen are; reduced costs to importing live boars, single dose insemination bottles/straws can be purchased and inseminated onto on-heat sows, several semen importations can be made when needed, cheaper to ship and risks to animal disease transmission is highly reduced. Chilled semen doses can be destroyed by temperature shocks and exposure to light during transportation. The costs of semen doses depend on the quality of the boar. It is intended that importation of quality semen should be done only with the aim to inseminate upgrade breeding herd.
It is anticipated that the AI of sows in Tarawa will be performed by the ALD staff trained at the MPI, Fiji. The other option is for an AI expert from MPI, Fiji to travel to Tarawa to oversee the first AI and to ensure that the practice is done correctly and successfully. Table 17 show estimated cost of importing chilled semen. Refer to chapter 6.0 for detailed goals, indicators, verifications, timelines and implementing agencies.

Timeframe: Year 2: April – June 2014

Table 15. Estimated cost of importing chilled semen for AI

Description	Qty	Unit Price (AUD)	Total (AUD)
Cost of AI equipment / tools		1000	1,000
Cost of chilled semen	1 shipment	2,500	2,500
Cost of transport (freight)		300	300
Expert from Fiji MPI (travel, DSA)	1	3,500	3,500
Total cost			**7,300**

PROJECT GROUP 2

5.3 Priority activity 1. Collection and conservation of adapted local pig breeds (Output 2.2)

a) Conservation of local pig breeds

The development and conservation of locally adapted breeds of livestock have been identified as a priority for adaptation to climate change. Areas identified for inputs include; scoping the atolls for adapted resilient local breed of pigs and chickens; recording the local environment they are living managed and surviving; characterization of the local breed; development of participatory breeding objectives that define characteristics of a desirable adapted breed; the establishment of a breeding nucleus within the project and the distribution of healthy superior breeding stock from the nucleus; cross breeding of local breed off-springs (F1) with improved breed for breeding vigour and increased performance.

Scoping trips to identify local pig breeds in the OIs will be made to collect breeds confirming to the physical description and adapted performance of local breeds. A breeding and multiplication unit to accommodate the local breeds of pigs sourced from the Outer Islands will be done at an existing uncompleted shed at the ALD Tanaea piggery. The main aim of the establishment is to distribute superior climate adapted breeding stock to farmers in the communities.

The pig shed can be used as a platform to trial out some potential climate change adaptation options on housing ventilation, pen types and pen floor designs. The shed is to be built of corrugated iron roofing, timber rails, and different various floor types of cement and dirt for trials. Animal waste management technologies of "composting piggery" and a biogas digester could be installed in the piggery to utilise the waste. Labour for construction and carpentry is expected to be provided by MELAD utilising the current labour force within the Ministry. It is anticipated that maintenance will be initially included in the donor's budget but to be met by the Kiribati government after the project period has lapsed.

The aims of this activity is to conserve best performing adaptated local breed, identify climate adaptation pen designs and appropriate floor types and crossbreeding to capture the best traits for production and adaptation for atoll countries.

Timeframe: January – June 2014

Table 16. Estimated cost of collection, shipment and pens of local pigs

Description	Qty	Unit Price (AUD)	Total (AUD)
Scoping and collection trip to OIs (travel, DSA, freight)	4	500	2,000
Purchase of local pig breeds (5 gilts, 2 boars)	7	300	2100
Vet drugs for treating pigs	1	300	300
Pen construction (timber, cement, bricks, nails, etc)		2000	2000
PVC pipes	10 lengths	10	100
Drinking nipples	5 nipples	20	100
Labour		500	500
Maintenance	3 years	500	1500
Total			**8,600**

b) Vanuatu 'Look and learn' education visit

To support this activity, it is proposed that 2 Kiribati livestock staff to make a 'Look 'N' Learn' mission to the Vanuatu GIZ funded 'Climate change and livestock project' on Pele Island and other Climate Change related projects in Vanuatu to learn and adopt appropriate ideas. The trip should last a week (estimated cost as per table 13.).

Timeframe: August 2013

Table 17. Estimated cost of Vanuatu 'Look N Learn trip

Description	Qty	Unit Price (AUD	Total (AUD)
Airfares	2 staff	1500	3000
DSA and accommodation	2 staff	1500	3000
Contingency	1	1000	1000
Total			**7,000**

5.4 Priority activity 2. Collection and conservation of local chicken breeds (Output 2.2)

To save costs of travelling Priority Activity 2, Priority Activity 3 and Priority Activity 8 can be done on the same collection missions. Similar activities are proposed for the collection to support the characterization, development and conservation of the local chickens breeds for food security. Areas identified for inputs include; scoping the atolls for adapted resilient local chicken breeds;

characterization of the local breed; recording the local environment they are living, managed and surviving in; development of participatory breeding objectives that define characteristics of a desirable adapted breed; the establishment of a breeding nucleus within the project and the distribution of healthy superior breeding stock from the nucleus; cross breeding of local breed off-springs (F1) with improved breed for breeding vigour and increased performance.

This activity of increasing local chicken conservation and production can sited on an existing local chicken farmer. Selected farmer is to be given basic husbandry training to improve their livestock husbandry production and recording systems to facilitate the identification of the productive potential of the local breed. Scoping trips to identify local chicken breeds in the OI will be made and bring back breeds confirming to the description and adapted performance of local breeds. Adapted breeding stock from the establishment will be distributed to other chicken farmers in Kiribati. It is anticipated that breeding and multiplication of the local chickens can increase production of meat and eggs in the communities for food security and livelihood. Labour for carpentry work and construction is expected to be provided by the community. Estimated cost of the activities is presented in table 14.

Timeframe: Year 2. January – June 2014

Table 18. Estimate cost of collection, shipment and pens of local chicken breeds

Description	Qty	Unit price (AUD)	Total (AUD)
Travels (2 persons x 5 islands, DSA, etc)	10	250.00	2,500.00
Chicken costs	25	20.00	500.00
Transport costs (freight, cages,)	10	50.00	500.00
Chicken wire mesh (50 m roll)	2	100.00	200.00
Timber (bulk purchase)	1	500.00	500.00
Sheets of corrugated iron (10ft)	10	42.00	420.00
Nails, bolts & Other Materials	1	200.00	200.00
Medicines	1	200.00	200.00
Labour	1	100.00	100.00
Maintenance	3 years	100.00	300.00
Total			**5,420.00**

5.5 Priority activity 3. Inventory of local Climate Change resilient feed stuff for livestock

The improved feeding of livestock is a key activity to increase the efficiency of production and reduce wastage. The activity review previous research activities carried out in Kiribati and other atoll countries and utilise published data, methods and materials of previous livestock feeding researches. Current feeding practice in smallholder and village livestock production systems in Kiribati to be documented.

Feeds samples collected of locally resilient plants to climate change and feed stuffs be sent to the Koronivia Research Station Chemistry laboratory, Fiji for analysis to determine their chemical composition and nutrient values of the feed stuffs (Proximate analysis, Kjeldahl Nitrogen, Gross Energy, AIA, ADF, NDF, Ca, P, Mg, K, Fe).

An inventory of available conventional and non-conventional feeds and feed resources that are resilient to climate change in Kiribati is established. Information on feed availability and composition will be used to formulate test diets to be evaluated under local conditions. This objective will build on the activities of a series of work and trials already conducted in Kiribati and other PICTs, using local feed ingredients to reduce the cost of imported feed for pig and poultry production.

It will also be helpful to Kiribati if candidate species be identified in other atoll countries that could be grown or utilised for feed. Small scale introductions will be made into project sites in Kiribati for evaluation and use in limited feeding trials.

Timelines: Year 2: March 2014 – June 2014

Table 19. Estimated cost of feed inventory

Description	Qty	Unit price (AUD)	Total (AUD)
Travels & recording to 8 islands (DSA, fares, accommodation,	8	500	4,000.00
Cost of feed materials collection	1	100	100.00
Cost of preparation	1	100	100.00
Freight costs of sending to lab	1	200	200.00
Analysis costs	1	1000	1000.00
Total			**5,400.00**

Project Group 3

5.6 Priority activity 1. Agroforestry production systems trials introduced (Output 2.1)

Agroforestry is an intensive land use management combining trees and or/shrubs with crops and or/livestock (Fisher, 2000).

Agroforestry production system is an example of a sustainable production system that integrates growing of crops/plants and raising livestock. It can be used in all types of soil types, production systems and land use practices. This concept looks at how this system could be adopted and adapted to suit the conditions of the atoll countries such as Kiribati. The choice of plants/crops and livestock species combination may be limited for atolls countries as not all livestock and crops are suitable in this type of environment but there is a need to identify the suitable combination of crops and livestock. The following integration options should be considered for trials in the OI where land is more available:

a) Local chickens run under coconuts and other useful tree crops

The main activity is to select a site that already has some trees /tree crops e.g. coconuts, pandanus tree or could plant new trees in the area, mark it out and erect a perimeter fence around this area for birds to roam free, feeding on plants leaves, grasses, insects and supplemented with feeds and water from keepers. Mark out an area (e.g. 10m x 7 m,) and fence it off with chicken wire mesh, build a small shed (a 'lean–to' design) inside the fence for the chickens to lay eggs, hatch and brood chicks and roost. Local adapted chickens (e.g. 25 hens with 3 roosters) will be purchased from the farmers in OIs using the ALD existing network to select and collect the best performing females and males. Prior to introducing the birds into the fence, the chickens will be treated for pests and disease. Sustainable production is a key factor for this activity thus it is hoped to be run on a small business-like activity whereby chickens (roosters and hens) and eggs will be sold to the public. Sales will contribute to the overall running of the operation. Simple business training such as simple book keeping, record keeping, simple accounting and so forth is recommended to be given to the keepers. Manure from the chickens can be collected and used for crops production as organic fertiliser.

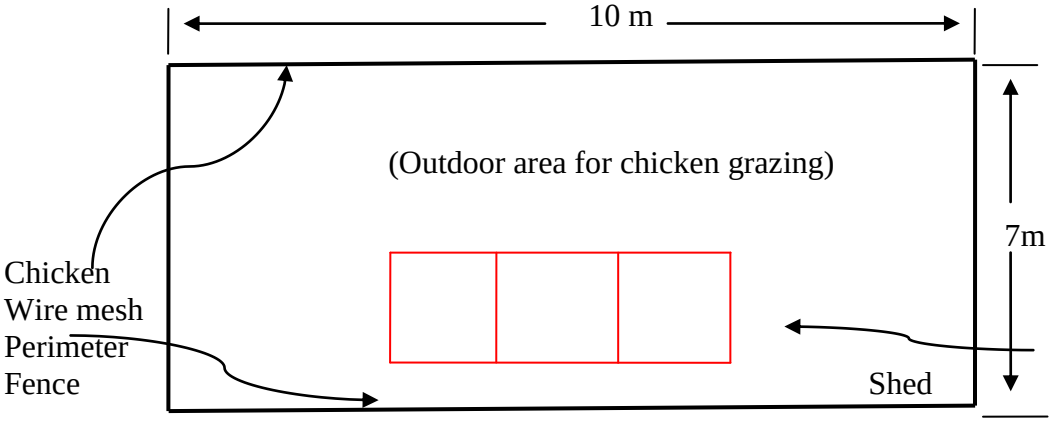
Timeframe:

Year 1. month 1 - 2 - Identify sites, arrange host farmer or institution, procure materials and construct pen and shed within fence

month 3 - 12 - stock the pen with chickens and start with operation and multiplication of stock.

Year 2. Start distribution of improved breed to other farmers

Diagram 1. Sketch plan of the chicken fence and shed



** two strands of mesh high around the perimeter fence

Table 20. Option 1 – Local chickens establishment costs

Description	Qty	Sites	Unit price (AUD)	Total (AUD)
Chickens stock	50 (45 hens, 5 roosters)	1	25	1,250
Timbers/sticks, nails, etc.	Assorted sizes	1	200	200
Chicken wire mesh (50 m)	2	1	100	200
Thatched roof materials		1	50	100
Nest boxes	1 x 3 compartments	1	50	150
Water / feed containers	5	1	20	200
Initial feed for stock	5 bags	1	20	100
Labour		1	100	100
Maintenance			200	200
Total				**2,500**

b) Temporary Pig pens under trees.

Pigs will be penned in simple rectangular area with pig wire, timber stakes with iron roofing(for rainwater collection). The fence is movable, and should be moved to another area after a period of time. Pigs will be treated for parasites before introduced into the pens. The floor will be of dirt or sand, with a simple shed over part of the pen to protect the pigs from sun and rain. After a period when the condition of the pen floor /ground is heavily used, the pen will then be moved to an adjacent area of similar size. The old site will then be planted with crops and plants with manure from pigs to fertilise trees/plants. Plants crops such as bananas, pawpaw, coconuts and other tree crops can be planted around the pen and the waste from the piggery applied to the plants (Plate 2.)

Timeframe: Year 2. July – December 2014

Plate 5. Example of a pig pen with crops planted around the pen.

Source: AHP image of a farm in Wallis & Futuna

Table 21. Option 2 - Pig establishment costs

Description	Qty	Sites	Unit price (AUD)	Total (AUD)
Pig stock	4	1	150	600
Plastic coated wire mesh	2 x 50m rolls	1	100	200
Timbers/sticks for shed and pen, nails, etc	Assorted sizes	1	200	200
Iron roofing sheets (10ft)	10	1	42	420
Initial feed for stock	5 bags	1	25	125
Drugs /medicine			400	400
Labour	1	1	100	100
Total				**2,045**

c) Ducks raised under tree crops.

Ducks are not new to Kiribati as these have been introduced to the villages in the past and there are adaptated duck breed available throughout the country. They have proved to be hardy animals and productive in the harsh environments with limited feed and water. The activity would be to scope the rural villages for adaptated ducks, collect them and stock the project site. These can be bred to be resilient to the climate impacts and could prove to be valuable for food security. The pens will be similar to the chicken pens as in (i) above. The pen will be an open one to be constructed under trees

with a small shed built inside for shade, roosting, laying eggs and for feeding. Prior to entering the project site the consignment of ducks will be treated for internal and external parasites to ensure that they are healthy and do not harbour pests/parasites. Eggs will be naturally hatched under brooding ducks. Ducks from the site will be sold to other farmers for breeding and clients for consumption.

Timelines: Year 2. September – December 2014

Table 22. Option 3 – Duck establishment

Description	Qty	Sites	Unit price (AUD)	Total (AUD)
Ducks stock	25	1	30	750
chicken wire mesh	2 x 50m rolls	1	150	300
Timbers/sticks	Assorted sizes x 4	1	100	100
Local thatched roof		1	150	150
Nests boxes, water / feeders		1	100	100
Initial feed for stock	4 bags	1	25	100
Medicines/drugs		1	300	300
Labour		1	100	100
Maintenance			100	100
Total				**1,950**

d) Introducing Honey Bees for honey production (Output 2.2)

The introduction of the European Honey Bees (*Apis mellifera*), Italian Variety in many countries of the Pacific for the production of honey for food security had brought many advantages to local farmers. Honey bees are environmentally helpful because they do not cause damages or pollution to the environment but promotes and assist in the pollination of forest trees/ plants, and crops and increasing production. Honey bees utilise trees, crops, weeds and shrubs' flowers for collecting nectar and pollen for the production of honey, a highly nutritious food item. One major advantage is that bee hives (apiaries) do not occupy large areas of land; hives can be located on borders or in a small piece of land or a space even on waste land. Hives can be sited in coastal areas to utilise the coastal bushes/vegetation. One possible disadvantage to the introduction of honey bees in Kiribati is that bees are attracted and could interfere with the production of the toddy or *te kamaimai* for domestic use.

Honey is very similar to the local coconut juice product 'toddy or *te kamaimai*' and should be easily accepted by the local population. Honey bees could be suitable for introduction to Kritimati Island where there is more bushland and to some Outer Islands with lower populations and larger areas of 'empty' spaces of trees or plants. Bees can utilise flowers of trees and plants such as coconuts, pandanus, noni trees, salt tolerant plants such as mangroves and other coastal plants.

An introduction could start with at least 5 hives. When these have built a strong working population, then they can be 'split' to expand the hive numbers. A 'Split' is when another hive is built using some frames of bees and a Queen from an existing hive to create another hive to start a new colony. A Queen bee is the head of the colony. A strong queen will produce many worker bees to forage and fill the hive quickly with honey. Honey harvests can be done in a space 3 - 4 months depending on the amount of flowers and strength of the working bees to forage. Honey bee- keeping has other advantages including; low work input during its keeping, (farmer can inspect the hive once or twice a week), suit the village life style and women and youth can take active part in keeping the hives.

Prior to importing honey bees into Kiribati, 2 staff from the ALD, MELAD will be sent to Fiji to do a honey bees training attachment with the Fiji's Animal Health & Production Division, Ministry of Primary Industry. They will then manage the hives.

Timeframe: Year 3. January – June 2014

Table 23. Estimated honey bees costs of stock, tools/equipment import

PRODUCT DESCRIPTION	QTY	Unit Price (FJD)	Total Cost (FJD)
Bee suit	2	250	500
Smoker	1	100	100
Hand Glove	2	20	40
Hive tool	1	37	37
4 frame honey extractor	1	1500	1500
Bee brush	1	40	40
Honey Tank with Strainer	1	300	300
Gum Boot	2	30	60
Nuc Box	10	60	600
Hive box without frame	1	40	40
Frame (ctn)	1	200	200
Top	10	18	180
Bottom	10	18	180
Sugar feed	1	18	18
Wax Foundation (ctn)	1	410	410
Frame Wire	1	110	110
Queen with worker bees	10	30	300
Import protocol (IRA assessment) Biosecurity fees	1	500	500
Training (airfares, DSA, Accommodation)	2	2000	4000
Freight	1	1500	1500
Labour		200	200
Maintenance	3 years	200	600
Total			**11,675**

5.7 Priority activity 2. Improved animal waste management technologies (Output 2.4)

Animal Waste has been blamed for the global increase of green house gases and other environmental issues. This issue is magnified in the Pacific region by the threats of climate changes affecting contamination of surface and under - ground water lens , contamination of the environment, animal welfare issues and spreading zoonotic diseases. Animal wastes has been identified as an area of concern in Kiribati on the potential contamination of underground water lens in the atoll islands, the spread of zoonotic disease and the damage to the reefs and marine ecosystem as a result of increases in nutrient levels from the waste going into the sea.

The project will explore the use of alternative methods of waste management to minimize contamination of underground water lens and capture nutrients (carbon and nitrogen) for use as manure. Composting piggeries and Biogas digesters are two waste management appropriate technologies that could be established in selected sites in Kiribati to demonstrate the use of the composting system and produce manures to fertilise crops. Two composting piggery sites are to be established, one at the Tanaea piggery (to utilise wood shavings available in Tarawa) and a second demonstration unit based on the design of local piggeries to be established at the selected pilot site (USAID, SPC/GIZ selected site), to use other potential litter materials. The composting piggeries sites could also take 'lessons learnt' from the findings of the GIZ- Pele Climate Change Piggery Project, Vanuatu. This proposal is to be used as a pilot project assessing the different types of pens, floors and roofs to determine the best climate change adapted pig shed for the atolls.

There is also potential to promote the adoption of biogas digester technology for the generation and utilization of renewable energy (methane gas) from animal wastes for domestic use. A pilot demonstration biogas digester unit to be constructed at a site, a piggery that has at least 2- 5 sow units.

Timeframe: Incorporate with other livestock activities - Year 1 – year 3

Table 24. Estimated cost of establishing animal waste management technologies

Description	Qty	Unit price (AUD)	Total (AUD)
Composting piggery			
Litter (wood shavings, dried grass, etc), transport, fuel, etc.		100	100
Wheel barrow	1	150	150
Spades	4	50	200
Labour		50	50
Subtotal			**500**
Biogas Digester (version 8.8 cu m)			
Bricks	1300	1.50	750
Cement bags	20	30	600
PVC pipes 6”	2	20	100
Sand, gravel		100	100
Reinforce wire	2	100	200
Labour		500	500
Maintenance		100	100
Sub-total			2,350
Total			**2,850**

5.8 Priority Activity 1. Livestock distribution mechanism to Outer Islands established (Output 2.1).

Distribution of livestock in such a geographically scattered country such as Kiribati is a major challenge and is an important factor to take into consideration in any livestock programme. Livestock are living things and are vulnerable to climate and environmental elements and especially during transportation in the distribution phase. They must be protected from the impacts of the environment such as direct sunlight, heat, wind, rain and sea. Livestock also need to be provided with feed, water, shade and care during transportation especially on long journeys. Shipments need to be well coordinated and done in the shortest time possible to avoid unnecessary stress and mortalities on livestock. Transport logistics, costs, reliability and timing are important factors to consider when distributing livestock to enable the stock reach their destinations safely.

Shipments of stock to OIs are done on adhoc basis and are organised by ALD staff in Tarawa, in coordination with the Outer Islands-based staff. Live pigs and layer pullets (10 weeks) are usually sent on government or private boats/ships except for day-old broiler chickens which are sent by air. Most of the Outer Islands have airports for planes and roads connecting the villages.

There are many obstacles, limitations and inefficiencies to the current livestock distribution system that need to be addressed to improve the system. There are no 'quick fixes' to many of these obstacles and would need the combined efforts of all stakeholders to improve them. The issues include;

- Islands are geographically scattered and far apart – ships journeys could take from 1 day to 2 weeks
- Shipping schedules are infrequent to the OIs (once or twice a month for ships to visit some islands)
- No specialized livestock ships transport available - livestock are shipped on general cargo ships and planes
- Livestock are given low priorities by shipping agencies for shipments.
- Costs of shipments are high due to long distances and time.
- Injuries and mortalities can happen to livestock due to exposure to climatic events, such as rough seas, sun, heat, wind rain etc.
- Feed and water shortages during transportation as a result of long journeys and unexpected delays.
- ALD - Lack of proper livestock delivery transport to deliver livestock from Tanaea to Tarawa ports of distribution.
- Outer Island Livestock staff lack transport to check livestock shipment on arrival to ensure that the livestock are healthy and fit to be handed to farmer, do follow-up visits to farmer.
- Government allocated funding to officers based in OI is usually insufficient.

Out of the above list, there are two immediate needs that could be considered for addressing. The first is that the Agriculture and Livestock Division, MELAD, who produces the stock and organises the shipments / consignments does not currently have a proper livestock transport for delivery to ports of distribution in Tarawa. An appropriate delivery vehicle is urgently required to improve the safety and welfare of stock delivered to ports of distribution in Tarawa bound for farmers in the Outer Islands. A suitable delivery vehicle would be a strong 4WD vehicle, have a metal crate with proper gates and shade built on the back for transporting livestock.

Secondly, it is also essential that livestock shipments arriving in the OIs are received with good transport logistics to deliver livestock to farmers. The distribution service can improve substantially if livestock /extension officers in the islands are equipped with transport to receive, check livestock and deliver livestock. This concept recommends that the extension/livestock officers based in the OIs be issued with motorcycles, e.g. Honda Trial 110 type. Motor cycles are cheaper to maintain and operate and could also be modified to pull carts for transporting livestock and other items. There are a total of 18 islands in Kiribati with Extension/livestock officers. Donor partners should assist to purchase these motor cycles and the Kiribati Government could shoulder the operational and maintenance costs. There are two immediate needs below and donors could fund both or either of the options below:

Recommendation 1: Procure one (1) Hilux vehicle for the ALD HQ at Tarawa to distribute livestock, feed and other items to shipping ports to Outer Islands.

Recommendation 2: Procurement of 18 motor cycles to equip extension staff in every island in the country.

Time frame:

Year 1(August – Dec 2013) - Recommendations 1 is a priority - to get a vehicle that could be used to serve the transportation of livestock

Year 2 (2014) - Ordering and procuring of m/cycles for the islands

Table 25. Estimated costs of transport (vehicles, m/bikes)

Description	Qty	Unit price (AUD)	Total (AUD)
Toyota 4 WD Vehicle (Duty free) (source LMX company, Tarawa)	1 LMX	35,000	35,000
Portable pens/shade on vehicle		500	500
Sub-total			**35,500**
Motor cycles	18	2700	48,600
Freight to OI and registrations of m/cycles	18	150	2,700
Sub-total			51,300
Total			**86,800**

6.0 Conclusions

The main goals, indicators, estimated costs, timelines and conclusions to the activities in this report are summarised in Table 26.

Table 26. Goals, Indicators timelines and verifications

Goal or Impact	Indicators	Means of Verification	Assumptions	Output	Costs	Timelines	Implementing Agencies
Build and strengthen the capacities of farmers to adapt to, and mitigate climate change in Kiribati for Food Security	**Livestock production is maintained or increases over the project period in spite of climate change**	**Project reports, reports from the Agriculture and Livestock Department in Kiribati Stakeholder reports**					
Objective 2: **Sustainable small livestock production systems developed and promoted**	**Promotion and improvement of small livestock production in the communities of Kiribati for food security.**	**Ministry/Department's reports, M & E Reports, Ag Livestock Extension reports**	**Appropriate Sustainable Livestock production systems linked to other local CC projects**				

Output 2.1: Appropriate livestock management practices developed and promoted	Appropriate livestock sustainable production systems adopted by farmers.	Project reports, Reports from ALD/MELAD,					
Activity 1. Improving piggery, poultry and feed storage sheds with rain water harvesting, ALD Tanaea Breeding Centre	20 sow unit piggery constructed	Project reports Materials procurement receipts, Construction / completion reports	Kiribati government, development partners and other donors to assist.	Output 2.1	Breeding sow unit 26,385	As soon as funds are secured - 2014	Kiribati govt., GIZ, SPC, donors.
	Pig shed 1 Farrowing, weaner and grower unit constructed	Project reports Materials procurement receipts, Construction / completion reports	Kiribati government, development partners and other donors to assist.	Output 2.1	Farrowing sow unit 25,534	As soon as funds are secured – 2014	Kiribati govt., GIZ, SPC, donors
	Chicken sheds renovations conducted	Project reports Materials procurement receipts, Construction / completion reports	Kiribati government, development partners and other donors to assist.	Output 2.1	Chicken shed 5,065	As soon as funds are secured – 2014	Kiribati govt., GIZ, SPC, donors

	Feed storage sheds improved for increased production,	Project reports Materials procurement receipts, Construction / completion reports	Kiribati government, development partners and other donors to assist.	Output 2.1	Feed shed 15,826	As soon as funds are secured – 2014	Kiribati govt., SPC/USAID, GSPC/GIZ, donors
	Rain-water harvesting capacity established	Project reports Materials procurement receipts, Construction / completion reports	Kiribati government, development partners and other donors to assist.	Output 2.1	Water installation 7,219	As soon as funds are secured – 2014	Kiribati govt., SPC/USAID, GSPC/GIZ, donors
Activity 2. Agroforestry production systems trials introduced	Agroforestry Sustainable production system introduced in Kiribati Selection of livestock species suited to crops / trees etc.	Ministry/Department's reports, M & E Reports, Ag Livestock Extension reports	Agroforestry systems adopted by farmers	Output 2.1			Kiribati govt., SPC/GIZ, SPC/USAID, donors
Activity 2.1 Local chickens raised under coconuts and other tree crops	Units of local chickens established	Project reports, Agency reports, Implementation reports	Units are located at selected site in OIs	Output 2.1	2,500	Jan 2014 – June 2014	Kiribati govt., SPC/GIZ, SPC/USAID, donors

Activity 2.2 Temporary Pig pens under trees (utilising waste for growing crops)	Utilisation of waste for crop growing / production	Project reports, MELAD's reports, Provincial reports	Establishments are	Output 2.1	2,045	Jan 2014 – June 2014	Kiribati govt., SPC/GIZ, SPC/USAID, donors
Activity 2.3 Ducks raised under tree crops	Ducks to increase food security and livelihood in producing meat and eggs.	Project reports, Ministry's reports, Ag./livestock Extension reports, Trip reports, M & E Reports	Agreements are in place for sharing of genetic materials	Output 2.1	1,950	Jan 2014 – June 2014	Kiribati govt., SPC/GIZ, SPC/USAID, donors
Activity 2.4. Honey Bees for honey production as an alternative.	Honey bees as an alternative to food security and livelihood introduced. Increase of choice of livestock in Kiribati	Project reports, Monitoring reports, Ministry reports on importations, Agriculture/livestock Extension reports Import protocols / certificates	Assume that people will accept bees because bees may interfere with the local toddy collection	Output 2.1	11,675	2014 – 2015	Kiribati govt., SPC/GIZ, SPC/USAID, donors

Activity 3. Importing improved pig breeding stock and semen for herd improvement **Option 1.** Importing improved pig breeding stock	Superior breeding stock distributed to farmers. Inbreeding problem is solved	Import protocols reports /certificates,	Pig sources in Fiji are identified for improved	Output 2.1	22,389	Jan 2014 – June 2014	Kiribati govt. , Donors, SPC/USAID, SPC/GIZ
Option 2. Importing semen for herd improvement	Superior breeding stock distributed to farmers. Inbreeding problem is solved	Import protocols reports /certificates,	Duroc breed Pig semen sources are identified in Australia or NZ	Output 2.1	7,300	June 2014 – December 2014	
Activity 4. Technical Training for livestock staff – Pig Artificial Insemination (AI)	Staff trained in Artificial Insemination (AI). AI technique introduced. Quality semen is introduced to pigs for better production.	Attachment reports, Project reports, Training reports, Training and practical experiences gained	Agreements are in place with MPI Animal Health & Production for attachment	Output	15,800	January 2014 - November 2014	

Activity 5. Livestock distribution mechanism to Outer Islands established	Logistics are available to promote a successful livestock distribution mechanism	Shipments reports, delivery reports, receipt reports	Proper shipping and delivery service agreements with shipping agents.	Output 2.1	Hilux – 35,500 Motor cycles – 51,300	Dec 2013 – Oct. 2013 Jan 2015 – April 2015	
Output 2.2 **Livestock diversity improved, conserved and utilized**	Selection of livestock species increased for local utilisation Indigenous livestock species resilient to climate change are identified and conserved for future breeding for food security.	Project reports, Selection and import reports and protocols, Shipments reports	Link in with existing climate change project in Vanuatu and Centre of Excellence in Kiribati. Links with existing FAO projects in Niue				
Activity 1. Development and conservation of adapted local pig breeds.	Improvement of local pig and for enhanced productivity Indigenous climate adapted breeds of pigs identified and conserved.	Project reports, Trip reports, Laboratory reports, Reports to participating countries Shipment of stock completed	National counterparts and SPC staff select breeding stock.	Output 2.2	8,600	Jan 2014 – June 2014	

	2 staff from MELAD to attend look and learn training in Vanuatu	Trip report, training report	Trainees accepted by Vanuatu	Output 2.2	7,000	August 2013 – Sept 2013	SPC/ GIZ, SPC/USAID
Activity 2. Local chicken development and conservation	Local chickens conserved and developed (farms established). Improvement of local chicken breeds for enhanced productivity.	Project reports, Department reports, M & E Reports Yearly reports	Link with existing climate change project in Vanuatu. Links with proposed FAO projects in Niue, Fiji and Cook Islands National counterparts and SPC staff select breeding stock.	Output 2.2	5,420	Jan 2014 – June 2014	
Output 2.3 **Livestock feeds with local ingredients developed**	Local plant/crops identified for livestock feed ingredients Climate resilient /adapted plants or crops developed for livestock feed Feed formulations for livestock rations developed	Project reports, Departments reports, Lab analytical reports	Local counterparts collect, dry and send feed samples to SPC. Analysis of feed samples is carried out at KRS and NARI. Import permits for feed samples are in place.			June 2014 – Dec. 2014	

Activity 1. Identification and inventory of local Climate Change resilient feed stuff for livestock feed.	Identification of feed sources from Kiribati. Feed samples collected in Kiribati and analysed. Database of plants and other feeds resilient to CC used in the Kiribati. Feed tables are created. Improved feeds are formulated and tested.	Project reports, Laboratory analysis reports, Databases and feed tables, Publications.	National counterparts and SPC staff do survey of resilient feed stuff.	Output 2.3	5,400	June 2014 – Dec 2014	
Output 2.4 **Solid waste management**	Composting piggery technology and biogas digester technology is extended to smallholder farmers in Kiribati.	Project reports, Trip reports, Digesters installed and composting piggeries constructed	Appropriate animal health measures/conditions are in place				

Activity 1. Improved animal waste management technologies	i) Composting piggery technology established in at 2 sites of local farms.	Project reports, Ministry's activity reports, Community's reports, Extension yearly production reports, M & E Reports	Builds on the result of ACIAR Project SMCN/2001/038 Management of animal waste to improve the productivity of Pacific farming systems.	Output 2.4	Composting piggery – 500	Jan 2014 – June 2014	
	ii) Biogas digester technology is utilised by smallholder farmers in Kiribati to address animal waste concern	Project reports, Ministry's activity reports, Community's reports, Extension yearly production reports, M & E Reports	Builds on the result of ACIAR Project SMCN/2001/038 Management of animal waste to improve the productivity of Pacific farming systems.	Output 2.4	Biogas digester – 11,000	June - Sept 2014	
Total Estimated							AUD 245,304

References:

Australian Bureau of Meteorology and CSIRO, (2011). New Research. Volume 1: Regional Overv Climate Change in the Pacific: Scientific Assessment and iew. Volume 2: Country Reports.

Animal Genetic Resources Report for the Republic of Kiribati, (2003), Department of Agriculture, Ministry of Environment, Lands and Agriculture .

Animal Health & Production 5 – Year Strategic Plan for mainstreaming climate change (2012 – 2016). Animal Health & Production Thematic Team, Land Resources Division, Secretariat of the Pacific Community.

Saville, P. H. (1996). The Animal Health Status of Kiribati, South Pacific Commission, 1996.

Annex I:

Consultations

Persons consulted (16 – 22-Oct- 2012):

Name	Organisation
Mr. Tianeti Beenna	Acting Director, Agriculture & Livestock Department, MELAD
Ms. Teaaro Otiuea	Principal Agriculture Officer, MELAD, Kiribati
Mr. Anterea Nautonga	Senior Livestock Officer, Agriculture & Livestock Department, MELAD
Mr. Erati Teremeti	Livestock Officer, Agriculture & Livestock Department, MELAD
Ms. Rakentai Kabotoa	Livestock Officer, Agriculture & Livestock Department, MELAD
Mr. Tokintekai Bakineti	Principal Agriculture Officer. Agriculture & Livestock Department, MELAD
Ms. Veronica Taake	Senior Assistant Secretary, MELAD

Others consulted in 2013

Mr. Kauaba Uriano	Carpenter, Agriculture & Livestock Department, MELAD
Mr. Tuake Teema	Department of Fisheries, Kiribati.
Mr. Kiriata Birita	Public Utilities Board, Kiribati
Mr. Itienang Timona	Public Utilities Board, Kiribati
Ms. Neneteitei Teariki Ruatu	Environment, Conservation Department, MELAD
Mr. Takuia Uakeia	Deputy Secretary, Ministry of Finance and Economic Development, Kiribati
Mr. Michael Fong	Office of te Beretitenti (OB), Kiribati
Ms. Reenate Willie	Energy Unit, Water Unit, MPWU

Annex II

ToR between SPC Land Resources Division & SPC/GIZ Coping with Climate Change in the Pacific Island Region.
Regional SPC/GIZ Programme
Coping with Climate Change in the Pacific Island Region (CCCPIR)

DRAFT Terms of Reference

Technical Assistance through the Animal Health & Production Team of the Land Resources Division (AHP/LRD) to develop a Climate Change / Food Security Concept for Livestock Production for the Department of Agriculture (MELAD), Republic of Kiribati

A. Background

With its Climate Change Engagement Strategy SPC assists Kiribati to strengthen its capacities to respond effectively to climate change. In response to Kiribati's request for support in addressing climate change, SPC has conducted a series of missions to introduce its "One Team" approach and identify priority areas of support at national coordination level, sector level and implementation on the ground (July 2011, April 2012 and August 2012). In collaboration with the Government of Kiribati the implementation of a number of climate change programs have been initiated in Kiribati – one of them being the Coping with Climate Change in the Pacific Region (CCCPIR) programme (implemented in partnership with Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for Economic Cooperation & Development (BMZ)).

Currently SPC with its climate change programs supports national level cooperation, integrating and implementing climate change related measures in agriculture, fisheries, health, energy and education, the implementation of an integrated multi-sector "whole of island" approach, and communication and documentation.

The Department of Agriculture under the Ministry of Environment, Lands and Agriculture Development (MELAD) will be supported by SPC/GIZ CCCPIR and the SPC Vegetation and Land Cover Mapping and Improving Food Security for Building Resilience to a Changing Climate in Pacific Island Communities Program, funded by USAID as follows:

Improve understanding of present and future climate related constraints on sustainable food production in Kiribati atoll agriculture ecosystems, and the adoption of innovative adaptation responses that contribute to maintaining or increasing food security (SPC USAID, SPC/GIZ CCCPIR)

1. Strengthen national and community capacity to build food security and respond proactively to climate change and climate variability (SPC USAID, SPC/GIZ CCCPIR)
2. Integrate successful approaches into national and sector climate change adaptation strategies

(SPC USAID & SPC/GIZ CCCPIR). This will be achieved through; engaging national and local counterparts in project activities, providing training and technical support; the development of national capacity to utilize Geographical Information Systems (GIS) to support adaptation decision making. SPC conducted GIS training in January and April 2012 for GIS Officers from MELAD (Agriculture). In addition, the finalization of an agriculture strategy that incorporates climate change considerations is currently under discussion.

3. Provision of climate resilient crop varieties from the CePaCT Climate Ready Collection to Kiribati and expanding field demonstration trials with farmers.
4. Assessing salinity levels in swamp taro pits and testing in-vitro screening method for salinity resilience.

The draft Agriculture Strategy of the Department of Agriculture identifies "Sustainable animal livestock systems" as one of its major objectives to ensure food security. SPC/GIZ CCCPIR has been requested to support its implementation in relation to climate change adaptation. The activities outlined in this TOR are focusing specifically on livestock in relation to climate change and food security and support the achievement of the above agreed outputs 1, 2 and 3.

B. Objective

As a first step SPC/GIZ CCCPIR, the SPC AHP LRD team and the Department of Agriculture agreed to send one SPC AHP expert to Tarawa to:

Develop an implementation plan on Sustainable Animal Livestock Systems (Agriculture Strategy and related outputs 2.1 to 2.4) that take into account climate change adaptation, food security and sustainability of the distribution mechanism to outer islands to strive towards increasing production of livestock products in Kiribati.

C. Tasks

The specific tasks to be achieved by AHP LRD expert in collaboration with the Department of Agriculture are:

1. Conduct a SWOT analysis on of the livestock breeding and distribution system of the Department of Agriculture that looks at the current livestock varieties, breeding stock, husbandry care (water, feed, housing, etc.) and maintenance and the sustainability of existing distribution mechanism of livestock to outer islands for food security.
2. Analyse likely impacts of climate change on livestock and food security in Kiribati (for each Agriculture Strategy Outputs 2.1 to 2.4)
3. Describe conditions for livestock breeding and care on outer islands to ensure a realistic baseline
4. Develop an implementation plan with specific activities, monitoring indicators, responsibilities, time lines and budget requirements for the Agriculture Strategy outputs 2.1 to 2.4 that take into account climate change adaptation and sustainability of the distribution mechanism.

Potential climate change adaptation measures to be considered:

a) Climate resilient and locally suitable breeds of livestock need to be identified. This involves scoping the country and the region for locally adapted breeds that could be used for breeding and multiplication for distribution to communities in Kiribati.
b) Meat and egg imports should ideally be substituted by local production to decrease dependency on imports.
c) Agroforestry systems that integrate animal husbandry should be assessed as a climate change adaptation option.
d) Modify or build climate change adapted pig housing (shed / pens) to suit Kiribati condition;

e) Provide rain-water harvesting and storage capacities for the provision of water to the piggery.
f) Look at the possibility of including transportation as a component of the concept note for funding. The transportation component will be an overall part to the distribution of breeding stock to communities in Kiribati.

D. Approach

SPC/GIZ CCCPIR will cover travel costs, per diem and accommodation as well as eventual workshop costs occurring according to GIZ rules and regulations.

The ATH LRD expert will coordinate the travel and the program with the Department of Agriculture and conduct the tasks describe above. The expert will build on prior work on climate change, disaster and animal health supported by SPC/GIZ CCCPIR and will brief and debrief the Office of te Beretitenti, the Department of Agriculture, SPC/GIZ CCCPIR and the USAID finances SPC CC program.

E. Deliverables (Outputs)

- Brief implementation plan with concept note covering outcomes of tasks 1 to 3 and a plan with specific activities, monitoring indicators, responsibilities, time lines and budget requirements for objective two on Sustainable Animal Livestock Systems (Agriculture Strategy and related outputs 2.1 to 2.4) that take into account climate change adaptation, food security and sustainability of the distribution mechanism to outer islands to strive towards increasing production of livestock products in Kiribati.

F. Timeframe

One week travel to Tarawa, Kiribati within October to mid December 2012.

Annex III

SCREENING EXERCISE FOR THE REGENERATION OF THE TANAEA LIVESTOCK FACILITY OF THE GOVERNMENT OF KIRIBATI

Anna Rios Wilks

September 2013

SOPAC - Applied Geoscience and Technology Division of SPC

LOGOS

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- Reenate Willie of the Ministry of Water and Public Utilities, Kiribati.
- Nenenteitei 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

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ACRONYMS

Acronym	Definition
AI	Artificial insemination
ALD	Agriculture & Livestock Department, Kiribati
EIA	Environmental Impact Analysis
MELAD	Land management Division, Kiribati
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
PIC	Pacific Island Countries
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 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 of 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 2 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 Agriculture and Livestock Department (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 to also produce pigs.

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 AI or keep boars in the facility was undertaken. 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[2].

[2] 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.

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 2 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 chicken. This analysis shows that by keeping pigs as well as chickens the facility would see estimated annual *reductions* in profit of about A$16,000 in nominal terms. The benefit to cost ratio of Step 2 is 0.66, which means that for every A$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 0.66cents.

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 chicken 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 chicken 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 the 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.

- 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.

- 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 SPXC 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 A$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 A$1 invested in these activities is expected to generate A$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
- it aids food security.

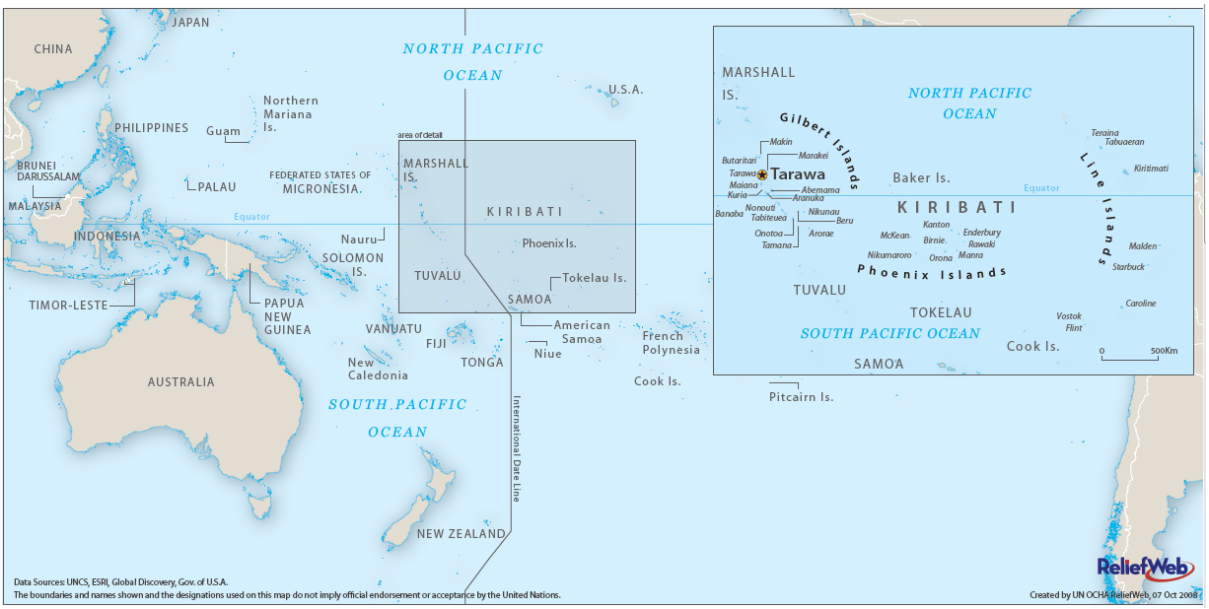
- In addition, because there is already a large number of chicken at the facility, investment in chicken related activities is unlikely to cause additional environmental effects.

SECTION 1: THE REGENERATION PROJECT

Background

The Republic of Kiribati stretches over vast spaces of ocean between latitudes 170º E and 150 º W and longitudes 5 º N and 11 º 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 (Kiribati, 2012).

Figure 1: Kiribati Map



Source: http://reliefweb.int/map/kiribati/map-kiribati-07-oct-2008

Kiribati has a relatively stable economy with a strong reliance fisheries which makes up a large proportion of 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 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 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 Agriculture and Livestock Department (ALD) Tanaea Breeding Centre Facilities[3] 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, other data and information needed before further development might be undertaken.

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

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 8 sows and 1 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

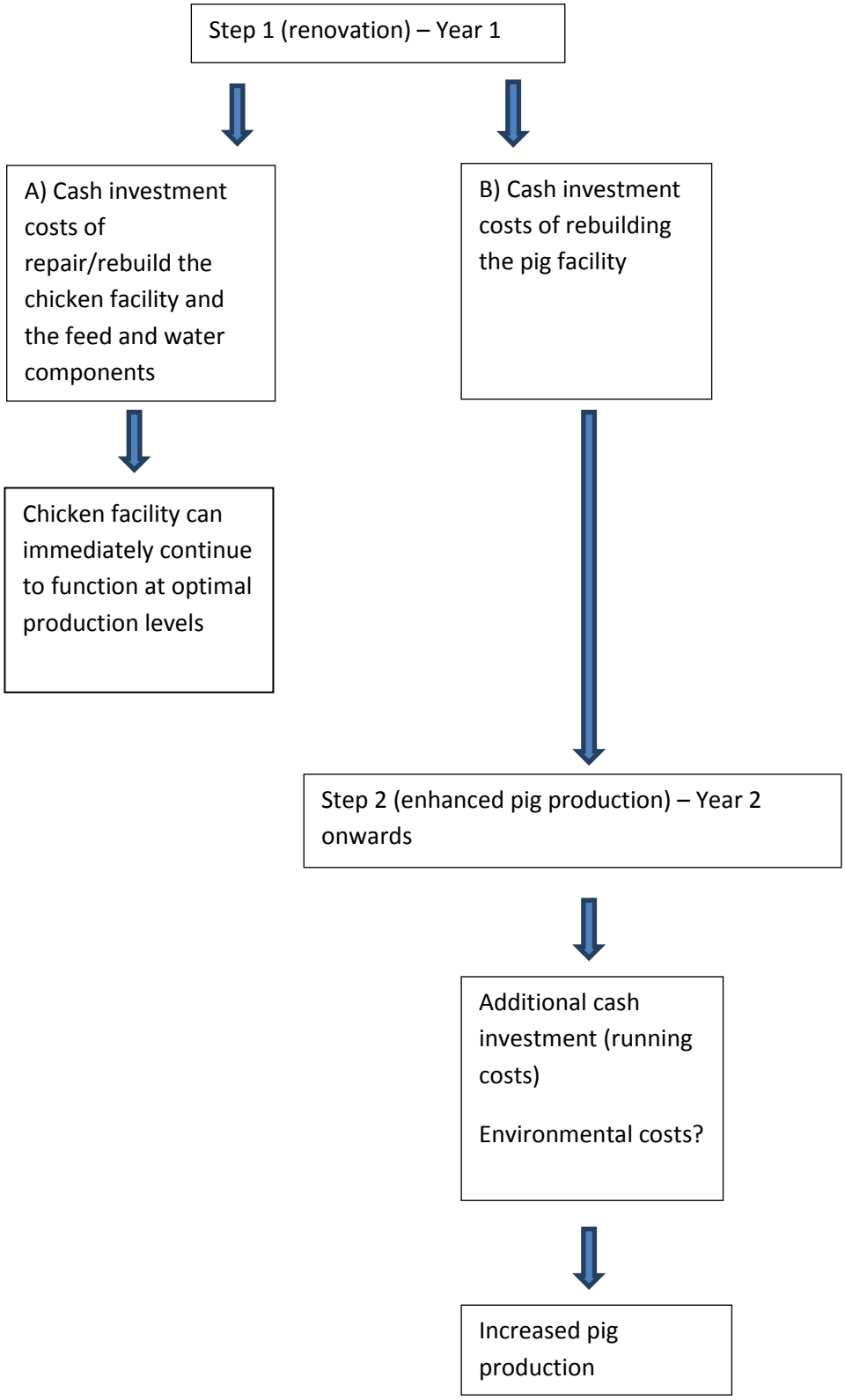
Nonga (2013) proposes that the four components of the ALD Tanaea Breeding facility could be improved to enable the community of Kiribati to have enhanced access to food resources in the future. Nonga (2013) suggests that a regeneration project could be conducted over two interdependent steps:

- Step 1: Renovate and or extend of 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 would be expected to generate and using this information to assess whether or not the activity is work while.

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 2 current pig sheds]. Having prepared this foundation, Step 2 could then be implemented to deliver and extend pig production beyond previous levels. These investments costs in 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 benefits 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.

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.[4]

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).

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 (2006) guidelines (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.[5]

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

[5] 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 A$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.

- 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 A$5,000. In this analysis in the case when the new larger pig facility has been set up, no change is be 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 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 the Tanaea facility is due to the running of the incubators and hatcher of chicken eggs.
- 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 1 poorly functioning farrowing crate[6]. 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 2 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 2 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

[6] A form of crate in which the sow and the suckling piglets can lie in order to reduce the crushing of piglets by the sow.

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 4 new tanks be installed. 2 of the tanks will hold 10,000 litres each, and 2 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) also tanks can be filled with local supply for storage before drought. Although CSIRO 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 6 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 3 unskilled labourers will be paid A$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.

Step 1 maintenance costs of the new facility 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 functioning 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.

Chicken shed renovations

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

Maintenance is estimated to be A$300 per year.

Table 2: Estimated fixed cost of 2 chickens sheds renovations

Description	**Quantity**	**Rate (A$)**	**Total (A$)**
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
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	312.00
Elbow	4	22.00	88.00
Gutter	10	78	780.00
PVC Glue	3	5.00	15.00
Other materials		300.00	300.00
Labour (per month)	3	435	1,305.00
Maintenance	3 years	300	900.00
Total			**6,090.00**

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

Feed storage shed

The table below displays the material costs of constructing the new shed. In addition extra labour would be needed: 3 unskilled labourers for 1 month. Total labour would cost A$1,305.

Maintenance is estimated to be A$250 per year.

Table 3: Estimated fixed cost of feed storage shed building

Materials	**Description**	**Quantity**	**Unit cost (A$)**	**Total (A$)**
Brick (6x8)	Wall	2400	1.90	4,560.00
Cement 40kg	Foundation	20	19.00	380.00
Cement 40kg	Floor	50	19.00	950.00
Cement 40kg	Mortar	10	19.00	190.00

Cement 40kg	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 (10ft)	Form Work	64	42.00	2,688.00
Ridge Cap (6ft)	Form Work	7	20.00	140.00
Roofing Nails (4")	Form Work	15	7.50	112.50
Nails (4")	Form Work	10kg	7.50	75.00
Nails (6")	Form Work	10kg	7.50	75.00
Nails (2")	Form Work	5kg	7.50	37.50
Security Wire	Window	1 roll	360.00	360.00
Hinges Pairs (6")	Door	2	5.50	11.00
Labour	1 month	3 persons	435.00	1,305.00
Maintenance	1	300		900.00
Total				**16,281.00**

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

Rainwater harvesting

Below, the table displays the material costs that would be incurred and in addition extra labour is expected to be only 1 week of 2 unskilled labourers, costing A$218.

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

Table 4: Estimated fixed cost of rainwater harvesting

Description	**Quantity**	**Size**	**Unit Price (A$)**	**Total (A$)**
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

The table below shows the material costs expected. In addition to this extra labour is also needed: 3 unskilled labourers for 2 months. This means that total labour for construction would cost A$2,610.

Maintenance per year is estimated to cost A$1,000.

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

Materials	**Description**	**Quantity**	**Unit cost (A$)**	**Total (A$)**
Brick (8x8)	Wall	2380	1.90	4,522.00
Cement 40kg	Foundation	32	19.50	624.00
Cement 40kg	Floor	112	19.50	2,184.00
Cement 40kg	Mortar	32	19.50	624.00
Cement 40kg	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 (10ft)	Form Work	104	42.00	4,368.00
Ridge Cap (6ft)	Form Work	12	22.00	264.00
Roofing Nails (4”)	Form Work	15kg	7.50	112.50
Rods(12mm)	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	40kg	7.50	300.00
Nails (6”)	Formwork	20kg	7.50	150.00
Nails (2”)	Formwork	10kg	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
Labour	3 months	3 persons	435.00	3,915.00
Maintenance		1	1,000	1,000.00
Total				**27,300.50**

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

Pig rearing shed

The table below displays the material costs incurred in building the shed. In addition to this this extra labour is also needed: 3 unskilled labourers for 2 months. Total labour would cost A$2,610.

The farrowing crates would also need to be purchased. 6 farrowing crates are needed for 25 sows. A local company can provide the crates for A$2,000 per crate, or A$12,000 in total.

Maintenance per year is estimated to cost A$1,000.

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

Materials	**Description**	**Quantity**	**Unit cost (A$)**	**Total (A$)**
Brick (6x8)	Wall	1500	1.90	2,850.00
Cement 40kg	Foundation	54	19.00	1,026.00
Cement 40kg	Floor	84	19.00	1,596.00
Cement 40kg	Mortar	20	19.00	380.00
Cement 40kg	Plaster	30	19.00	570.00
Cement 40kg	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 (12ft)	Form Work	76	42.00	3,192.00
Ridge Cap (6ft)	Form Work	15	22.00	330.00
Roofing Nails (4”)	Form Work	15kg	7.50	112.50
Rods(12mm)	Post	40	25.00	1,000.00
PVC Pipes (150mm)	Drain-Out	7	78.00	546.00
Elbow (150mm)	Drain-Out	10	22.00	220.00
Tee (150mm)	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	10kg	7.50	75.00
Nails (6”)	Formwork	10kg	7.50	75.00
Nails (2”)	Formwork	10kg	7.50	75.00
Iron Nail (4”)	Formwork	10kg	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
Labour	3 months	3 persons	435.00	3,915.00
Maintenance		1	1,000.00	1,000.00
Total				**26,449.50**

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) (A$)**	**Annual maintenance cost (A$)**
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, weaner and grower shed with farrowing crates)	36,144	1,000

Table 8: Total investment in fixed costs for scenarios

Scenario	**Total fixed cost (A$)**
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 artificial insemination (AI) in its breeding of pigs.

After describing current stock of the livestock at the facility and the stock planned if Step 2 is implemented, this section goes on to identify the least costs method of running the facility in order to reach the levels of production planned. It addresses three questions: first identifying whether the facility might use live boars or AI in its breeding, then evaluating the least cost method of initially increasing the pig stock, and finally evaluating the least costly method of replacing the parent stock at the end of their reproductive lives. The findings of this Section will then be used in Section 5 when comparing the costs and benefits of the 2 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 8 sows and 1 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 4 weeks old for A$3. The broilers produce chicks sold on at 1 day old for A$0.75.
- On average 680 (85% production rate) eggs are laid each day. Tanaea has 2 incubators at a capacity of 3,276 eggs each, meaning that up to 6,552 eggs can be processed at any 1 time. If there is a surplus of eggs laid, then they are sold (half as 1 day old broiler chicks and half as 4 week old layer chicks).
- Each egg is kept in the incubator for between 1819 days and moved to the hatching machine for the last 2 – 3 days (21 days total). This means that it takes up to 25 days (including 3-4 days for cleaning) for this process to occur and then 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% 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 8 staff paid an average annual salary of A$4,600.

Electricity: The price of electricity is 70cents/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 A$400 to A$1,200, depending on how many machines were in use. Because 800 chickens will require maximum capacity the maximum A$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 facilit*y: The number of pigs is envisaged to increase to: 25 sows, 3 boars and 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 per litter, so 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's 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 which will have concrete floors, the contamination of the surroundings should be kept to a minimum. Nevertheless, it may be required that an EIA is carried out 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 considered to use the exotic Duroc breed of pig. This breed is considered to be more productive than the local breeds found in Kiribati and 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 15 and 16 in 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 lack of facilities 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 2 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 has 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 artificial insemination (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 stocks 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
- if the facility implements Step 2 to produce both chicken and pigs.

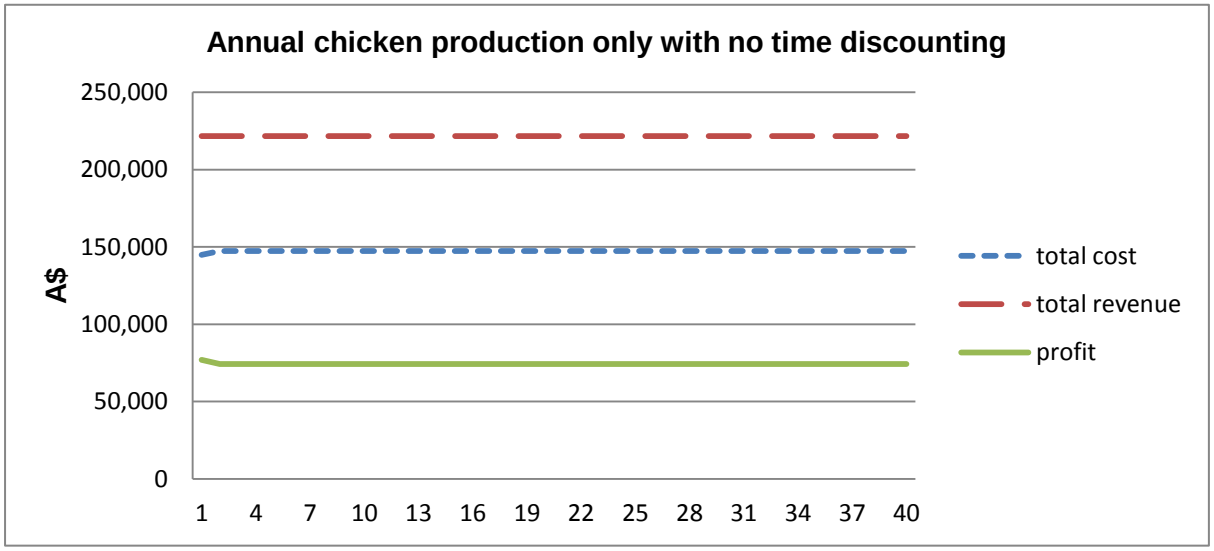
Tables detailing the lifecycles of livestock, the feed and water requirements and the costs of feed and water can be found in Annex 1.

Results

Running costs, sales revenues and profits[7]

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 – chicken only



[7] Here, the term "profit" refers the revenue produced by the facility minus the variable costs of the facility per annum. This is because in 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: Socially discounted costs, revenue and profit over time – chicken only

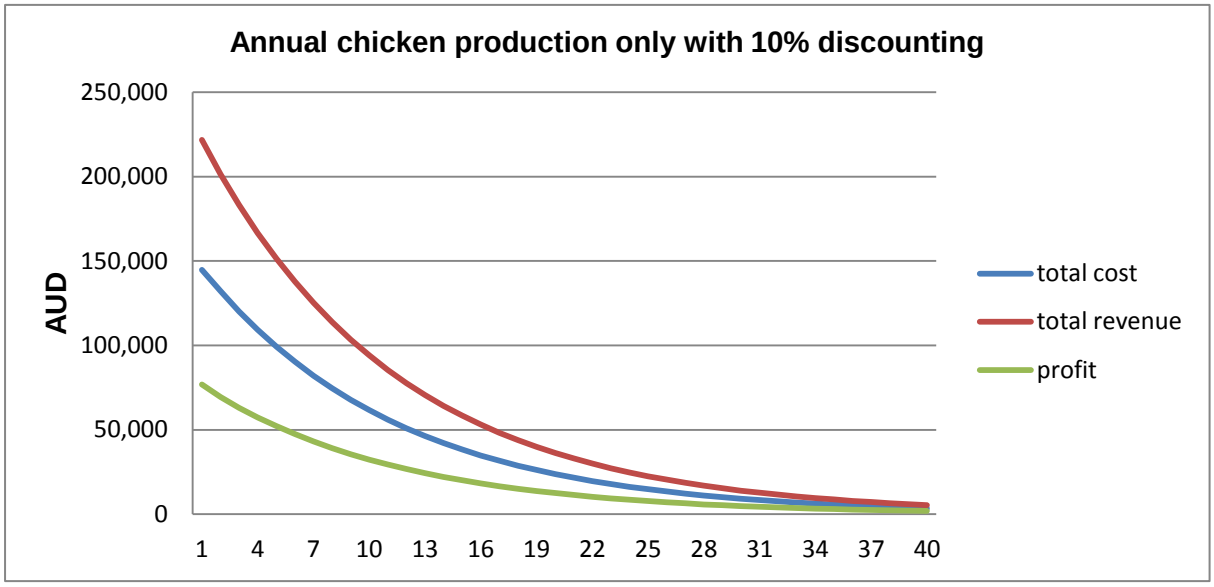


Figure 5: Undiscounted costs, revenue and profit over time – chicken and pigs

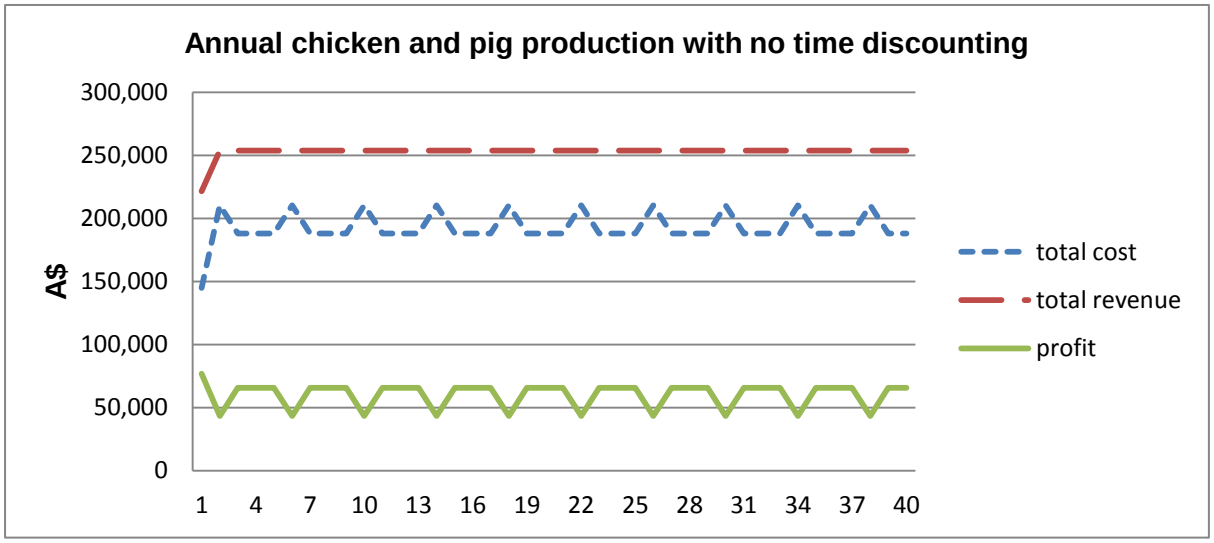
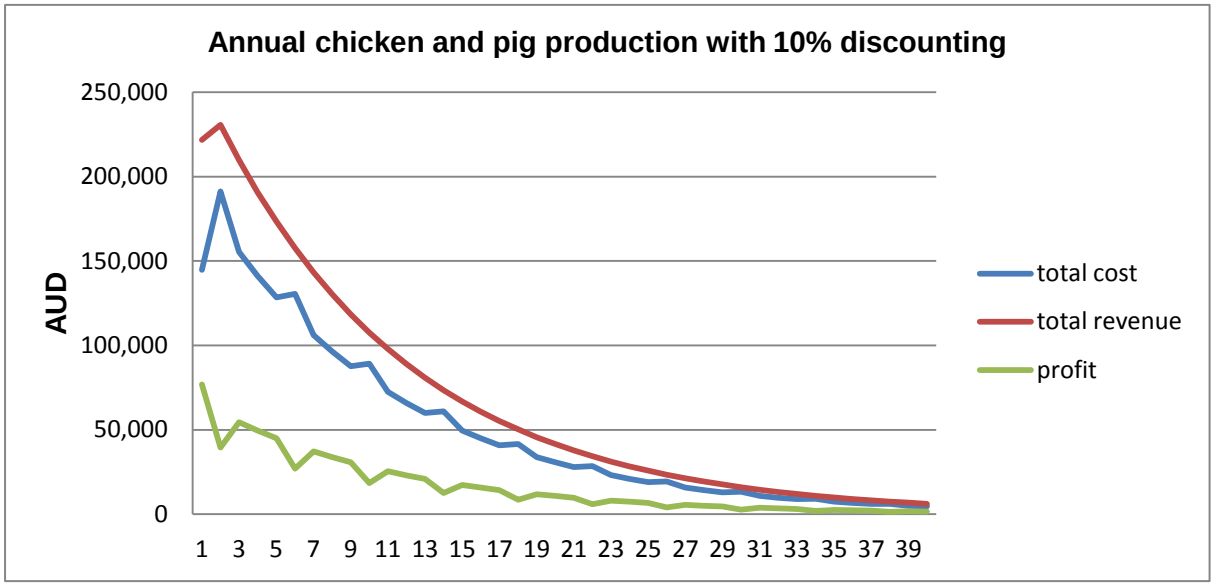


Figure 6: Socially discounted costs, revenue and profit over time – chicken and pigs



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: A comparison of the expected profit produced by the facility by keeping chicken and pigs rather than continuing to keep chickens only

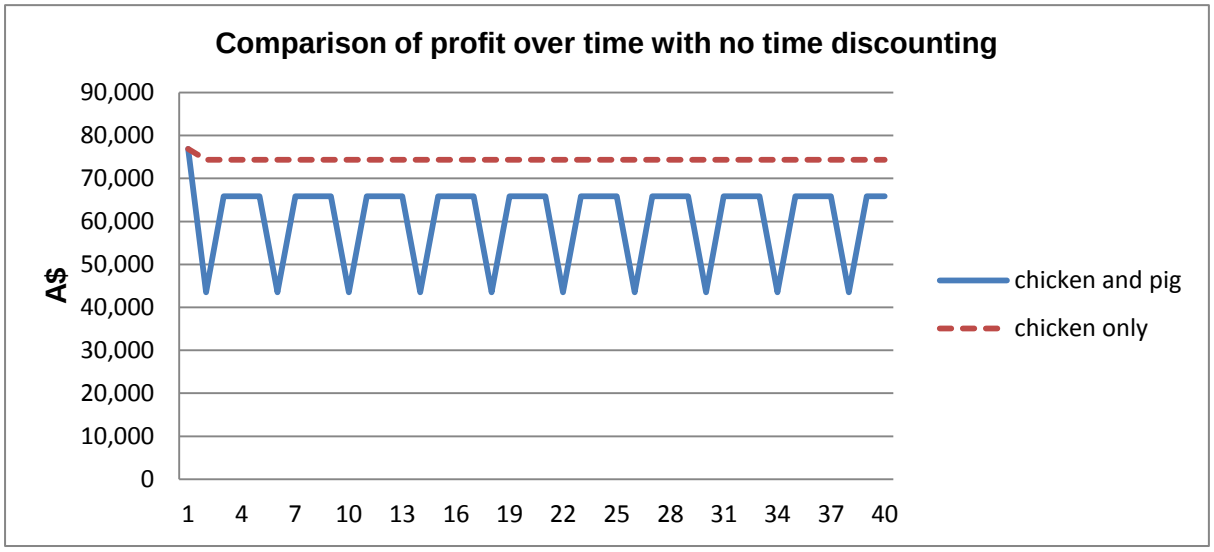
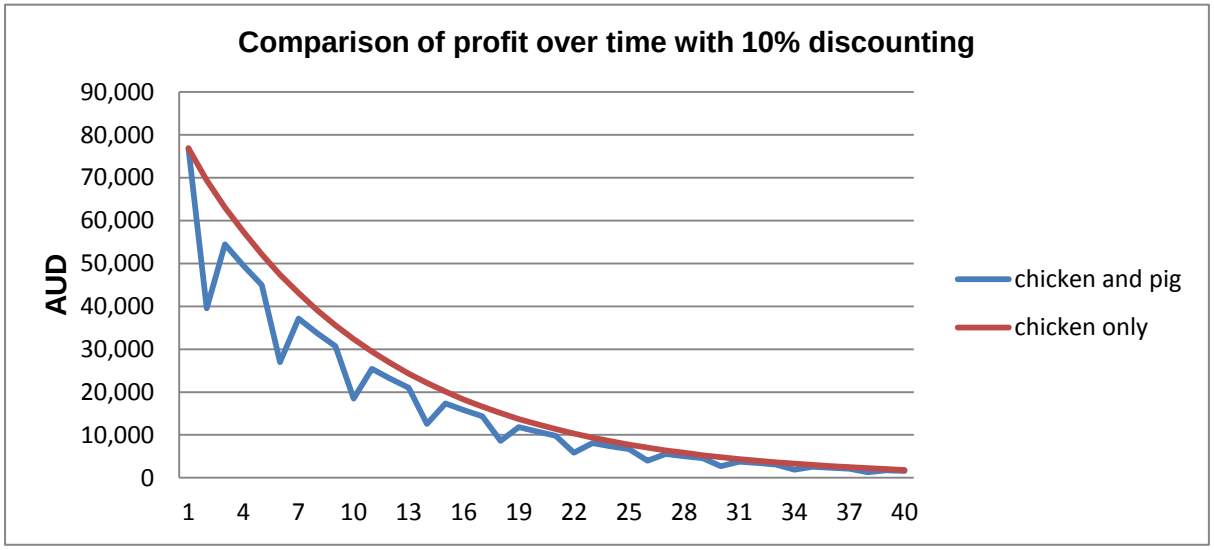


Figure 8: A comparison of the expected socially discounted profit produced by the facility by keeping chicken and pigs rather than continuing to keep chickens only



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 non-discounted losses over time incurred due to implementing Step 2

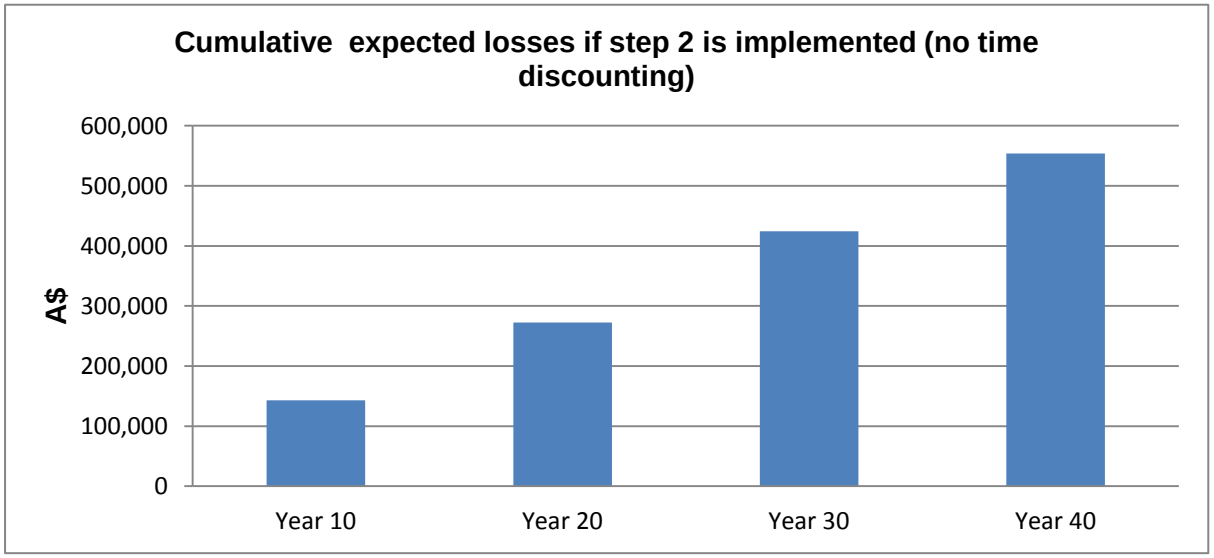
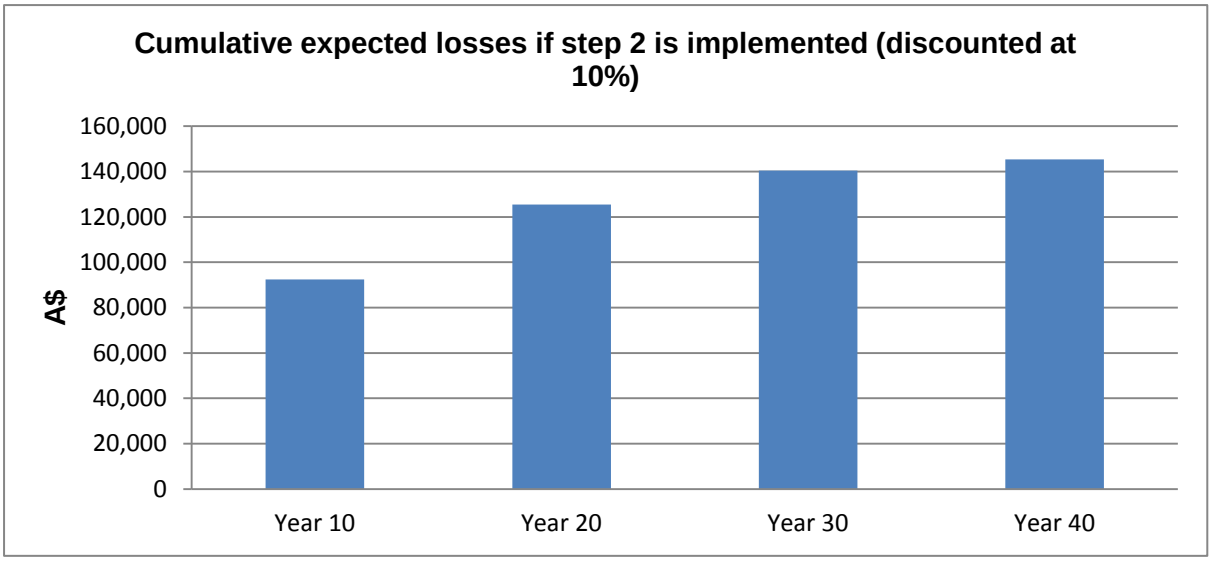


Figure 10: Cumulative losses over time with 10 per cent discounting incurred due to implementing Step 2



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 A$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 A$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 A$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.

The table below summarises the results of Section 5 thus far.

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

Option	Average discounted annual costs (A$)	Average discounted annual revenue (A$)	Average discounted annual profit (A$)
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[8]). This means that for every A$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 compared to not running the facility at all

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 A$1 the government invests in producing pigs only A$0.66 is regained, A$0.34 is lost.

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

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, then the facility would incur overall losses.

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 2 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 (A$26,813) or the expansion to support pig production as well (A$87,952). Table 9, section 5 shows 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)	A$ 26,813	A$ 87,952
Present value of costs of running facility	A$ 1,563,145	A$ 2,041,475
Total present value of costs	A$ 1,589,958	A$ 2,129,427
Total present value of benefits	A$ 2,384,582	A$ 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 A$1.52	For every A$1 spent, this option is expected to produce about A$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)	A$ 61,139
Present value of extra costs of running facility with pigs	A$ 478,330
Total present value of extra costs associated with pig activities	A$ 539,469
Total present value of benefits associated with pig activities	A$ 313,491
Cost benefit ratio (10 per cent time discounting)	0.58
Comment	For every A$1 invested in the pig related activities, only A$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% 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 that focussing 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 in 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 SPXC 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 A$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
- it aids food security

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

REFERENCES

CSIRO (2011) *Climate Change in the Pacific: Scientific Assessment and New Research. Volume 2.* Accessed September 2013 at: http://www.cawcr.gov.au/projects/PCCSP/publications.html.

Food and Agriculture Organisation of the United Nations (2004) Status and potential of fisheries and aquaculture in Asia and the Pacific. *RAP Publication. FAOUN.* Available at ftp://ftp.fao.org/docrep/fao/007/ad514e

HM Treasury (2003) The Green Book - Appraisal and Evaluation in Central Government. *Treasury Guidance,* London:TSO.

Holland, P. (2008) *An Economic Analysis of Flood Warning in Navua, Fiji*. SOPAC Technical Report. Available online at: http://ict.sopac.org/VirLib/ER0122.pdf.

Kiribati (2012) *Report on the Kiribati 2010 Census of Population and Housing. Vol 1: Basic Information and Tables*. National Statistics Office Ministry of Finance and Economic Planning, Bairiki, Tarawa

Kiribati (2013) *Encyclopædia Britannica Online*. Retrieved 10 September, 2013, from http://www.britannica.com/EBchecked/topic/319111/Kiribati

Nonga, N (2013) *Kiribati Livestock Production Concept to support Climate Change Adaptation and Food Security 2013 – 2015*. Department of Agriculture and Livestock, Ministry of Environment, Lands and Agricultural Development (MELAD), Republic of Kiribati.

Reliefweb (2008) Map of Kiribati. Accessed September 2013 at: http://reliefweb.int/map/kiribati/map-kiribati-07-oct-2008

Republic Of Kiribati (2007) National Adaptation Program of Action (NAPA). Environment and Conservation Division, Ministry of Environment, Land, and Agricultural Development. Government of Kiribati. Tarawa

ANNEX 1: DATA TABLES

Table 13: 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 14: 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 15: Pig feed and water requirement[9]

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

Table 16: 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

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

Table 17: Running costs

	Cost per unit (A$)
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 18: Growth rate of pigs

Growth rate	Average weight
Av. Weight @birth	>1.2 kg
Av. Weight weaning (4-7weeks)	6 – 8kg
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 19: Prices of livestock sold

	Price per unit (A$)
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 8 sows in the facility and 1 boar. These are all over 4 years old and will soon be culled or on sold because their reproductive capacity is low.

An extended facility would have the capacity to hold up to 25 sows and 3 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 stocks has been conducted.

Option a) Use AI on pure breed sows

Using table 20 below, it is possible to see that from one sow successfully inseminated, the average number of piglets born are 10. The mortality rate indicates that from these only 8 will be successfully reared if best practice is undertaken (the use of well-functioning farrowing crates is essential). On average 4 of these will be sows and 4 will be boars.

Table 20: Productivity of Duroc breed pigs

	Exotic Breeds (Duroc)
Parameter	Average
No.sows in facility	25
No boars in facility	3
Av. No of litters/sow/year	1.8
Av. No pigs born/litter (total)	10
Av no pigs born / litter (alive)	9.5
Av. No pigs weaned/litter	8.5
Av. no of pigs reared/litter	8

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% on average which means that from the insemination of 1 sow, the expected number of pigs reared would be 4: 2 sows and 2 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, 8 sows would first need to be imported from abroad. These would then be inseminated to produce an average of 2 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 8 imported sows, 16 sows would be reared successfully using AI, meaning that 1 more sow should be imported to make up the full 25 proposed.

The cost of importing 9 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 2 pigs, meaning that in this case 5 crates would be needed.

Table 21: Estimated cost of importing 9 sows

Description	**Quantity**	**Unit price (A$)**	**Total (A$)**
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 requirement (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 the table below:

Table 22: Estimated cost of importing chilled semen for AI of up to 25 sows

Description	**Quantity**	**Unit price (A$)**
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 1 piglet to maturity has been calculated to be A$610 if only feed and water costs are considered. To rear the 16 sows and 3 boars needed, the cost of feed and water alone is estimated to be A$11,576.

Finally, it can be estimated that 16 boars would be produced from AI of 8 sows, as only 3 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 20kg (at 11 weeks of age on average), for A$84 (4.2 A$/kg). The cost of rearing these extra boars to 20 kg is estimated to be A$23.5 for feed and water alone. This means that the profit (A$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 3 boars would be A$26,840.

Of course, it would be possible to import less sows to begin with and do multiple course of AI to gradually build up numbers, but this would take even longer than the 49 weeks (almost 1 year) needed to rear the 1 set of piglets from 1 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

The table below demonstrates the estimated cost of importing 25 sows and 3 boars in total.

Table 23: Estimated cost of livestock for importation

Description	**Quantity**	**Unit Price (A$)**	**Total (A$)**
Females prices (imported)	25	500	12,500
Boars prices (imported)	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 4 years of age their reproductive capacity declines. Every 4 years, there is a need to replace the 25 sows and 3 boars with new parent stock.

Because this process would be repeated every 4 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 23 the cost of replacing the 25 sows and 3 boars is estimated to be A$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 A$223,890 and with a 10 per cent time discount is A$62,791.

Option b) Train 2 staff on AI and use imported semen

The cost of training 2 staff is detailed below:

Table 24: Costs of training staff

Description	Quantity	Rate (A$)	Total (A$)
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
Total			

Assumptions:

- It is possible to assume that these 2 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.[10]
- The freezer will need replacing every 10 years.[11]

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

[11] 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-

From Annex 2 it has been estimated that the AI of 1 sow will have an expected production of 2 sows and 2 boars. In order to achieve the 25 sows needed to replace the parent stock, 12-13 sows would need to undergo AI every 4 years. Table 22 shows that the cost of importing 1 shipment of semen which could be used for AI of all these 12-13 sows is A$3,800.

The total cost after 40 years, with no time discounting is A$233,228 and with a 10 per cent time discount is A$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 A$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 A$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. Nevertheless, if the Government is also concerned with increasing the knowledge of the staff, they may wish to provide training and explore the AI option further.

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.