Workshop report:

Livestock & climate change in the pacific island region

22-25 August 2011, Secretariat of the Pacific Community
Nabua Suva, Fiji

SPC AHP/GIZ

Acronyms

AFS	Australian Friesian Sahiwal
AMZ	Australian Milking Zebu
CAHWs	Community animal health workers
CCCPIR	Coping with Climate Change in the Pacific Islands Region
ENSO	El Nino southern oscillation
GIS	Geographic information systems
GIZ	German Development Cooperation
GFDRR	Global Facility for Disaster Reduction and Recovery
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
MJO	Madden Julian Oscillation
OIE	World Animal Health Organization
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PHOVAPS	Pacific Heads of Veterinary and Animal Production Services
PICT	Pacific Islands Countries and Territory
RCDCL	Rewa Cooperative Dairy Company Limited
SOP	Standard operating procedures
SOPEC	Applied Geoscience and Technology Division of the SPC
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
WAHIS	World Animal Health Information System (WAHIS)

Table of Contents

Introduction

Climate change will impact Pacific island countries and territories (PICTs), including agriculture, food security and livelihoods in villages and rural communities. Livestock is an important component of agriculture in the region. Livestock farmers of all sizes, including backyard, smallholder and commercial producers, are at risk.

In light of the above threats, the workshop 'Livestock and Climate Change' was held at the Secretariat of the Pacific Community (SPC), Nabua, Suva, from 22-25 August 2011. The workshop included 17 participants, mainly livestock technical staff from SPC, governments of Fiji and Vanuatu, as well as dairy sector stakeholders from Fiji. The workshop was organized by the SPC Animal Health and Production thematic group and German Development Cooperation (GIZ) 'Coping with Climate Change in the Pacific Islands Region (CCCPIR)' programme.

The workshop format was participatory, to take advantage of the knowledge and experiences of the participants. Workshop outputs included identification of the climate hazards likely to impact livestock in PICTs over the next 50-100 years, identification of the diverse actors that participate in the various PICT livestock value chains and that will be impacted by the region's changing climate, identification of the overall drivers of change in the PICT livestock sector, identification of the impacts that climate change will have on livestock in the region, identification of mechanisms for adapting the region's livestock sector to climate change, and draft concept notes for adaptation trials.

This workshop report provides information for each session, major discussion points and the outputs of participants' work.

Workshop objectives

1. To review the expected impacts of climate change on livestock production in the Pacific region.
2. To identify and prioritize adaptation options within the livestock sector in the Pacific Region.
3. To identify the baseline data that is required to fully assess and prioritize adaptation options, including the use of traditional knowledge to provide insights where limited scientific data is available.

Presentations

Overview of livestock production in Fiji

Senior Agriculture Officer, Mr. Eduari Navukiboro, of the Animal Health and Production (AH&P) Division Ministry of Primary Industries (MPI) provided an overview of the livestock production in Fiji. He mentioned that agriculture sector of Fiji plays an important role in the economic development contributing at least 15% to GDP, with 5% coming from livestock production. The livestock sector has major implications for employment creation, economic development and food security, and contributes positively to foreign exchange earnings.

Dairy production in Fiji is mostly based in Central Division (Tailevu, Naitasiri, Rewa, Serua & Namosi) while beef producers are scattered in rural and very remote areas. Beef cattle farms in Fiji range from semi-subsistence to semi-commercial level. Cattle breeds include (dairy) Friesian, Jersey, (beef) Santa Gertrudis, Brahman, Hereford, Limousine and Charolaise among others with much crossing among other cross breeds. In 2009, the total stock in Fiji reached 22,533 heads dairy cattle and 134,411 heads beef cattle. Supervised farms are large farms regularly visited by extension or industry advisors. From the 2010 records of supervised farms, there were 290 dairy farmers and 555 beef cattle farmers, owning at least 8,000 dairy cows and 28,108 beef cattle, respectively.

Total sheep population in Fiji reached to 11,268 heads in 2010. Breed is mostly Fiji Fantastic. Majority of the 372 supervised sheep farms recorded in 2010 are located in the Northern Division (226).

Goat population breeds in Fiji include Anglo Nubian, Saanen and Boer. The total population reached 101,196 in 2009 as recorded in the National Agriculture Census. The population is distributed in the Western Division (47%), the Northern division (46%) and the Central/Eastern (6%).

There have been fluctuations in Fiji's pig industry for the last ten years. Total swine population reached 73,698 in 2009. There are 5 major commercial farms contributing to 90% of commercial pork production. The remaining 10% comprises backyard farming. In 2010, 613 supervised farms owned 22,215 heads of pigs. Swine breeds in Fiji include Large white, Landrace, Duroc, indigenous and crosses.

Participants agreed that the definition of different farming levels should be clarified because traditional farming contributes the greatest number of pigs in the region, but tends to be unaccounted and underreported. For the purpose of the workshop, participants defined the different production systems as:

- Traditional production systems include palisade enclosure, communal or common pens systems, walled enclosure, slated floor enclosure (fully enclosure), free range and tethering.
- Semi commercial production represents a step up from slated floor, where enclosures are larger with perhaps concrete floors. Pigs may still be allowed to free range during the day.
- Commercial production is usually by a single individual or a company to meet an organized, urban market. Unit may involve automated feeding and watering with a controlled environment. There is no consumer differentiation between local and improved breed pork, and prices are the same.

Chicken breeds in Fiji include local, Rhode Island Red, Australorp, Leghorn, Plymouth Rock and crosses. Imported breeds are mostly from Australia and New Zealand. Commercial hybrids such as Ross, Tegal, Cobb (meat), Shavers White/Brown, Hyline White/Brown (layer) are now being used in Fiji. The indigenous chickens are common only in backyard farming at the villages. Most consumers are in the urban areas. Crest poultry started the commercial industry after the independence declaration in Fiji. Village-based participation in the commercial sector includes small broiler out growers (Crest and Roosters Poultry) and small layer operations. In 2010 there were 107 leased broiler farms contracted to Goodman

Fielders Fiji Ltd, 100 to Crest and 7 to Rooster Poultry. Farm capacity ranges from 3,000 to 30,000 birds. Most of those contracted to Crest are in the Nausori and Navua corridor, while those contracted to Rooster Poultry are concentrated in the Ba and Lautoka. Ram Sami is the main commercial egg producer in Fiji, with a capacity of 200,000 birds. There are 4 semi-commercial layer farms operating in the Central division, with a capacity of 6,000 to 20,000 birds, and 60+ small layer farms with capacities ranging from 50-500 birds/farm. There are 2 semi-commercial farms in the Western division with capacity for 4,000 to 20,000 birds/farm and 22 small farms in the North with capacities of 50 to 200 birds/farm.

Backyard chicken production systems was described as free range, night housing, and keeping chickens in pens of wire or other fencing. Traditional poultry used to be the main type produced. To date, consumers prefer traditional poultry because it tastes better, but are more expensive.

Breeds of ducks in Fiji include Muscovy (dual purpose) and Pekin (newly introduced meat type) and the local cross-breed. The 2 commercial duck farm in Fiji are Reddy's in the Western and Imam Ali in the Central Division with total stock of 2,000 and 800 birds, respectively. Both farms have their own hatcheries and abattoirs. A total of 8,000+ ducks were slaughtered at the rural abattoir during first quarter of 2011.

In conclusion, it was determined that in general, everyone in Fiji has some type of livestock and the rural household is the most common farming unit. They go unrepresented, underreported and under-served because they are difficult to reach and enumerate. Often this is because there is no incentive for the smallholder to report disease problems or livestock numbers.

Fiji's dairy industry: Climate change vs. livestock production

Mr. Hirday Lakhan,
Rewa Co-operative Dairy Company Limited (RCDCL)

Milk consumption in Fiji is approximately 74,430,000 liters annually, but only 16% of this demand is met by local production. Organized dairy farming (Shorthorn cattle) began in sometime in 1914 to 1918 near Suva, with 20 small farms. Rewa Co-Operative Dairy started in 1924 with a factory at Waila, Nausori. In the 1930's, Fiji exported butter to England and Canada. In 1974 the House of Representatives approved the Co-Operative Dairy Companies bill and Rewa Cooperative Dairy Company Limited (RCDCL) was established. Owned by 220 farmer shareholders, RCDCL is the major provider of local dairy products. The company serves farmers, and collaborates with the government for industry development. In 2009 there was restructuring of the industry, separating processing and farm production services. The objective of the restructuring is to provide better on-farm support services to achieve self-sufficiency in milk production for Fiji. Most dairy farm systems are pasture-based. Majority of the dairy farms and infrastructure are concentrated in the West and some are located throughout Viti Levu. The 2015 target is production of 15 million liters of raw milk.

Milk production trends in Fiji are decreasing. Farmers face several constraints including high feed costs, low pasture quality, low milk prices, low production per cow, one milking per day, high calf mortality, irregular farm services, high milk spoilage, and land tenure problems. The cost of molasses has increased 58% in the past year, coconut meal 177% and mill mix 294%. The cost of producing butter has increased 60% in the past 2 years, white life

17% and blue life 33%. While there have been increases in wholesale prices, suppliers are still paid $0.55/liter since 2006. Annually, milk production is lowest in the summer when rejection of milk is common due to high curd content. It is at this time that rainfall and temperature is highest, flood and hurricane threats are greatest. A one-degree increase in ambient temperature will result in a 2% decrease in production level. Brucellosis is also a continuing problem since 2009. From the tests conducted from 2009 to 2011, reactor cows were found in 13 farms and constituted 7% of total cattle population in Fiji.

Participants noted that in the past RCDCL used to have one veterinarian per division (4 veterinarians altogether), but now there are none. The company has commodity heads that had specialization in dairy production. In the past these leaders spend time on farms advising farmers, which doesn't happen now. Thus human resources for the commercial sector are an important constraint. There are lots of farmers that do not sell to the dairy industry anymore, even though the majority of consumption in all areas of Fiji is from commercial products.

Overview of livestock production in Vanuatu

Mr. Stephenson Boe, Livestock Officer (Northern Province),
Livestock Department, Ministry of Agriculture, Vanuatu

Livestock holdings in Vanuatu composed of (a) small holder farmers raising all types of farm animals grazing mainly under coconuts or tethering (53%) and (b) large-beef operations on open grazing or under coconuts (47%). The whole family normally participates in livestock production, but the male head of the household serves as the primary decision-maker. Women feed small livestock. Other forms of farming, such as gardening are also normally done by the whole family, but with the female head of household taking the lead.

Distribution of livestock in Vanuatu includes cattle 170,000 heads, sheep1,500 heads, goats 8,000 heads, pigs 86,000 heads, chicken 360,000 heads. Sheep production is very small due to low market demand while goat production is largely village level, usually in areas where cattle raising is not viable. Pigs and poultry are important with social obligations and food security but largely reared on village level. Large beef cattle farmers typically have 200 - 2,000 plus breeding cows, 100 – 10,000 hectares of farm land per ranch, an on-farm breeding program with artificial insemination, fattening and marketing programs. Small beef cattle farmers graze 5 – 50 cows on private or common property; run a breeding herd with all stock categories, and are underserved by extension (husbandry, marketing, pasture rehabilitation). Animals usually graze on improved pasture (Signal grass, Guinea grass, Koronivia and Mulato), native grassland, legume and shrubs. Small stocks are normally fed with copra by-product, supplemented with household scraps. FAO have supported a dairy project in 2003, but the industry ended with the completion of the project. Brucellosis was last detected in 1992 and tuberculosis in 1993. The country is considered free of both diseases under the International Animal Health Code, and conducts regular surveillance and monitoring.

In terms of market outputs, SMP, a Japanese owned company (Nitchuku) in Luganville, produces approximately 500,000 – 600,000 kg of meat per year with 90% of productions goes to the Japanese market. The other 10% goes to the Solomon Islands and New Caledonia. VAL produces approximately 500,000 – 900,000 kg per year. 70% of its production is exported to Japan, Tuvalu, Papua New Guinea, Solomon Islands and Kiribati while the remaining 30% is exported to Australia as organic product. The Livestock Department and the Shefa provincial council supports the existence of a local livestock market by allocating a venue where all small stock can be marketed once a month.

In conclusion, it was noted that the beef industry of Vanuatu is facing constraints due to geographical distribution of islands in Vanuatu, high cost of operation and transport, lack of sufficient facilities and infrastructure, lack of livestock extension support to farmers and political instability.

Global climate change and its impacts on small island developing states

Ms. Marita Manley, SPC/GIZ

The presentation was aimed at defining and clarifying issues that arose during earlier group discussions. It was clarified that as climate represent the 'normal' weather experienced over few decades, climate change represents a shift in what is normal. It is very difficult to pin point one event and say that it is directly due to climate change, because climate change means an increased probability of certain extremes occurring. In the discussions of the 2009 floods for example, questions arose if it was due climate change or was it due to riverbeds rising from increased sedimentation and the need to dredge the river. It was also mentioned that the most severe impacts are those that are likely to be faced by people and systems that are currently stressed – such as rivers with degraded watersheds and those which are already affected by soil sedimentation. The participants also discussed the role of farmer's observations which are very important for detecting climatic changes.

The Climate of Vanuatu

The observed climate, climate variability and change

Dr. Christopher Bartlett, SPC/ GIZ

Vanuatu has a total land and sea area of 700,000 sq. km. Land area covering 12,190 sq. km with 65 out of 83 islands inhabited. Estimated human population in the 2009 was 243,000 (Prelim count, Oct. 2009). Approximately 80% live in rural villages and live off the land. Agriculture is predominantly on subsistence level. Traditional crop calendars (based on seasonal rainfall variability) are used. There is limited use of pesticides and chemicals, giving advantage to the export of organic foods. Agriculture (organic) contributes 23% of the total economy. Climate variability such as ENSO events that destabilize the availability of water to plants is important. The main climate drivers affecting Vanuatu includes El Nino (all year), La Nina (all year), SPCZ (November to April), ITCZ (November to April), subtropical frontal systems (May-October), MJO (all year).

The major impacts of El Nino in 1998 include death of livestock, shortage of water, fires and food shortages. For tropical cyclones, there has been an increase in hurricane intensity in the North Atlantic since the 1970s, and that increase correlates with increases in sea surface temperature. There is currently no clear trend in the number of South Pacific cyclones and hurricanes since 1981. Investigation and studies on temperature change are ongoing. Historical rainfall trends are not very clear. There are constraints in providing reliable predictions since the length of datasets available varies. To be able to provide more reliable climate change predictions for Vanuatu, it is recommended to continue consolidation of data to lengthen data series, strengthen observation systems and installation of at least 2-3 reference climate stations.

Coping with climate change in the Pacific Islands Region Project - Vanuatu

Dr. Christopher Bartlett, SPC/GIZ

Climate Change is affecting all sectors including agriculture, environment, forestry and health. Adaptation ideas in these are relatively well developed, but not in the livestock sector. Climate change affects the livestock sector through water availability and distribution, feed availability and distribution, behavioural changes Physiological changes, exposure to extremes, mortality rates (progeny), cyclone damage to enclosures, pests and disease.

In Pele Island of Vanuatu, which is the GIZ site, various trials were conducted to identify ways to enable livestock adaptation to climate change. These trials included selective breeding for desirable traits, feed and nutrition systems, facility design and construction, exposure control, reproductive enhancement and management, integrated agriculture systems.

Fig 1. Pele island livestock adaptation project

A trial in swine production involved crossing the Large White (fast growing, high progeny, temperament) with wild pigs (selected for feed tolerance, environmental tolerance, pest and disease tolerance) crossed with local domestic pigs. The cross-breeding trial benefited the local communities through inexpensive source of genetic hybrids pigs, established skill and capacity in livestock husbandry and management (training, demo site etc), source of extra income through sale of local produce, extra income through increased productivity and decreasing mortality. The project have received support from the government, donors and visitors from different sectors**.**

Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)

Ms. Litea Biukoko,
Applied Geoscience and Technology Division (SOPAC), SPC.

Since 1950 disasters have affected ~9.2 million people in the Pacific region, causing 9,811 reported deaths, at a cost of ~USD3.2 billion in associated damage costs. PCRAFI is a joint initiative of SOPAC, World Bank and Asian Development Bank with financial support from Government of Japan and Global Facility for Disaster Reduction and Recovery (GFDRR). Technical support is provided by multiple corporations and technical services from the United States, Australia, New Zealand and PICTs.

There are two main outputs of PCRAFI. The Pacific Risk Information System provides a probabilistic assessment of major perils in a risk-based framework to direct resources of countries and development partners. The Pacific disaster risk financing solutions estimates disaster related fiscal risk exposure for financial disaster risk management and regional risk pooling. PCRAFI has the most comprehensive risk exposure data set ever collected within the Pacific Islands, including population, buildings (residential, commercial, industrial, public, other), infrastructure (bridges, dams, ports, etc.), utilities (electric, water, waste, communications) and major cash crops (coconut, banana, taro, grazing land, etc.). Geo-referenced data for hazard modeling includes satellite imagery, topographic maps, bathymetry maps, surface geology maps, surface soil maps, land cover/ land use maps, geodetic and fault data and historical catalogs of tropical cyclones and earthquakes. Hazards modeled include tropical cycles with winds, storm surge and rain, and earthquakes with ground shaking and tsunami risk. Outputs that are displayed geographically include land cover by crop type, population and population density, buildings and major infrastructure assets (airports, helipad, power plant, port, dock, etc.). Total and disaggregated replacement costs are assessed, and consequence estimates based on hazard provided.

Participants asked about the resolution of maps available from the database. Resolution depends on the country, as data such as population numbers were obtained at different scales in different countries. Agricultural land use data only deals with cash crops, not livestock activities. However participants noted that even some cash crops, such as coconuts, were not included.

Workshop group work

Climate hazards group work

Participants were given a handout of climate change predictions which Fiji may experience in the future. Although projections are fairly uncertain, there are events that can be expected with a high degree of certainty.

In a large group brainstorming, participants identified the following key climate hazards for PICTs' livestock sector. These hazards included drought (increased frequency and increased duration), flooding (increased severity and increase frequency), cyclones (increased intensity), storm surge (increased severity), increased ambient temperatures (increased mean daily maximums and minimums), sea level rise (salt water intrusion and salt spray), rainfall (more severe, more variability, extreme event highs and lows). During the discussion, it was agreed that disasters such as earthquakes and tsunamis are not climate hazards while disease outbreaks, fires and waterway damage can be considered as impacts of climate hazards.

Participants were divided into three groups and were tasked to discuss the following in relation to the identified climate change hazards:

A. How confident they were that these predicted hazards would occur as a result of climate change.
B. The economic impact of these hazards.

C. The impacts of these hazards on livestock livelihoods.

Each group was then provided with 100 shells. The shells were used for groups to show the relative importance of the different hazards under each factor using proportional piling. More shells indicate a higher score. The higher the score, the greater the importance of the hazard in terms of confidence of the prediction, economic impact and impact on livestock livelihoods.

Participants generally viewed temperature increases with a higher degree of confidence, but had divergent views on how important that was for livestock livelihoods. Overall more severe drought, flooding and more intense cyclones were considered important from an economic perspective and a livestock livelihood perspective.

Mapping risks and threats

Participants were asked to discuss geographical features and data that can be mapped using a tool like geographic information systems (GIS). Features identified included:

1. Natural resources – coconuts, pastures, rivers, water sources, forests, mountain/hills/topography, farms, crop covers/types, coral reefs.
2. Infrastructure – roads, bridges, airstrips, wharfs/ports, farms, farm infrastructures, slaughterhouses, markets, feed mills, vet labs, mining, government administration, agriculture shops, milk centers
3. Livestock – population densities, species distribution, dairy farms, beef ranches, industrial pig feeds, commercial chicken, slaughterhouses, sheep/goat farms, government farms/stations
4. Threats and risks due to climate hazards

Participants were divided into four groups and were provided four different maps to draw as many of the abovementioned features as they could. This method is known as participatory mapping with the aim to develop a map based on a community's knowledge, drawn interactively with village farmers. This method can be effectively used by extension workers and researchers to understand an area of interest and document specific features of the surroundings. It can also be used as an entry point for discussing hazards and risk.

In addition to mapping these landmarks, participants were asked to consider how GIS can be used to better understand the livestock industry and its resources. Other features which could not be mapped were also identified. These features included wealth, mobile phone ownership and coverage, education, water storage and access, traditional boundaries and governance, biodiversity, fish and wild animal distribution, exact location of resources, small villages or settlements, individual animals or smallholdings, backyard scale farms and drought. Often the groups found that such features or types of data could not be mapped because of the scale of the map they were using. Suggestions on how to improve documentation or representation of these features include:

1. Use maps of different scales
2. Socio-economic or statistical survey
3. Photographs/visual examples
4. Time series data (photos, longitudinal studies, etc.)
5. Integration of climate change topics in schools
6. Environmental protection

7. Genetic preservation
8. 3D mapping
9. Give real examples of occurring impacts
10. Use traditional communication (face-to-face) and demonstrations
11. Radio programs

Based from the group discussions, participants agree that GIS is useful in providing visual communication with farmers. Relevance can be increased by including indigenous knowledge in maps and discussions. GIS is also important in providing quick information to decision makers, donors, governments and others particularly when there is limited time to present information. The tool effectively provides visual representation of topography, hazards, threats and risks. GIS will also become relevant in risk-mapping, to better understand climate change hazards, to locate critical livestock resources and to identify places/areas at greatest risk and threatened by different hazards. Once identified, this can be used as a communication tool, and to direct scarce resources for relocation or to increase the resilience of high-risk areas. It was also suggested that a good entry point for introducing GIS is with children in schools.

Adaptation and vulnerability frameworks: Key concepts

The vulnerability of a livestock production system to a climate change hazard depends on how the system is exposed and how sensitive it is to that hazard. This will influence the impact that that hazard can have on the livestock system. The potential impact, combined with the capacity of the system to adapt, determines the vulnerability of the livestock system (Fig 2). Important climate change terminologies were also defined.

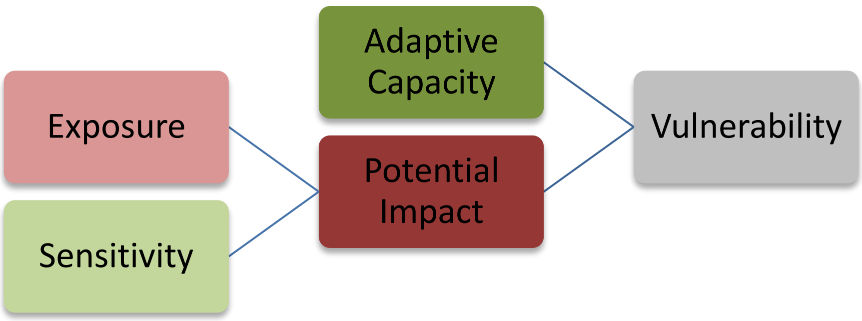

Fig 2. The components of climate change vulnerability, showing how each contribute to vulnerability

Traditional knowledge about a location, production practices and management for livestock contributes to adaptive capacity. Often farming families have been exposed to different climate hazards in the past (such as that of flooding or sea surges), and have established their own ways to adapt and decrease their sensitivity to these hazards and its impacts. These traditional ideas are usually more culturally appropriate and provide lower cost options for village-level and smallholder producers.

Participants were asked to work into three groups to draw maps of village-based livestock systems for village pigs, beef ranching, and smallholder broiler production. Participants provided visual representations of the vulnerabilities of the production system and possible adaptations to climate change. Possible adaptation tools were identified as follows:

- **Communication**. All groups noted that access to communication and information, through radios and phones, is an important adaptation for livestock producers. Radio allows farmers to receive regular climate information such as seasonal climate forecasts, and emergency information such as cyclone warnings. With this source of information, production systems can prepare short-term and long-term adaptation practices for the hazards. For example, pigs can be moved to higher ground when cyclones are expected, or a goat farmer can collect and stock forage if low rainfall is expected. Cell phones also allow instant communication to report and receive information about approaching disasters, allow farmers to have direct access market, potential sellers and buyers for stocking or de-stocking in preparation for a climate hazard, etc.
- **Social networks**. The importance of strong social networks to help livestock farmers adapt to the potential impacts of climate change and recover after an extreme event was also discussed. Strong families and communities not only help and support one another when a disaster happens. Strong social networks increase the sharing of information and resources, allowing each member of the community to have access to a wider range of information and new ideas.
- **Diversification**. The group focusing on commercial broilers noted that farmers that are more diversified are less vulnerable to climate change hazards because they have alternative sources of income should a climate hazard affect their broiler operation. For many climate hazards, small-scale broiler operations may be more sensitive to a hazard exposure than layers, because layer cages are raised. The group focusing on pigs noted that the different types of village production systems are adapted to different hazards. Small enclosures are situated in mangroves near water. This type of system is good for protecting animals from increasing temperatures, and helps keep the village area clean during flooding. However, palisade enclosures, for example, can be located on higher ground to protect swine from cyclones and storm surges. It was noted that local breeds, though probably less productive, might be better adapted to periods of high heat, variable feeds and increased salt content in drinking water. The group focusing on cattle noted that for villagers and smallholder producers, cattle provide a means to diversify risk in integrated production systems. Forestation to provide shade and reduce erosion and landslides is important for cattle production. Growing adapted pasture and fodder species in specific vulnerable areas within the farm can help manage when hazards occur. The large size of cattle could also help in reducing mortality rates for cattle when hazards occur.

Mapping livestock value chains in Fiji and Vanuatu

Value chains can be defined as, “The full range of activities that are required to bring a product or service from conception, through the intermediary phases of production, delivery to final consumers, and final disposal after use”[1]. In other words value chains provide us with a description of how we get from a concept for a product, producing, delivering, consuming and managing its wastes. Each link in the chain adds value to the product. Kaplinsky (2000) describes value chains as having three basic categories of links,

[1] Rachel Kaplinsky (2000. Globalization and Unequalisation: What Can Be Learned from Value Chain Analysis? *Journal of Development Studies* 37, no. 2 (December 1): 117-146)

design, production and marketing. Each category often has multiple links. Fig 3 provides an example of an American beef value chain, with 10 links from ranch planning to consumption.

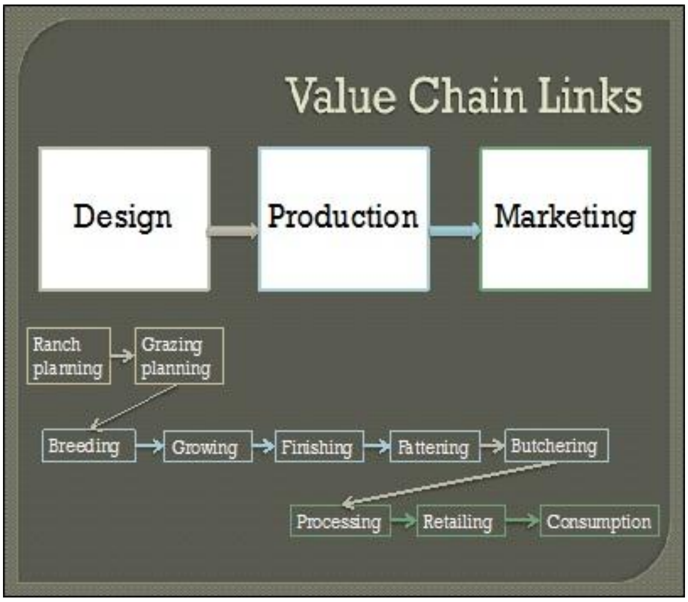

Fig 3. A value chain for American beef production shown to demonstrate the three basic categories of links in a value chain (design, production and marketing)

At every link there are multiple actors contributing services or products to create value addition at that link (Fig 4). Each one of these actors is vulnerable to climate change. The nature of the vulnerability of each actor needs to be identified and addressed if the value chain itself is going to be resilient to climate change.

The participants were divided into working groups to draw the following value chains in dairy, beef, commercial poultry, local poultry, swine and small ruminants in the region. The actors, services/products they provide and the hazards the actors are vulnerable to were identified for each link. The climate change hazards considered for the exercise were drought, disease, flood, cyclone, storm surges, sea level rise, temperature and rainfall. The overall level of vulnerability for each actor was ranked according to the following scale: 1= no vulnerability; 2 = low vulnerability; 3 = vulnerable; 4 = high vulnerability; and 5 = highest vulnerability.

The result of the exercise shows that for the livestock sector, each link in the value chain will be affected by at least two climate change hazards. The result of the exercise shows that cyclone, floods and temperature changes are the three most significant climate change hazards in livestock production. The growing/fattening link and to a lesser extent the marketing link in the value chain will be most affected by these hazards. The actors that will be most vulnerable are those that directly look after the animals, such as farm owners, family members, ranchers, breeders, veterinarians and stockmen.

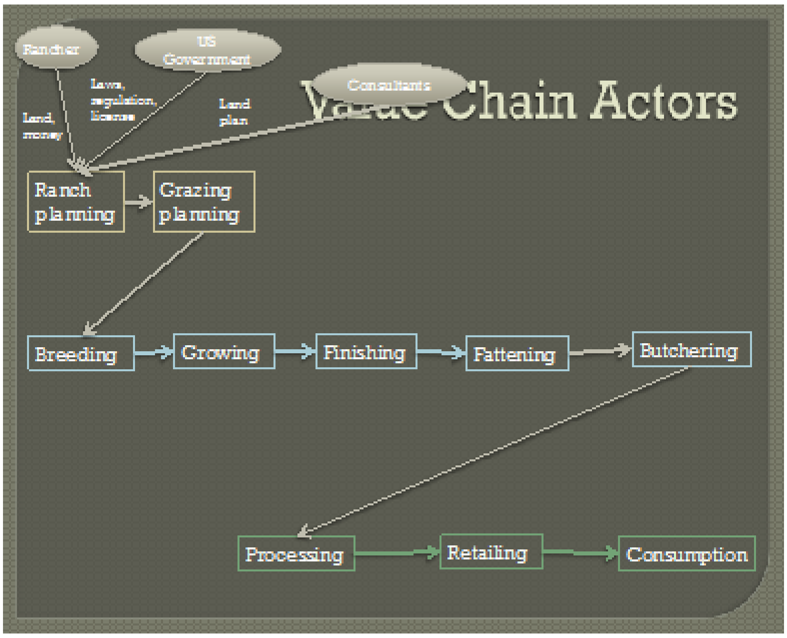

Fig 4. An American beef value chain, showing three actors that contribute to ranch planning and the products and services each of the three provides.

Climate change impacts on livestock in PICTs

Participants identified the following as key climate hazards for the PICTs' livestock sector:

1. Temperature (increased daily minimum and maximum)[2]
2. Precipitation (increased variability and extreme events, increased flooding severity and frequency)
3. Drought (increased frequency and duration)
4. Cyclones (increased intensity and frequency)[3]
5. Sea Levels (storm surge, salt water intrusion and salt spray)

For this exercise, the groups defined specific ways on how each hazard would impact livestock production and the different ways each impact would be possibly observed. In general, these hazards will impact the livestock sector through:

- Nutritional deficiency - due to effect of climate change hazards to animal feed intake and metabolism, effect to forest, pasture and forage growth, feed storage and water availability
- Increased disease susceptibility – due to added physical stress adapting to environmental changes, climate changes conducive to growth of animal pests parasites and undesirable weeds and forages, nutritional imbalances, water availability
- Water availability – changes in volume and quality of water sources
- Farm infrastructure – increased input on materials, labor and maintenance due to damage brought about by the hazards.

[2] Note to remember: tolerance to temperature and humidity are linked

[3] In planning for adaptation, the sequels to cyclones need to be considered: flooding, precipitation extremes, storm surge, etc.

Participants also considered the different ways genetics would contribute in livestock adaptation, how it will regulate the impacts of climate hazards and how genetics could be used to manage livestock diseases.

Genetics contributes to regulate responses to changes in the climate. The participants suggested that selecting a specific breed or desirable traits from different breeds for cross-breeding will be needed for adaptation to future climate. This will ensure maximum production in the midst of climate change. Conservation of national genetic resources of livestock species adapted to local environments through germplasm (ex situ), living bank (in situ), research/ government facilities and villages will also be important. The training of community animal health workers (CAHWs) and paraveterinarians on active and passive disease surveillance will aid in early detection of animal diseases and effective livestock adaptation.

Climate change and its impact on livestock: Breed tolerance

Participants were grouped into four to name breeds of beef cattle, dairy cattle, swine and poultry and define the desirability of each breed in terms of key performance traits. Each group was also tasked to analyze the tolerance of the different breeds to climate change. Groups selected five breeds for each species, and scored the tolerance to different climate hazards using the following scale:

5 = highest (highest tolerance to the projected change of all the breeds)
4 = high (tolerance to the projected change is very good)
3 = good (tolerance is sufficient for the projected change)
2 = poor (tolerance is insufficient for the project change)
1 = none (unsuitable for the project change)

Hazards/traits were also ranked based from overall importance on the specific livestock industry assigned to each group. The breeds were also ranked by their overall suitability for production in the Pacific island region.

For village swine producers, suitability was ranked as the most important trait for pigs to have, followed by ease of handling, tolerance to increased temperatures, productivity, and finally tolerance to drought. Thus, for village producers, indigenous pigs were found to be most suited for PICTs, followed by crosses with indigenous pigs, Duroc and finally Landrace and Large White. This potentially indicates Duroc as the best choice for crossing with indigenous pigs for village producers in the region. For small and large commercial producers, productivity was ranked as the most important trait, followed by reproduction, then ease of handling, tolerance of increased temperatures and finally suitability for the local environment. Thus for smallholder commercial producers, Duroc was found to be best suited for PICTs, followed by Landrace and Large White, then crosses with indigenous pigs and finally indigenous pigs. For large commercial producers, Landrace, Large White and Duroc were found to be equally best, followed by crosses with indigenous pigs and finally local breeds.

Tolerance of increased temperatures was ranked as the most important trait for dairy cattle to have in PICTs, followed by suitability for local environment, then productivity, reproduction and finally ease of handling. Thus, local crosses were found to be best for production in the region, followed by Jersey, Friesian/Brahman /Jersey cross, Ayrshire and finally Friesian. The group also noted that Australian Milking Zebu (AMZ) / Australian Friesian Sahiwal (AFS) crosses from Australia and New Zealand might be well suited for the region as they are high producers in harsh conditions.

Tolerance to increased temperature and drought was identified as the most important traits for beef cattle to have in the region, followed by reproduction, then salt water tolerance, ease of handling and finally productivity in terms of marbling (desirable for the export market). The group noted that the Charolaise and Limousine are hairy breeds that may make them unsuitable for the tropical climate of the region. Therefore, Brahman was ranked as the most suitable breed for the region, followed by Santa Gertrudis, Limousine, Angus and the Charolaise.

For smallholder poultry producers, the group ranked tolerance of increased temperatures as the most important trait for chickens to have, followed by productivity, reproductive success, value of the finished bird and finally tolerance of drought. However, for larger commercial producers they ranked productivity as the most important trait, followed by reproductive success, value of the finished bird, tolerance of flooding and finally ease of handling. Thus, they ranked crosses of improved breeds with indigenous chickens as likely the most suitable broiler bird for the region, followed by Rhode Island Red, Leghorn, Australope and finally Plymouth rock.

Drivers of change in the PICT livestock industry

Participants were divided into three groups and were asked to list the main drivers of change in the region that will have the greatest impact on the livestock industry over the next 50 years. The drivers of change in the region common to each of the three groups are (1) population increase and (2) market economy/demand. The groups were then asked to pick the top five drivers of change among those they have identified. Using the proportional piling method, groups were tasked to rank the significance/magnitude of impact of each driver through different time periods:

1. Impact on the livestock industry over the next 10 years
2. Impact on the livestock industry over the next 50 years
3. Impact on overall development in the next 10 years
4. Impact on overall development in the next 50 years

There were no drivers of change common to all three groups. Two out of three groups have selected the following top drivers of change in the region: (1) population increase, (2) market economy/demand, (3) food security and (4) trade/export revenues/import substitution. Among these, two groups agreed that food security will have its most significant impact on livestock while market economy/demand will have significant impact on overall development in the region for the next 10 years. The ranking for the remaining drivers of change varied among the groups.

Exceptional epidemiological events

Animal disease events from 2006-2011 relevant for the region were downloaded from the World Animal Health Information System (WAHIS) of the World Animal Health Organization (OIE) (www.OIE.int) . The discussion focused on:

1. What the participants know about each disease reported in the region (pathogen, species affected, presentation, vectors, reservoirs).
2. Diseases that may have not been reported in the past 5 years, but may be present.
3. Reason for notification, why countries report.
4. Meaning and relevance of 'date resolved' entry.
5. Importance of countries reporting a surveillance activity, even when no disease is detected.
6. The need to adapt surveillance systems for early detection and rapid response in relation to climate change.
7. Other information is available from WAHIS.

It was noted that most of the disease reports available at the OIE WAHIS were from Australia and New Zealand with the exception of the disease report from New Caledonia on Babesiosis (bovine) submitted 31st March 2008 and Leishmaniosis (dogs) submitted in 13th March 2011. Participants were encouraged to improve animal data recording and disease monitoring for their respective industries.

Climate change adaptation in the livestock sector

Participants were divided into groups and were tasked to propose adaptations for each climate hazard in the dairy sector, smallholder cattle, commercial pigs, local pigs, layers, broilers, local small ruminants, and local poultry. Adaptations to impacts that are expected as a result of temperature (increased daily minimum and maximum), precipitation (increased variability and extreme events, increased flooding severity and frequency), drought (increased frequency and duration), cyclones (increased intensity and frequency), and sea levels (storm surge, salt water intrusion and salt spray) were identified. Disease impacts were also included.

Given the wide variety of possible adaptations, participants were asked to choose the most promising adaptations for commercial poultry, cattle, commercial pigs and village livestock systems. The aim is to outline and document the following

1. The feasibility of the adaptation in terms of cost to the farmer
2. The feasibility of the adaptation in terms of farmers' available knowledge
3. Research required to develop the new technology and knowledge for the adaptation
4. Impact on overall climate vulnerability
5. Contribution to overall development of the sector

The top adaptations per sector include the following:

- Cattle
    1. Research on crossbreeds that are more heat tolerant, less susceptibility to disease, heat stress, drought tolerance (already have some, we know that Brahman, SG are proven to be well adapted but not scientifically proven – need validation of local knowledge). Scoping survey to identify and propagate locally adapted pure and cross breeds. Assessment of feasibility to introduce Australian Milking Zebu, Australian Friesian/Sahiwal cross-breeds. Research to back up new cross-breeds to persuade farmers.
    2. Water management to maintain good quality and availability. Regular check and testing for water quality (e.g. coliform count), improved design and management of

watering troughs, establishment of proper tank/well gutters and new water sources (e.g. frilling of own bore hole)

3. Improved record keeping, disease surveillance and monitoring systems at the level of farmer and local livestock officers.
4. Paddock management such as good rotation to control life cycle of bacteria and parasites. Increase tree cover, good drainage of paddock and road access, day and night paddocks (rotate stock) - daytime, graze in paddock, night – move closer to milking shed.
5. Modifications in milking management to improve production and hygiene despite changes in the environment. Activities to include improvement of shed designs to ensure appropriate location, ventilation, flooring, drainage, waste management .Feed and pasture management including appropriate feed allocation to match production, pasture research on more tolerant species (heat, drought, flooding), effective feeds and pasture seed storage, legumes and shade trees which can be used as supplementary feeds

- Swine
  1. Appropriate housing designs and location.
  2. Ensure adequate source of potable water such as rain water harvests, water tanks, water pumps and bore holes.
  3. Hygiene and sanitation such as use of appropriate disinfectants, good drainages, personal protective equipment and sanitation instruction signage.
  4. Proper husbandry practices such as observing appropriate stocking rates and management of feeding, growing, finishing, record keeping and biosecurity plans.
  5. Use of appropriate breeds which are heat tolerant, disease resistant, efficient feed conversion, good production and mothering ability.

- Commercial poultry
  1. Feed improvement through determination of nutritional contents of locally available feed resources which can be used to supplement compound feeds.
  2. Shed design management through development of methodologies for assessing the climate vulnerabilities of new and existing commercial poultry sites. Assessment results can be used to improve farm infrastructures.
  3. Identification of climate resilient breeds of poultry species.
  4. Utilization of renewable energy to reduce input costs for commercial poultry.
  5. Poultry waste management for income generation and reduction of pollution. Establishment of additional demonstration sites in villages.

- Village livestock production
  1. Identification of climate change tolerant fodder plants and pasture species and establishment of pilot sites for planting and nurseries.
  2. Formulation of least cost rations using local raw feed ingredients and utilization of local resources, traditional and indigenous knowledge on feed ingredients.
  3. Site selection, improved shed designs and drainage.
  4. Establishment of early warning systems for floods, cyclones and diseases. Promoting passive surveillance system & undertaking appropriate emergency preparedness and response programs with village communities and farmers.
  5. Research of climate change tolerant breeds of animals including DNA characterization and documentation of traditional knowledge on local breeds.

Establishment of pilot sites for breeding sites for propagating pure lines and crosses of local breeds.

Livestock and climate change adaption trials

Each group (cattle, poultry, swine and village livestock production) was tasked to choose one adaptation option and develop a draft concept note. The goal is to test and provide evidence that the selected adaption option will benefit the livestock sector of the region. Workshop participants developed draft concept notes for research and development of the highest priority adaptations. Concepts proposed include:

1. **Local poultry breed productivity enhancement**. The objectives of research (for 5 atolls in Micronesia, Polynesian country and a large volcanic island) are:
   a. Increasing productivity of locally adapted poultry breeds for village-rural situations.
   b. Multiple F1 (offspring) and distribute to local village farms.
2. **Livestock disease surveillance in PICTs**. The objectives of the research (for 5 atolls in Micronesia, Polynesian country and a large volcanic island) are:
   a. Establish early warning disease surveillance system and capacity in 5 PICTs.
   b. Monitor animal disease status in the country.
   c. Promote the census of animal productions data to address need for better animal identification and trace-back system.
2. **Nutrition enhancement for community poultry**. The objective of the project is to improve nutrition of local free ranging chickens in villages by introducing locally appropriate feed formulations that are low cost, makes use of available foods, and are climate tolerant.
3. Five adaptations for commercial pigs in PICTs including housing designs and location, water quality and availability, hygiene and sanitation, proper husbandry practices, and adapted breeds
4. **Operation super cow for Fiji**. The objective of the research is crossbreeding to produce dairy breeds tolerant to high temperature, high production and early calving.

The completed concept notes are summarized in the 'AHP 5- Year strategic plan for mainstreaming climate change'.

Fig 5. Participants of the Livestock and Climate Change in the Pacific Island Region Workshop

Next steps

Participants were finally asked to provide ideas and initiatives which they can progress in the next year and the next five years, as a step forward. Valuable responses for the year one initiatives include documentation of workshop outputs for circulation and presentation to PICTs, development of action plans for each country during the PHOVAPS session in October 2012, develop the capacity of member countries on climate change mainstreaming and development of national livestock adaptation strategies. The immediate action for SPC as a regional organization, include further development of project proposal in LRD AHP on disease prevention, cross breeding programs for desired traits, feed development, survey for livestock and land use as support to climate change mainstreaming in the Pacific region. In the industry and farmer level, immediate actions include coordinating climate change mitigation activities with the North Pacific, conduct of local poultry nutrition trial, development of awareness on integrated farming systems, improvement of record keeping, farm management and training programs, improvement of milk production and quality systems to resist the changing climate. The long term (5-Year) initiatives generally follow through suggested short-term initiatives (year-1) with the addition of progressing development of full legislative and strategy/policy support (including funding) for regular mainstreaming of climate change in livestock.

Conclusion

Through the discussion and sharing of experiences during the workshop, the livestock sector was provided an opportunity to identify climate change adaptation and mitigation options that are relevant specifically for the PICTs. The comprehensive workshop report that was developed will serve as a living document for regular updating. The report will become a source of technical information to assist farmers and stakeholders in addressing climate change impacts on the region's livestock sector. As an immediate result of the workshop, the SPC AHP, in collaboration with GIZ, has spearheaded the development of six climate change facts sheets for the PICTs' livestock sector, and the AHP 5-year strategic plan for mainstreaming climate change. The strategic plan focuses on the following elements:

- Activity 1.2: In collaboration with SOPAC and the SPC Statistics for Development Division, develop a GIS-based system for climate change risk assessment and resiliency planning for the livestock sector.
- Activity 1.3: Support the process of livestock climate disaster planning at village, national and regional levels.
- Activity 2.3: Develop and disseminate climate adapted breeds and lines of chickens and pigs.
- Activity 2.5: Develop and disseminate climate appropriate livestock housing technologies adapted from current SPC designs. These technologies will be developed and tested in partnership with one or more national agricultural research services (NARS).
- Activity 4.1: Establish a program to support member countries in integrating livestock advice into seasonal forecast information production and dissemination.
- Activity 4.3: Implement a program of annual climate change training for AHP and stakeholders on key technical topics.

- Activity 4.4: Establish program of AHP visits, information sharing and networking with livestock units in other regional organizations, to facilitate transfer of knowledge and experiences related to adapting livestock to climate change.

As a result of the workshop, key information was defined for the Pacific livestock sector:

- The key climate hazards for the livestock sector in the Pacific includes drought, flooding, cyclones, storm surges, rainfall and increase in ambient temperatures, sea level rise. The top three most significant hazards are cyclone, floods and temperature changes.
- The growing/fattening link and to a lesser extent the marketing link in the livestock value chain in the Pacific will be most affected by climate change hazards. The actors that will be most vulnerable are those that directly look after the animals, such as farm owners, family members, ranchers, breeders, veterinarians and stockmen.
- The most significant drivers of change in the region are population increase, food security, market economics/demand and trade. For the next ten years food security and market economics/demand will potentially have the greatest impact on the livestock sector and overall development in the region.
- On breed tolerance, Duroc is potentially the best option for commercial pig production and its cross with indigenous pigs most suitable for village producers. Brahman for beef and crosses of improved broiler poultry breeds will be most suitable for commercial beef and poultry production respectively.
- To be able to provide more reliable climate change predictions in the future (like in Vanuatu) it is recommended to continue consolidation of data to lengthen available data series, strengthen observation systems and installation of reference climate stations.
- The training of CAHWs and paraveterinarians on active and passive disease surveillance will aid in early detection of animal diseases and effective livestock adaptation.

Acknowledgement

The Animal Health and Production team of SPC extends its appreciation to GIZ and the workshop participants for their contributions towards the achievement of the objectives of the workshop, and to Dr. Christine Jost, the workshop consultant, for facilitating the discussions, sharing her expertise and for developing the comprehensive report to document the specific outputs of this workshop.

References

Kaplinsky, R. (2000). Globalization and unequalisation: What can be learned from value chain analysis? *Journal of Developmental Studies , 37* (2), 117-146.

-End-