A SURVEY OF COMMERCIAL SMALL-SCALE POULTRY PRODUCTION SYSTEMS AND NUTRIENT CHARACTERISATION OF LOCAL FEED INGREDIENTS IN LAOS

A Thesis Presented in Partial Fulfilment of the Requirements for the Degree of Master of AgriScience at Massey University

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ABSTRACT

This thesis comprises of two separate studies. A survey of small-scale chicken production (layer and broiler) in Laos is presented in Part 1 and the characterisation of local feed ingredients is presented in Part 2.

Part 1 examined aspects of demographic details, breeds and sources, management systems, labour, diseases, production parameters, marketing and farmer attitude in small-scale chicken farms. For the survey of layer farms, a total of 35 farmers from Xaythany and Naxaithong districts were interviewed. All producers were over 30 years of age. Almost 75% of interviewees were males, showing that males play a significant role in the leadership in the families. The average hen day production was found to be 0.65 and an average of 1.81 kg feed was required to produce a dozen eggs. It was observed that this feed conversion efficiency level was similar to those reported in some tropical countries, but poorer than the recommendation by breeding companies for modern layers (1.58 kg feed/dozen eggs). Hens were culled after 18 months of production (around 2 years of age). During this period, a hen produced an average of 242 eggs, which was lower than the 300 or more eggs expected for modern layers under optimum conditions. Number factors are responsible for the poor layer performance under small farm conditions in Laos, with poor management being the main cause. This problem can be solved by the involvement of government and better veterinary and extension services. The average mortality was 11%; diarrhoea and bird flu were the main causes associated with the deaths. Vaccines and drugs were regularly used by all farms.

For the broiler survey, 7 broiler farms in Naxaithong district were surveyed. All farms operated under contract with a large company (Charoen Pokphand Laos Company). The annual broiler output per farm ranged from 15,000 to 24,000 birds. The number of production cycles per year and the type of breed provided are decided by the company. Three breeds are raised, namely Ross 308, Brown Nick and 3-line crossbreeds. The average market age was 8.6 weeks at an average body weight at 1.5 kg. The FCR (feed conversion ratio) was 2.1 kg feed/kg gain. Although all farms received good quality feed and regular monitoring from the CP Company, the feed efficiency was higher compared to breeding company standards (1.6 kg feed/kg gain).

The average mortality was 1.4%. Ross 308 was found to be more susceptible to the hot environment than the other two breeds. Deaths in Ross 308 were related largely to the faster growth rate.

The study reported in Part 2 aimed at characterising the nutrient contents of locally available poultry feedstuffs so that dependence on imported commercial feeds can be reduced. Fifteen local feedstuffs (rice bran, broken rice, cassava leaf meal, cassava root meal, coconut meal, fish meal, green banana meal, groundnut, leucaena leaf meal, maize, sesame seed, snail meal, soybean, sweet potato tuber meal and taro meal) were collected. Each sample was analysed for proximate composition, minerals and amino acids. Of the tested ingredients, fishmeal had the highest crude protein content (54.4 g/100 g), while sweet potato tuber meal had the lowest crude protein content (3.5 g/100 g). The highest crude fat value (65.0 g/100 g) determined for full-fat copra, followed by sesame and groundnut seeds (54.8 and 54.4 g/100 g, respectively). Roce bran had the highest fibre content (14.7 g/100 g) and snail meal the highest ash content (71.3 g/100 g). Snail meal had the highest calcium content (30.0 g/100 g) followed by fish meal (4.50 g/100 g). Snail meal was also rich in t iron, copper, manganese and zinc. Fish meal had high contents of amino acids. Whereas cassavas root meal had the lowest.

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LIST OF ABBREVIATIONS

%	Percentage
AOAC	Association of Analytical Communities
AME	The apparent metabolisable energy
AHD	The Animal Health Division
^{0}C	The degree Celcius
CP	Charoen Pokphand
CSM	Cottonseed meal
DM	Dry matter
FAO	Food and Agriculture Organization
FCR	Feed conversion ratio
g	gram
GDP	Gross Domestic Product
H5N1	Hemagglutinin Type 5 and Neuraminidase Type 1
kg	kilogram
MAF	Ministry of Agriculture and Forestry
ME	Metabolisable energy
MJ	mega joules
N/A	Not applicable
NFE	Nitrogen-free extract
NGOs	Non-Government Organisations
NRC	National Research Council

SD	Standard deviation
US$	The United States dollar

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

Laos (Lao People's Democratic Republic) is a landlocked country situated in South-East Asia, which is bordered by China in the North, Cambodia in the South, Burma and Thailand in the West, and Vietnam in the East. Laos has an estimated population of 6.4 million, with a land area of 236,800 km^2 (Lao Statistics Bureau, 2011).

Laos' economy is mainly dependent on agriculture. Around 75% of the population are small-scale farmers. Agriculture sector contributes 47% of the gross domestic product (GDP); livestock and fisheries share 16% of the total GDP (Wilson, 2007). Rice is the most important crop, while the livestock plays an integral part in farming systems and poverty reduction in rural areas.

1.2 Poultry industry in Laos

Poultry production is considered as an opportunity to improve the livelihoods and provide additional income to people in remote areas. Poultry is also one of the most significant sectors supplying animal protein for domestic consumption, but the production systems remain traditional (MAF, 2005). The poultry industry in Laos is based largely on indigenous birds kept by almost every household in rural areas and supplemented by imports of eggs and poultry meat from neighbouring countries. The estimated poultry population in 2011 is 27 million birds, which represented an increase of 35% since 2005 (Lao Statistics Bureau, 2013). Most of the poultry, however, rely on scavenging and are reared in backyards, and only 5% are reared in commercial systems. The commercial farms are mostly concentrated in the Vientiane Capital (MAF, 2005). This is due mainly to the proximity to markets and easy availability of inputs.

In the Vientiane Capital, two districts (Xaythany and Naxaithong districts) have high concentrations of commercial farms. According to provincial agricultural officials, the poultry population in Vientiane Capital dramatically declined between 2005 and

2009 due to outbreaks of Avian Influenza (H5N1). In 2013, it is estimated that there are 121 layer and 10 broiler farms in the Vientiane Capital. Chickens are the predominant species, but ducks and quails are also reared. Chicken production is small- to medium-scale systems. Flock size in layer farms generally range 500 to 6,000 birds, whereas annual output in broiler farms is between 12,000 – 24,000 birds.

Currently, there is great deal of investment in the poultry sector in Laos. There appears to be considerable opportunities for small-scale farmers to expand their production to meet the growing domestic demand (Stur et al., 2002). However, they are heavily reliant on imported feed to feed their birds, and limited local feedstuffs are used in feed formulations. The short supply and high cost of imported feeds are the greatest constraint to the expansion of small- and medium-scale commercial farms (Stur et al., 2002; Harding et al., 2007).

Considerable potential exists in Laos to use locally available feedstuffs, but no detailed study is available on their nutrient composition and the limitations for their use in poultry diets. There are two main reasons for this lack of interest. First, limitations in analytical and human resources and, second, the lower priority on poultry compared to ruminant and pig sectors.

1.3 Objectives of the study

Limited published information is available on commercial poultry enterprises in Laos. The prime objective of the present study was to obtain baseline information on specific aspects of production systems and productivity in small- and medium-scale poultry farms. A single visit, questionnaire survey was conducted to 25 layer farms and 7 broiler farms in districts of Vientiane Capital. It was envisaged that the final outcome would be the identification of constraints faced by the industry and areas to improve productivity. It is hoped that the findings from this study will provide useful information, for the policy makers and extension personnel, on the husbandry conditions and productivity of these poultry operations.

The second aim of this study is to collect and characterise the nutrient contents in a range, locally available feed ingredients that are not traditionally used for poultry feeding. Overall, it is envisaged that this study will establish a benchmark for follow-up surveys and research in Laos.

1.4 Outline of the thesis

This introductory Chapter provides a brief background on the status of the poultry industry in Laos and defines the objectives of the thesis research. A review of literature is presented in Chapter 2, followed by the results from the field surveys. The results from surveys of layer and broiler farms are discussed in Chapters 3 and 4, respectively. The results from laboratory analysis of 15 Laotian feedstuffs, with potential for use in poultry feeding, are presented and discussed in Chapter 5. A brief discussion of the overall results, along with future recommendations, is presented in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

2.1 Animal production

Introduction

Lao People's Democratic Republic is one of the poorest countries in Southeast Asia, with a per capita income of US$ 3,000 in 2012. But the economy has rapidly grown in recent years, with the government decentralising controls and encouraging private enterprises. During the past two decades, Lao government have emphasized on improvements in agriculture, health, education and infrastructure. One of the strategies being considered to help farmers to escape the poverty is the development of animal production. Animals represent a significant component of smallholder farms in Laos and, animals and fisheries account for 16% of total GDP (Wilson, 2007). Animals contribute more than 50% of cash income in the remote areas. In addition, livestock provides many other on-farm benefits such as draft power and manure. For poor households, animals are considered as accumulated income and are sold when cash is needed (Stur et al., 2002). Most animal breeds are of indigenous origin. Their productivity levels are poor, but these breeds are adapted well to the existing husbandry and environmental conditions in Laos.

Extensive systems of production are commonly practiced by small-scale farmers and they still remain in traditional ways, resulting in low animal productivity.

2.1.1 Large ruminants

Lao farmers raise buffaloes and cattle mainly for draught power and manure. Large ruminants play an important role as cash reserves; farmers sell their animals when they need money. Ruminants are mainly farmed in the free range. Culturally, farmers let loose their animals for natural grazing in the rice fields or public land for about 10 hours a day, starting from 7 am to 5 pm. The major sources of feed are natural grasses and supplementary rice straw is provided when natural grasses are scarce during the dry season. The animals are driven back home in the evening. Buffaloes and cattle are confined in pens or shelters during the night, allowing farmers to collect the manure.

Most large ruminants are concentrated in the central region of the country, including Vientiane Capital, Vientiane and Savannakhet provinces (Figure 2.1). The other main production areas are in the southern part (Saravan and Champasack provinces), where rice fields can support a large animal production.

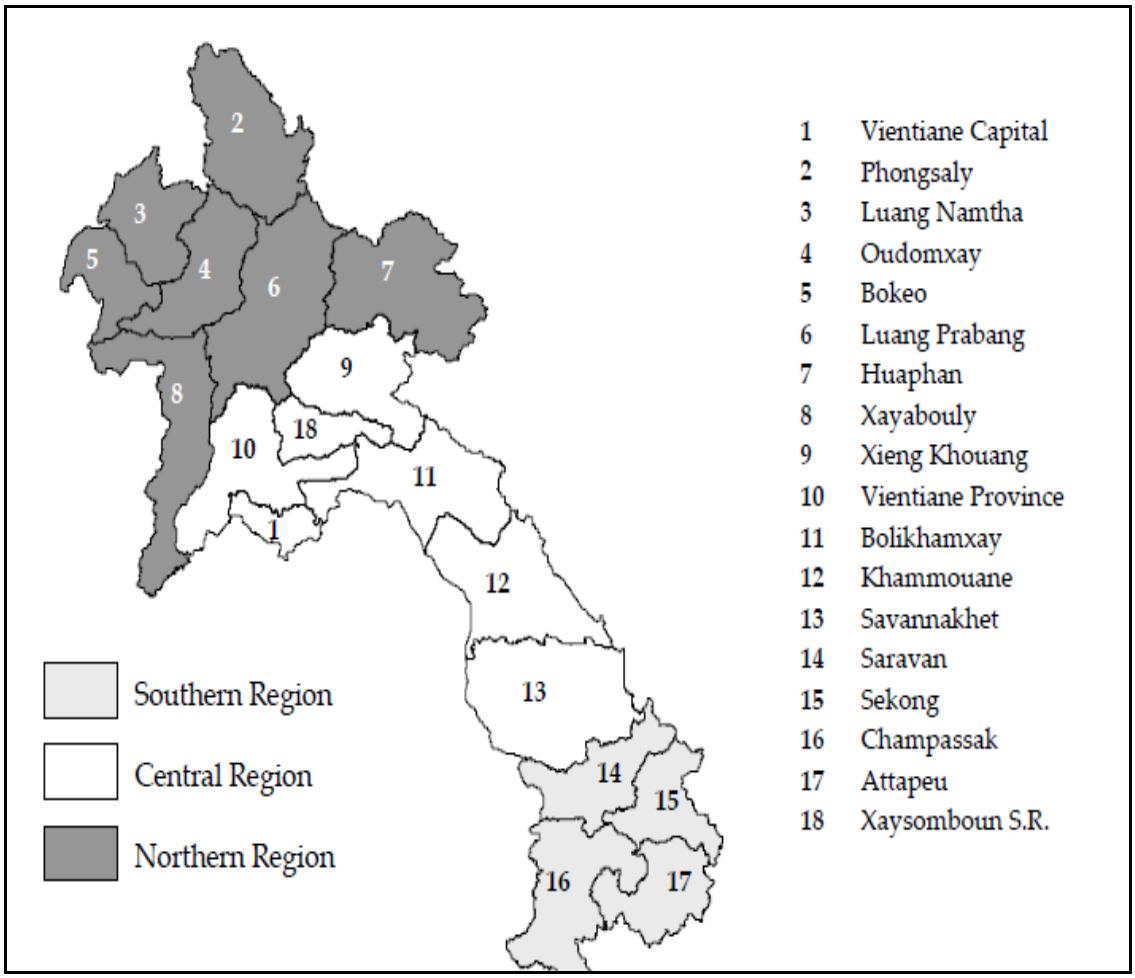

Figure 2.1 Map of Laos.

2.1.2 Small ruminants

Goats and sheep are found mainly in the upland areas of the northern region, where fodder trees, shrubs, bushes and natural grass are available throughout the year. Goats are mostly found in Savannakhet province (Table 2.1). Households raise native goats, with a mature weight of 25-28 kg for meat production. Animals are generally left loose to graze freely all year with little communal herding. But they are housed at nights in different types of enclosures (Wilson, 2007). Villagers usually prefer to rear these animals in small groups to avoid damage to crops, since the owners are held responsible

for any damage. The goat population has been increased during the past decade (Table 2.1) owing to high demand for goat meat among local population (Stur et al., 2002).

Table 2.1 Population and percentage change of buffalo, cattle, and goats and sheep

Province	Buffalo		Cattle		Goats and sheep	
	2011	% change	2011	% change	2011	% change
Vientiane Capital	20	10	99	34.34	24	41.67
Phongsaly	41	19.51	43	53.49	6	66.67
Luangnamtha	20	-20	24	0	9	33.33
Oudomxay	44	13.64	39	25.64	33	57.58
Bokeo	27	22.22	39	33.33	16	75.00
Luangprabang	66	13.64	65	40	81	55.56
Houaphanh	55	-14.55	63	25.4	28	42.86
Xayabury	49	-26.53	84	22.62	13	38.46
Xiengkhuang	57	22.81	94	5.32	18	61.11
Vientiane	73	17.81	149	28.86	22	50.00
Borikhamxay	46	8.7	58	10.34	22	90.91
Khammouane	76	13.16	70	27.14	28	75.00
Savannakhet	293	3.75	397	2.52	66	40.91
Saravane	117	25.64	135	22.22	33	66.67
Sekong	31	25.81	27	40.74	18	66.67
Champasack	131	10.69	136	9.56	12	75.00
Attapeu	50	12	16	25	4	50.00
Xaysomboon SR	-	-	-	-	-	-

Note: Values expressed in 1,000 heads; % change is growth between 2005 and 2011.
Source: Adapted from Lao Statistics Bureau (2013).

2.1.3 Pigs

Both local and imported pig breeds are used in Laos. The local breeds play a key role in supplying the pig meat to the rural population. There are three main local breeds called Moo Lath, Moo Chid and Moo Hmong, They can be found all over the country. But Moo Lath is most common breed. The body weight of female at puberty is 21-30 kg,

while that of the male is about 30 kg. Piglets are weaned at 2-3 months of age weighing 7-8 kg, and a sow produces 1.2 litters per year. Traditionally, women are responsible for raising the pigs and local feed ingredients such as cassava root, rice bran and banana stems are widely used for feeding. Thus, it is a low-input system and the productivity is poor. Free range system is widely practiced, in which animals are susceptible to a variety of parasitic and disease problems. In semi-intensive systems, pigs are confined in pens and fed by-products such as rice bran, distillery by-products and kitchen wastes; sometimes supplements of root crops (cassava, sweet potato, and taro) are provided. In some farms, pigs are integrated with fish farming, with fish ponds located below the pig house.

In urban and peri-urban areas, the farms are commercial or semi-commercial and exotic breeds, such as Large White, Landrace and Duroc Jersey, are used. But crossbred piglets from Large White and Landrace are most favoured. In this intensive system, pigs are raised in confinement from birth through slaughter in age-segregated management systems (i.e., nursery, grower and finishing phases). All-in and all-out management is commonly practiced to prevent the occurrence of infectious diseases (Wilson, 2007). Medications are used for growth enhancement and disease control at different stages of production. Antimicrobials and, prophylactic and therapeutic treatments are used in these commercial farms (Theungphachan, 2012).

2.1.4 Poultry

Laos had an estimated poultry population of 26.9 million birds in 2011 (Table 2.2) which was a 27.6% increase over the 2005 population of 19.8 million (Table 2.3). Households raise the poultry along with other animal species such as goats, pigs, cattle and buffaloes. Chickens and ducks are the major poultry species, while geese, turkey and other species play a minor role. 95% of the poultry population is found in traditional scavenging systems in rural areas and only 5% in commercial systems, mainly in the Vientiane Capital (MAF, 2005). Poultry population is concentrated primarily in central and northern regions where poultry consumption is relatively high.

Table 2.2 Population of pigs and poultry (‘000 heads) and % change between 2005 and 2011

Province	Pig		Poultry	
	2011	% change	2011	% change
Vientiane Capital	107	7.48	2101	87.48
Phongsaly	180	60.56	561	26.56
Luangnamtha	88	31.82	425	17.88
Oudomxay	148	39.19	1522	51.77
Bokeo	56	21.43	371	-14.56
Luangprabang	209	27.75	2407	44.12
Houaphanh	166	-40.96	940	-102.87
Xayabury	122	29.51	1747	-14.42
Xiengkhuang	81	6.17	939	15.55
Vientiane	93	7.53	1508	-15.58
Borikhamxay	66	18.18	694	0.86
Khammouane	103	11.65	560	-99.46
Savannakhet	269	2.23	2528	9.45
Saravane	639	63.69	4899	45.40
Sekong	134	65.67	705	81.13
Champasack	163	34.97	4525	46.74
Attapeu	26	26.92	420	14.29
Xaysomboon SR	-	-	-	-

Source: Adapted from Lao Statistics Bureau (2013).

2.1.4.1 Chickens

95 per cent of poultry in Laos are located in villages. Most households raise a small number of other poultry species such as ducks and turkeys. The main product is meat for family consumption with some surplus sold in local markets. Raising chickens usually is the task of women in the household. Local breeds of chicken are popular, because consumers prefer local types rather than imported breeds from Thailand.

Scavenging system is the pre-dominant way of raising chickens all over the country. Commercial chicken farms can be found only near major population centres, which supply meat and eggs to the urban centres (Stur et al., 2002).

Chicken production systems in Laos can be divided into three categories, namely traditional, semi-intensive and commercial (intensive).

a) Traditional system

In this system, women are the main source labour, rearing between 10-30 birds per household. Birds scavenge for food in the backyard, and normally spend the night on trees around the house, underneath the house or in natural sheds (Burgos, 2008). Most households raise 20-30 chickens consisting of 3-5 hens, one cock and growing chickens of various ages (Stur et al., 2002). Own-stock hatching is used to produce the chicks. The use of vaccination, feed additives, and veterinary assistance in this production system are rare. As a result, mortality rate is high and productivity is low (Burgos, 2008); in addition, hens produce few eggs (30-50) per year (Stur et al., 2002). In this system, chicken are usually raised along with ducks, goats and pigs. Households raise local breeds for meat and eggs, which are consumed mostly within the by household and any surplus is sold locally for cash. The cash is used for family needs (Burgos, 2008).

b) Semi-intensive system

In this system, birds scavenge during the day and are housed in enclosures at night to protect them against predators. The housing is very basic made with bamboo with palm thatch or rice straw roof, and chickens and ducks are housed together. One household may carry from 50-1,000 birds and hatch their day-old chicks needs from own stock (Burgos, 2008). Equipment such as plates and trays are used to provide feed and water (Wilson, 2007). Mixtures of rice bran, broken rice and food waste are provided in the morning and evening as supplementary feed after scavenging (Wilson, 2007). Thus, the mortality is moderate and the production efficiency is medium owing to improved sanitation, management and disease control compared to the traditional system (Burgos, 2008).

c) Commercial (Intensive) system

In this system, improved breeds of layers and broilers imported from Thailand are used. Flock size ranges from 1,000 to 5000 birds in a single barn. Broilers are marketed at 6 weeks of age at a weight of 1.75 to 2.0 kg, and layer produces 250 to 270 eggs per year. Standard infrastructures that include housing, feeding and drinking systems are used. Moreover, more attention is paid on bird health, house maintenance and bio-security to improve the productivity. The products from these commercial units are marketed in urban areas (Burgos, 2008). Medications and vaccinations are used to prevent and treat major infectious diseases. Supplemental vitamins and minerals are also provided through water (Theungphachan, 2012).

Most of these agribusinesses are small industries with few employees. In general, production costs tend to be high since production is dependent on concentrate feed which, in many cases, is imported from Thailand. Some farms use concentrate feeds mixed with locally available feeds such as rice bran and ground maize to reduce production costs. In some cases, commercial poultry farms are closely associated with rice mills (Stur et al., 2002).

2.1.4.2 Ducks

Duck is the second most important species of poultry and the breeding stock is imported from Vietnam. There are two types of ducks, namely Muscovy (*Cairinamoschata*) and common duck (*Anasplatyrhyncos*). Muscovy males weigh up to 2.2 kg and female Muscovy lays one or two clutches of 10 to 20 eggs once or twice a year. While the common ducks weigh up to 2 kg and lay three or four clutches of 10 to 12 eggs per year. Hatching rates in both species are about 80 to 85% (Wilson, 2007). In the scavenging system, ducks are reared in rice fields, natural ponds, rivers and backyards. They scavenge for food, small fish, snails and aquatic plants. Farmers raise duck for multiple purposes, such as home consumption, income and pest control in the rice paddy. Because of outdoor production, ducks are susceptible to diseases resulting in half or more of ducklings dying before three months of age (Wilson, 2007).

Table 2.3 Summary of livestock population, 2005 to 2011

	Year						
	2005	2006	2007	2008	2009	2010	2011
Buffaloes	1,097	1,108	1,123	1,155	1,178	1,183	1,197
Cattle	1,272	1,321	1,353	1,499	1,426	1,474	1,538
Pig	1,827	2,033	2,186	2,548	2,947	2,753	2,650
Goats and sheep	190	210	268	289	339	366	433
Poultry	19,802	20,803	20,453	21,983	22,521	24,079	26,852

Note: Values expressed in 1,000 heads.

Source: Adapted from Lao Statistics Bureau (2013).

2.1.5 Trends in animal population

Figure 2.2 and 2.3 show the trend of animal population from 2005 to 2011. It is clear that the animal population increased gradually over this 7-year period. Although the pig population rose quickly from 2007 to 2009 by nearly 600,000 heads, it declined in 2011. But the pig population increased at a faster rate than other species over the 7-year period. The population of ruminant animals slightly increased every year. Poultry population increased gradually from 2005 to 2011 from 19.80 to 26.85 million birds.

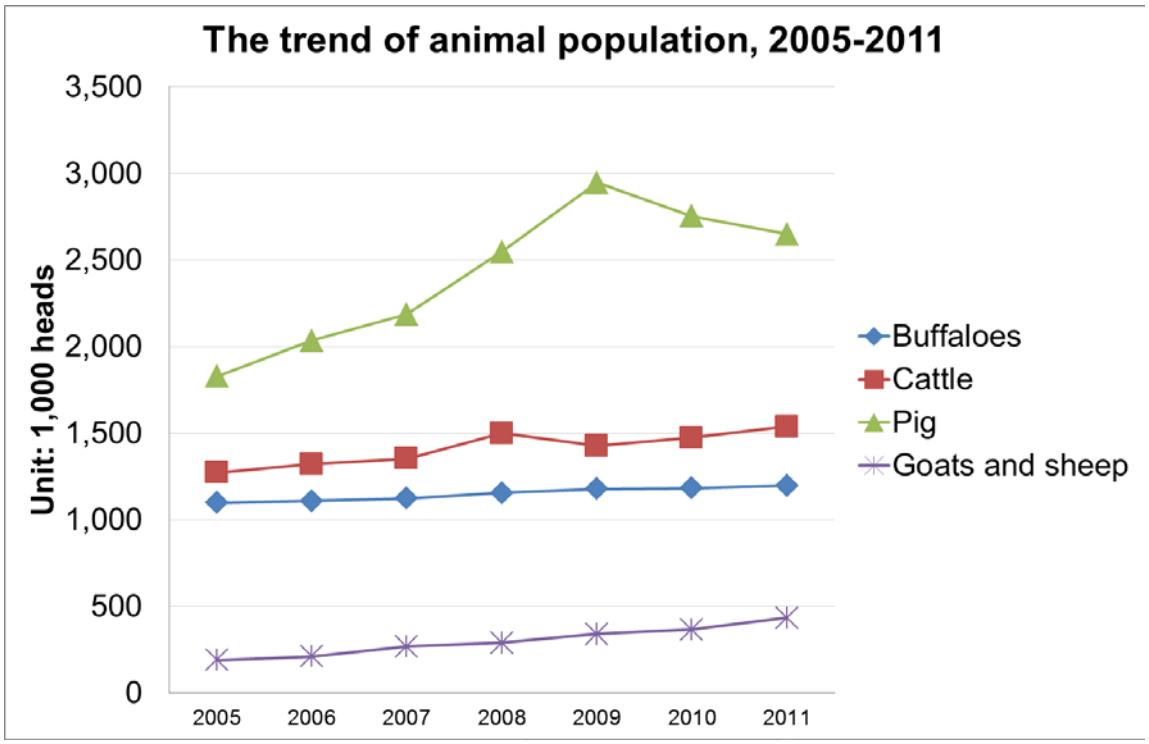

Figure 2.2 Trends in the population of buffalo, cattle, pig, and goat and sheep

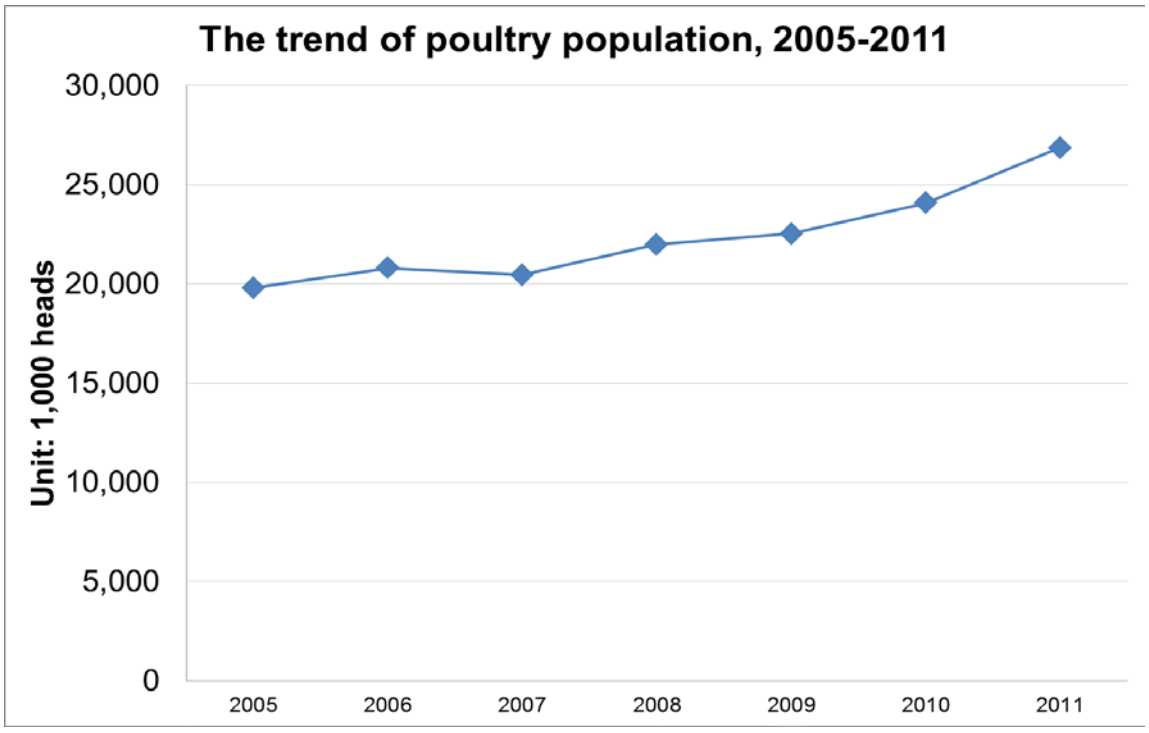

Figure 2.3 The trend in poultry population

2.1.6 Consumption of animal products in Laos

Differences exist between urban and rural areas in the consumption pattern of animal products (Table 2.4) and the largest difference is in the per capita consumption of eggs. For all protein types, urban dwellers consumed much more than rural people. Fish is the primary source of animal protein in Laos. People who live in urban areas consume more animal protein because they are not only more prosperous, but also have access to a wider variety of foods at local markets. With rising income levels, the demand for animal proteins in Laos is increasing.

Table 2.4 The consumption of animal products in urban and rural areas, kg/person/year

Protein source	Urban	Rural	Difference (%)
Fish	10	8	20
Pork	8	5	38
Poultry meat	5	4	20
Eggs	6	2	67
Buffalo meat	3	1.8	40
Beef	3	1.2	60
Total	35	22	37

Source: Wilson (2007).

2.1.7 Problems faced by the animal industry

Diseases are the main constraint limiting the growth of animal production. Sporadic disease epidemics frequently kill the pigs in large numbers. In calves, high mortality (30-40%) is experienced due to internal parasites. A number of factors contribute to the incidence of diseases, including nutritional deficiencies, poor husbandry practices and movement of animals and selling of diseased animals (Stur et al., 2002). In the past, the government has provided vaccination services against Newcastle disease and fowl cholera. These vaccines are produced locally. The vaccination programme covered about 25 to 30% of the farms, but was not successful in some areas due to inadequate

storage facilities and lack of electricity. In addition, the distribution channels were inadequate and the farmers were often unwilling to vaccinate their animals (Bouahom et al., 2007). Wilson (2007) reported that the mortality in poultry was high, especially in young birds. The main diseases were Newcastle disease in poultry and duck plague in ducks. In upland villages, mortality was said to be more than 80%. The following reasons were provided for the relatively high incidence of diseases. (i) poor nutrition and sanitation; (ii) uncontrolled movement of animals; (iii) movement of diseased animals (iv) lack of correct disease diagnosis; (v) poor access to information on how to control and treat diseases; (vi) restricted coverage and ineffective vaccines; (vii) weak veterinary support services, and (viii) inappropriate management practices.

Most farmers have poor knowledge about parasites, infectious diseases, reproductive and nutritional management of animals (Nampanya et al., 2010). Lack of knowledge of the production potential of local genetic resources is another problem. Large gaps exist in the understanding of the characteristics and diversity of local breeds. With regard to genetics research, financial support is limited and donor organisations often are more interested in wildlife than domestic animals. Many Non-Governmental Organisations (NGOs) have tried to promote imported chicken breeds from other countries for distribution in a small number of villages in Northern provinces, but poor management resulted in failure of these introductions (Stur et al., 2002).

The Animal Health Division (AHD) of the Department of Livestock and Fisheries is responsible for disease diagnosis and control, quarantine, veterinary extension network, vaccine production, distribution and use with partial cost recovery. ADH has only a basic information system to record and analyse animal health status, and find it difficult to prioritize the use of scarce resources for animal diseases (FAO, 2005). Only a small number of veterinary professionals are available in Laos and most practice in the large-scale production systems. It is the NGOs and international organizations that have tried to provide rural villagers with practical veterinary training (Stur et al., 2002). However, not all problems can be solved by extension. For example, the extension system cannot improve the condition of roads or change market prices. But good extension will help farmers to examine their problems and find the best way to manage their resources in a given situation.

Commercial pig and poultry production in Laos is disadvantaged by higher feed costs than neighbouring countries which have access to cheaper ingredients (e.g. by-

products of industrial crops such as sugarcane, cassava and coconuts) and port access for importation and a larger domestic market. This limits the expansion of commercial livestock production beyond meeting the domestic demand of the urban population. Moreover, animal feed producers in the Lao PDR are unlikely to be able to compete with Thai feed mills given the high cost of raw materials and transport.

Most livestock farmers are poor and do not have enough capital to improve the production systems. Although the Agricultural Promotion Bank provides credit to farmers, the amounts that can be borrowed are limited (Bouahom et al., 2007). In commercial chicken production, most farmers struggle to repay the high interest on bank loans and also have the added burden of high feed costs. For example, banks in Thailand and Vietnam charge about 3-5 per cent interest annually on loans to farmers, whereas banks in Laos impose an exorbitant rate of 13-15 per cent a year.

Apart from production constraints, the major problems limiting animal production are marketing, cross-border trade and policy issues. Additionally, agribusiness tend to be constrained by an uncertain legal environment and many regard the Lao PDR as a more difficult place to conduct business compared to other countries in the region (Stur et al., 2002)

2.1.8 Government plans

The Lao government wants to improve and expand animal production to reduce poverty and increase the per capita animal protein consumption from 22 to 50 kg in rural areas and from 35 to 70 kg in urban areas. The National Growth and Poverty Eradication Strategy identifies targets of an average meat supply of 70 kg/capita/year and increased exports to the value of US$50 million by 2020 (Theungphachan, 2012). To achieve this, AHD has trained veterinary support workers at the village level. Approximately 6,400 workers have been trained thus far and it is intended to train at least one veterinarian for each of the 12,000 villages in the country (FAO, 2005).

Moreover, the government has tried to seek the support of neighbouring countries to build feed mills to increase the production of good quality animal feeds. For example, a US$5.25 million feed mill has been built in the Oudomxay province funded by China's Southwest Yunnan province. This factory is expected to be able to produce up to 6,000 tonnes of animal feed per year (Vientiane Time, 2013).

2.1.9 Proposed strategies to improve animal production

Improvements in animal production can be achieved through interventions such as disease control and prevention, improved feeding, animal management and breeding strategies, and extension services. These include:

1) Disease control and prevention: All animals before moving between villages and farms should be separated for examination. If possible, the animals need to be vaccinated. . In addition, village-based vaccination must be carried out against diseases for which heat-stable vaccines (not requiring cold storage) are available such as Fowl Cholera and New-Castle Disease. Improved early recognition of animal diseases by farmers to enable them to respond with rapid quarantine and containment measures, thus limiting the spread and impact of diseases, and enabling early treatment of infected animals (Stur et al., 2002).
2) Extension services: In the community, facilitating the exchange of experience and knowledge between farmers is useful. Livestock fairs could be organized to increase such farmer interaction. Capacity building in livestock extension is also important to rural development. National, provincial and district authorities recognize these facts and the importance of providing assistance. To achieve this, participatory livestock interventions need to be encouraged. The Lao government and NGO agencies must employ male and female extension workers who can communicate with the villagers through participatory extension approaches. The Government should not only play a significant role in supporting livestock sector development, but also promote private sector initiatives to develop local markets in the country (Photakoun, 2010).
3) Management: To improve productivity, support from government agencies, policy-makers and NGOs is needed. Possible actions could involve the following: a) introduction of husbandry and breeding techniques compatible with traditional practices to improve the efficiency of farming systems; b) promotion of mixed farming and diversified production; c) record keeping of animal performance, management and animal health; d) practical strategies to increase the survival of one-day old chicks, by supplementing chick feed with extra protein and building brooding units; e) Interventions to improve village production. Improved sanitation, for example, would improve the growth rate, survival and reproduction; and g)

breeding strategies for local chickens through the establishment of structured methods in selecting the breeding stock (Bouahom et al., 2007).

4) Feeding: little is known about the nutritive value of locally available feed ingredients. Planting crops such as maize, cassava, soybean, sweet potatoes, and legumes to feed chickens will reduce the cost of production compared to the purchase of commercial feeds. Available agricultural by-products such as rice bran, cassava leaves can also be used in poultry diets. In addition, provision of adequate supply of clean drinking water and some supplementary feeding would reduce the mortality. Snails or egg shells can provide extra calcium.
5) Credit: for the establishment of commercial chicken production, access to easy credit is critical. The government can help producers by providing loans with lower interest rates.

2.2 Potential feed resources for poultry

Rice is the staple food in Lao. Laos produced 3.07 million tonnes of rice in 2011 (Table 2.5). Most rice is grown in the central regions of the country, and the remainder is grown in southern and northern regions where maize and other crops are also produced. There are number of crops and their by-products that can be used as feed resources for poultry production

Table 2.5 Production of major crops in Laos, 2011

Commodities	**Tonnes**
Rice	3,065,760
Maize	1,097,990
Cassava	743,190
Sweet potatoes	236,677
Soybean	13,820
Cotton seed	3,700
Sesame seed	1,204

Source: FAO (2013).

A list of potential resources that can be used as animal feed and available in the country is summarised in Table 2.6.

Table 2.6 Potentially local feed resources that are available for poultry production

Feed resources	Region of the country		
	Northern	Central	Southern
Energy sources			
Cassava	**	***	**
Rice bran	**	***	**
Broken rice	**	***	**
Maize	***	*	*
Sweet potato	**	**	**
Protein sources			
Fish meal	*	**	***
Soybean	***	***	**
Cotton seed	*	**	***
Sesame seed	**	*	*
Snails	*	***	***

Note: * = available; ** = reasonable quantity; *** = abundant

2.2.1 Energy sources

2.2.1.1 Rice

Rice (*Oryza sativa*) is a major food grain for billions of people in the tropics, particularly in Asia. . During the milling of paddy rice to polished rice, several by-products are obtained. Of which, rice bran and broken rice are good sources of carbohydrates for use in poultry diets.

a) Rice bran

Good quality rice bran can replace the expensive cereal grains in animal feeding. In Laos, rice bran is widely used in poultry feeds. In rural areas, households mix the rice bran with other ingredients and feed their birds.

Rice bran comprises of the pericarp, the aleurone layer, the germ and some of the endosperm, and it contains about 120 – 145 g crude protein/kg, 110-180g fat/kg which increase its energy value (McDonald et al., 2011). Crude protein content of Lao rice bran is reported to range between 86 to 90 g/kg (Table 2.7). Furthermore, it is rich in B-vitamins (Blair, 2007). According to Samli et al. (2006), its nutrient density and profiles of amino acids and fatty acids are superior to cereal grains. However, the chemical composition of rice bran varies widely, depending on a number of factors.

Table 2.7 Chemical composition of rice bran from Laos, g/kg on dry matter basis

	Khoutsavang (2005)	Keoboualaphet & Mikled (2003)
Dry matter	904	858
Crude protein	102	86
Crude fibre	279	119
Ash	108	131
Calcium	4	7.8
Phosphorus	7	7.8

However, the use of rice bran in poultry diets is limited by the presence of number of limiting factors, especially oxidative rancidity, trypsin inhibitors and high amounts of phytate. Lipoxidases are enzymes that promote oxidation of unsaturated fatty acids, and the resultant rancid feeds are unpalatable and potentially toxic. Under hot and humid conditions, rice bran becomes rancid, which results in unpleasant taste and odour, and reduced palatability (Blair, 2007).

Heat treatment of rice bran improves its feed value by inactivating the lipoxidases and trypsin inhibitors. According to Chae et al. (2002), rancid rice bran causes negatives effects on the growth performance of broilers. To stabilize rice bran from oxidative rancidity, Randall et al. (1985) reported that heat processing must be applied as soon as possible after milling and should be heated up to 130-140 ^{0}C and held at 97-99 ^{0}C before cooling. Most of the phosphorus in rice bran is in the form of phytic acid that reduces the availability of phosphorus and several other minerals, and also of

amino acids (Warren & Farrell, 1991). However, Farrell (1998) reported that this limitation can be partly overcome by the supplementation of phytase enzyme to diets containing rice bran. Dadang (2006) found that supplemental phytase improved the dry matter digestibility and increased the apparent metabolisable energy (AME) in laying hens. Alternatively, animal proteins, such as fish meal, could improve the feed value of rice bran. Martin et al. (1998) reported that the supplementation of small amount of fish meal improved the performance, digestibility of some amino acids and mineral retention in ducklings fed diets containing rice bran.

According to Farrell (1994), rice bran can be included in broiler diets up to 200 g/kg with no adverse effects on performance. Diets up to dietary levels of rice bran can replace part of the grain component up to 200-350 g/kg in diets for laying hens (Ravindran & Blair, 1991; Dadang, 2006).

b) Broken rice

Broken rice is separated after the polishing stage and therefore has the same chemical composition as polished rice. Broken rice is highly palatable and has a high energy content and low fibre content (Table 2.8), which makes it a good energy source for poultry. According to Ravindran & Blair (1991), broken rice and maize have similar nutritive values and broken rice can be used for all classes of poultry when the price is reasonable.

Table 2.8 Chemical composition of broken rice from Laos and Thailand, g/kg on dry basis

	Khoutsavang (2005)	Chittavong (2007)	Chumpawadee et al. (2007)
	Laos	Laos	Thailand
DM	850	869	910
CP	83	57.4	71.9
CF	12.5	27.8	N/A
Ash	11.4	8.1	27.9
Ca	3.3	N/A	1.8
P	5.8	N/A	5.4

According to Wan Zahari & Wong (2009), broken rice can replace maize-soybean meal diets at levels of 600 g/kg in both broiler and layer diets. However, there is one report showing that the inclusion of broken rice in layer diets at more than 200 g/kg decreased egg production (Tyagi et al., 1994).

2.2.1.2 Maize

Maize (Z*ea mays* L.) is grown for human consumption and export in Laos. Yellow varieties are grown mainly for exports as grain for animal feed to neighbouring countries (Thailand, Vietnam and China).

Maize is the major source of energy in poultry feeds worldwide. The metabolizable energy of maize is generally considered as a standard for energy sources (Ravindran & Blair, 1991). It contains about 730g starch/kg and highly palatable and digestible for poultry (Ravindran & Blair, 1991). Although it is an excellent source of energy, it is low in protein and the proteins are poor quality (McDonald et al., 2011). Maize, like other grains, is also relatively low in calcium, but the problem of low protein and calcium can be solved by considering these in feed formulations. Maize can be included in poultry diets without any restriction.

Maize is susceptible to a number of mycotoxins, particularly aflatoxins. These toxins can adversely affect poultry performance. Thus proper drying and storage of maize is critical.

2.2.1.3 Cassava

Cassava (*Manihot esculenta Crantz*) is the third most important crop after rice and maize in Laos. Farmers grow cassava as a subsistence crop in rural areas. Recently, due to the promotion of Lao-Indochina group public company, cassava cultivation area in Laos has increased significantly. The tubers are harvested and used for starch production, but the leaves are left in the field as crop residues.

Cassava grows well in tropical condition and produces high yield. Thailand is the world's leading cassava exporter (Ravindran & Blair, 1991). Cassava tuber meal contains high energy, but low in protein, fat, minerals and vitamins. The carbohydrate of cassava is an excellent digestible starch. The chemical composition of tubers varies with maturity, cultivar and growing conditions (McDonald et al., 2011). The most common feed materials produced from cassava tubers are root chips and pellets.

The major constraint to the use of cassava in animal feeds is its cyanide content. Fresh cassava has hydrocyanic acid (HCN) content ranging between 15-400 mg/kg (Ravindran & Blair, 1991). However, cyanide content in cassava differs among cultivars, and is also dependent on many other plant factors. According to Sarouen (2008), the moisture content of cassava tuber should be reduced around 10% before storage or feeding poultry. The HCN content in cassava products can be reduced by boiling, sun-drying or ensilage.

Properly processed cassava meal can be fed to broilers at a level of 500 g/kg without any adverse effects (Panigrahi et al., 1992). In layer diets, the use of 300 g/kg cassava starch was comparable to the conventional maize-soybean meal diet, but layer performance was lower when included at levels of more than 450 g/kg (Wan Zahari & Wong, 2009). Aderemi et al. (2012) concluded that whole cassava meal could replace the maize in layer diets at levels up to 250 g/kg without adverse effects on performance characteristics and egg quality.

2.2.1.4 Sweet potato

Sweet potato (*Ipomoea batamas*) is produced in Laos mainly for home consumption and for extra income in rural areas. Sweet potato starch is highly digestible. Fresh tubers are cut into small pieces, sun-dried and then ground to produce the sweet potato meal (McDonald et al., 2011). Ravindran & Blair (1991) reported that the chemical composition of sweet potato tuber meal is similar to that of maize (Table 2.9).

Some farmers feed sweet potato tubers to poultry in the fresh form, but raw tubers contain some anti-nutritional factors, particularly trypsin inhibitors, which have negative effects on protein digestibility (Gerpacio et al., 1978). According to McDonald et al. (2011), sun-drying does not destroy the trypsin inhibitors. However, according to Sasi Kiran & Padmaja (2003), these can be minimized by cooking and processing into flour. The results show that when the sweet potato tuber was cooked 17-31% of the trypsin inhibitor activity remained and when it was prepared into flour only 5-12% trypsin inhibitor activity was found.

Ravindran & Sivakanesan (1995) found that sweet potato meal can replace up to 400g/kg maize in broiler diets without negative effects on performance. In addition,

replacing 334.3 g maize/kg with sweet potato did not significantly affect the performance of chickens (Job et al., 1979).

2.2.1.5 Taro

Taro (*Colocasia esculenta* (L.) Schott) or Old Cocoyam is a wetland crop in many tropical and subtropical areas of the world, cultivated mainly for its corm. In Laos, taro corms are eaten boiled in rural areas and are also processed as an ingredient for the food industry. Due to their oxalate content, taro corms should be cooked or soaked before feeding to animals (Buntha et al., 2008). Taro also contains enzyme inhibitors (antitrypsic factors) and saponins. These toxicants can be removed or reduced by cooking. Therefore, raw taro corm meal is not a good feed ingredient for poultry and is an inferior substitute for maize.

Raw taro corm meal fed at 100 g/kg in broiler diets for starting chicks severely reduced feed intake and growth (Samarasinghe et al., 1992). This problem was overcome by boiling the corms and it was possible to include it at 100 g/kg level with no adverse effects (Ravindran et al., 1996). Raw sun-dried corms could replace 250 g/kg of maize (120 g/kg of the diet) while boiled corms could replace up to 500 g/kg of maize (240 g/kg of the diet). Live weight and carcass yield of birds fed taro diets were lower than for the control, which was attributed to the presence of anti-nutritional factors (Abdulrashid et al., 2009). Processing the corms by drying, grinding and boiling increases their nutritive value, but even in processed form taro corms cannot replace more than 50% of the maize in the diet without negative performance.

2.2.1.6 Banana

Bananas (*Musaceae spp*) are grown in almost all home gardens in the Asian countries. India, Philippines, China, Indonesia, Thailand and Vietnam are major producers and grow them on commercial basis for exports (Ravindran & Blair, 1991). The banana is picked green and ripened in sheds. It has been estimated that 30-40% of the total banana production are rejected for failing to meet quality standards and therefore are potentially available to livestock. Fresh bananas have high water content (780–800 g/kg), with the dry matter consisting mainly of starch (720 g/kg) which turns into simple sugars during ripening (Babatunde, 1992). Green bananas can be dehydrated and ground into meal, but its feed use is limited because of its astringent taste and poor palatability resulted from the presence of 50-80 g/kg hydrolysable tannins (Ravindran & Blair, 1991).

Cooking the unripe fruit before dehydration can solve the palatability problem. Peel removal can also enhance the feed value of banana meal owing to high concentration of tannins in the peel. Drying of green bananas, however, does not significantly change the poor quality of the product. Early research suggested that banana meal can be used in poultry diets but not more than 50 or 100 g/kg of the grain content should be replaced by the banana meal; higher levels will have detrimental effects on growth and feed efficiency (Göhl, 1975). A recent study by Saroeun et al. (2010) showed that local chickens with free access to various sources of carbohydrates (broken rice, cassava roots, sweet potato tubers and ripe bananas) preferred other feeds over banana.

Table 2.9 Nutrient composition and metabolizable energy (ME) values of energy feeds in Asia and the Pacific area (dry matter basis)

Feedstuff	Crude protein (g/100 g)	Crude fat (g/100 g)	Crude fibre (g/100 g)	Ash (g/100 g)	NFE (g/100 g)	Calcium (g/100 g)	Phosphorus (g/100 g)	ME (kcal/g)
Cereals and by-products:								
Ground maize	9.0	4.0	2.5	1.5	83.0	0.02	0.25	3.45
Rice, unmilled grain with husk (paddy)	8.0	2.0	10.0	6.5	73.5	0.04	0.20	2.55
Rice, grain, broken	7.0	2.5	3.0	3.5	84.0	0.05	0.30	3.25
Rice, bran with germ, with polishings with broken grain, full-fat	13.0	13.0	13.0	12.0	49.0	0.07	1.30	2.85
Rice, bran with germ, with polishings with broken grain, solvent-extracted	18.0	1.0	19.0	14.0	48.0	0.10	1.70	2.20
Roots and tubers:								
Cassava root	2.5	1.0	2.5	1.5	92.5	0.10	0.15	3.45
Sweet potato tuber	6.0	1.0	2.5	3.0	87.5	0.15	0.20	3.50
Taro	8.5	0.5	3.5	4.0	83.5	0.40	0.40	2.95
Fruit:								
Banana fruit, green (unripe), peeled, dehydrated, ground	5.0	1.0	3.0	3.5	87.5	0.03	0.10	3.00

Source: Ravindran & Blair (1991).

2.2.2 Protein sources

2.2.2.1 Soybean

Soybean (*Glycine max*) is a rich source of protein used in the feed formulation for all animal species. In Laos, soybeans are grown in several areas; the major soybean producing areas are located in northern region. Whole soybeans contain not only high-quality protein (380-420 g/kg), but are also a rich source of energy due to an oil content of 180-220 g/kg (Waldroup, 1982). Thus, they have the potential of providing both energy and protein for all classes of poultry and properly processed soybean meal can be included in poultry diets without restriction on its use (Ravindran & Blair, 1992).

Table 2.10 Average chemical composition of soybean meal with different crude protein, (g/100 g DM)

Item	Moisture	Crude protein	Crude fat	Crude fibre	Ash
SBM 44[b]	12.8	49.8	2.04	6.01	7.50
	11.0[a]	49.4	0.90	7.87	
SBM 48[c]	11.9	52.8	1.53	3.61	6.94
	10.0[a]	53.9	1.11	4.33	

Note: [a] Document values (NRC, 1998); [b] 44% crude protein soybean meal; and [c] 48% crude protein soybean meal.

Source: Adapted from Barbour et al. (2008)

Soybean meal has an excellent amino balance. It is a good source of lysine, tryptophan, threonine and isoleucine, but deficient in methionine for poultry (McDonald et al., 2011). This problem can be solved by the inclusion of synthetic methionine (Waldroup & Smith, 2008, cited by Heuze et al., 2012). Like other legume seeds, soybean contains several anti-nutritional factors, such as trypsin inhibitor, saponins and oligosaccharides that can negatively affect protein digestion and bird performance. However, these inhibitors can be minimized by heat during the processing of soybeans (Liener, 1979). But an excess of heat increases the incidence of Maillard reactions that inevitably occurs between the amino groups of the amino acids and the reducing sugars present in the meal (Quin et al., 1998).

Heuze et al. (2012) concluded that the soybean meal inclusion levels range from 250 g/kg in chicks to 300-400 g/kg in broilers, breeder and laying hens. According to Senkoylu et al. (2005), full-fat soybeans can be used in layer diets up to the inclusion level of 220 g/kg.

2.2.2.2 Cottonseed

Cotton (*Gossypium* spp.) has been produced in Laos for centuries, mostly on a small scale for use by the households who transform the fibre into cloth material. It is well integrated into farming systems that have rice as the major crop. When processed, the typical yields from 1 kg of cotton seed are 520 g meal, 230 g hull, 170 g oil and 80 g linters (Ravindran & Blair, 1992).

Cottonseed meal (CSM) is the residue of cottonseed oil extraction; it is a good source of protein ranging from 222.0 to 560.2 g/kg and contains metabolisable energy ranging from 7.4 to 11.99 MJ/kg (Nagalakshmi et al., 2007). But, compared to soybean meal, cottonseed meal has lower protein content and a lower metabolisable energy (Ravindran & Blair, 1992).

The use of CSM in poultry diets is limited due to the presence of gossypol, cyclopropenoid fatty acids (CPFA), high fibre and poor protein quality (Nagalakshmi et al., 2007). The toxic effects of gossypol vary depending on the animal species, source of gossypol, level of consumption, period of consumption, age of the animal, and stress conditions. The two most important factors considered when evaluating CSM for poultry nutrition are free gossypol levels and protein quality (Gamboa et al., 2001). However, iron supplementation in the form of ferrous sulphate can minimize the biological effects of gossypol (Waldroup, 1981, cited by Ravindran & Blair, 1992). Moreover, Nagalakshmi et al. (2007) concluded that the addition of synthetic lysine to CSM based diets could overcome the detrimental influence on poultry.

According to Ravindran & Blair (1992), CSM can be used in broiler the diets containing lysine-rich supplements, replacing up to 400 g/kg of the protein of soybean meal in broiler diets without any negative impact. Panigrahi et al. (1989) found that CSM could be included in layer diets up to 75 g/kg.

2.2.2.3 Cassava leaves

Cassava leaves are by-products after tuber harvesting. According to Eggum (1970), cassava leaves can be turned into a useful ingredient because of their moderately high protein and mineral contents (Ravindran et al., 1982).

In Laos, cassava leaves are not used for feeding poultry. Some farmers use fresh or dried leaves to feed ruminants. Research in Laos showed that cassava leaves contained 252 g/kg on dry matter basis (Inthaphanya, 2012).

Table 2.11 Chemical composition of cassava leaves in Laos (dry matter basis)

Item	Percentage
Dry matter	33.4
Ash	5.88
Crude protein	25.2
Solubility of N, %	32.5

Source: Inthapanya (2012).

Cassava leaf meal contains the two cyanogenic glucosides, such as linamarin and lotaustralin; high levels of cyanogenic glucosides are found in fresh cassava leaves (Lancaster & Brooks, 1983), and six times higher than cassava roots (Yeoh & Oh, 1979). However, Ravindran et al. (1987) suggested that cyanide content of cassava leaf meal can be reduced by simple processing techniques. Drying cassava leaves after chopping and wilting is an effective way to minimize the cyanide content.

Another limiting factor in cassava leaves is high tannin content ranging from 30 to 50 g/kg DM (Ravindran, 1993). The tannins are combined with protein to form indigestible complexes, which cause low feed intake and performance in animals (Barry & McNabb, 1999). However, according to Borin (2005), the results show that drying and ensiling cassava leaves resulted in reduced tannin contents.

2.2.2.4 Sesame meal

Sesame (*Sesamum indicum*) is produced by small farmers in Laos. Sesame oil is extracted from sesame seeds by hand operated or electric press. The average protein content of sesame meal is about 400 g/kg, and fibre content is around 100 g/kg, but these values vary depending on several factors, such as the variety, degree of

decortication and method of processing. In addition, sesame meal is an excellent source of methionine, cysteine and tryptophan, but is deficient in lysine. The inadequacy of lysine limits the use of sesame meal as the sole source protein in poultry diets (Ravindran & Blair, 1992). Although sesame meal has calcium content ten times higher than that of soybean meal, because of the presence of high levels of oxalates and phytate in the hull fraction of the seed, mineral availability in sesame meal is lower (Ravindran & Blair, 1992).

Table 2.12 Chemical composition (g/100 g air dry basis) of local sesame meal compared to NRC (1994)

Item	Local[1]	NRC (1994)
Crude protein	35.7	43.8
Ether extract	24.7	8.6
Crude fibre	12.1	9.7
Ash	9.4	NA
Metabolisable energy (kcal/g)	2.9	2.2

[1]**Source**: Adapted from Cheva-Isarakul & Tangtaweewipat (1993).

Improvement of mineral availability, decrease in the fibre content, and increase in the protein level and palatability can be achieved by the removal of hull fraction. In addition, the deficiency of lysine can be overcome when poultry diets are supplemented with lysine or mixed with high-lysine ingredients, such as soybean meal or fish meal (Ravindran & Blair, 1992). Sesame seed meal (SSM) could be included up to 94g/kg in the broiler diets. Inclusion above this level resulted in poor performance (Kaneko et al., 2002).

2.2.2.5 Coconut meal

Coconut (*Cocos nucifera*) is a tropical crop. The major coconut producers are Indonesia, the Philippines, India, Brazil, Sri Lanka, Vietnam and Thailand.Coconut is dried to produce copra and the copra is processed into coconut oil and coconut meal. Some 350-400 g/kg by weight of copra remains as coconut meal after oil extraction (Ravindran & Blair, 1992). Copra normally has an oil content varying from 650 to 720 g/kg (Moorthy & Viswanathan, 2009). Coconut meal represents a potential source of protein in production areas where protein supply is usually a limiting factor in animal diets (Wingjosoesastro et al., 1971).

During the sun-drying process, split coconuts are susceptible to molds and subsequent aflatoxin contamination. It mostly occurs when the drying time is too short (2-3 days vs 5-7 days) or when the weather is wet (FAO/IAEA, 2001). In order to prevent mold growth, it is recommended not to use the coconuts that have been damaged during dehusking and to avoid contact between split coconuts and the soil as the latter it is a source of contamination. Copra meal should not contain more than 120 g/kg moisture and should be stored in a well-aerated place (FAO/IAEA, 2001). Coconut meal contains 200-220 g crude protein/kg with low concentrates of essential amino acids (Table 2.14). Lysine, in particular, is extremely deficient for poultry. The ME content of coconut meal is also low due to its high fibre content (Table 2.13). The successful use of coconut meal in poultry diets requires the inclusion of supplementary lysine or such supplements as fish meal or soybean meal which are rich in available lysine (Ravindran & Blair, 1992).

Table 2.13 Nutrient composition and metabolizable energy (ME) values of energy feeds in Asia and the Pacific area (dry matter basis)

Feedstuff	Crude protein (g/100 g)	Crude fat (g/100 g)	Crude fibre (g/100 g)	Ash (g/100 g)	NFE (g/100 g)	Calcium (g/100 g)	Phosphorus (g/100 g)	ME (kcal/g)
Soybean meal	42.0	6.0	8.0	6	38.00	0.20	0.60	2.40
Soybean meal, dehulled, solvent	45.0	2.0	5.0	6.0	42.00	0.20	0.60	2.50
Cottonseed meal	38.0	6.0	14.0	6.0	36.00	0.15	1.10	2.00
Groundnut meal, dehulled	44.0	7.0	13.0	6.0	30.00	0.15	0.60	2.30
Coconut meal	21.0	8.0	14.0	8.0	49.00	0.30	0.60	1.90
Sesame meal, partially dehull	40.0	6.0	8.0	12.0	34.00	2.00	1.30	2.00
Leucaena, leaflets, dried, meal	22.0	4.0	15.0	9.0	50.00	1.40	0.20	0.90
Cassava, leaves with petiole, dried, meal	21.0	5.5	20.0	8.5	45.00	1.40	0.40	1.80
Fishmeal	62.0	10.0	1.0	20.0	-	5.00	3.00	2.85
Snail meal	60.0	6.0	4.0	10.0	-	2.00	1.00	3.40

Source: Ravindran & Blair (1992; 1993).

Table 2.14 Essential amino acid composition (g/100g protein) of selected protein sources

	Arginine	Cysteine	Glycine	Histidine	Isoleucine	Leucine	Lysine	Methionine	Phenylalanine	Threonine	Tryptophan	Tyrosine	Valine
Soyabean meal	8.3	1.0	4.5	2.9	5.6	8.2	6.8	1.4	4.9	4.0	1.4	4.2	5.2
Cottonseed meal	11.1	1.5	4.1	2.8	3.2	5.8	4.2	1.3	5.6	3.2	1.2	2.5	4.6
Groundnut meal	11.0	1.6	6.0	2.4	3.8	6.5	3.6	1.1	5.2	2.8	1.0	3.9	5.3
Coconut meal	11.6	0.9	4.2	2.1	3.0	6.0	3.0	1.5	4.1	3.0	1.0	2.2	4.7
Sesame meal	12.8	2.2	5.3	2.8	3.8	7.6	3.0	3.2	5.5	3.9	1.5	4.5	4.8
Cassava leaf meal	5.3	1.2	7.0	2.0	4.5	8.2	5.9	1.5	5.4	4.4	2.0	5.4	5.6
Leucaena leaf meal	4.4	0.7	4.4	1.7	5.3	6.8	5.5	0.9	4.6	3.7	1.0	3.4	4.2
Fishmeal	5.2	1.0	4.5	3.0	5.6	8.2	6.8	1.4	4.9	4.0	1.4	4.2	5.5
Snail meal	8.0	1.0	6.2	2.3	4.2	7.5	7.2	1.7	4.2	4.6	1.4	3.9	5.1

Source: Ravindran & Blair (1992; 1993).

2.2.2.6 Fish meal

Fish meal is produced by cooking the fish and then pressing the cooked mass to remove the oil and water. The dried product is ground so that less than 10 per cent passes a 1 mm screen and more than 90 per cent passes a 10 mm screen (McDonald et al., 2011). Fishmeal is an excellent animal protein source because of its availability and high crude protein and amino acid contents, particularly lysine, cysteine, methionine and tryptophan. It is also a rich source of calcium, phosphorus and a number of trace minerals, including manganese, iron and iodine (McDonald et al., 2011). It is also a good source B complex vitamins and essential fatty acids, and highly palatable to poultry (Ravindran & Blair, 1993). The contents of protein in fishmeal vary between 500-750g/kg depending on the fish species.

The amount of fish meal to be included in poultry diets depends on the composition of the diet (Gohl, 1975). The cost of fishmeal is another important factor to be considering its use. Gohl (1975) summarized that fish meal can be included in chick diets at 100 g/kg, 80 g/kg in finisher diets and 50-60 g/kg in layer diets. Higher levels must be avoided in finisher and layer diets, as it may cause a fishy flavour to meat and eggs.

CHAPTER 3

A SURVEY OF COMMERCIAL LAYER PRODUCTION SYSTEMS IN LAOS

3.1 Background

Commercial layer operations in Laos are still in their infancy. Eggs from backyard chickens remain an important source of animal protein in rural areas of Laos, but their contribution to the national egg supply is small. Currently, most commercial layer farms are of small- and medium-scale, with flock sizes ranging from 500 to 6,000 birds. Some large-scale farms, operated by multi-national companies, have flock sizes of 20,000 birds or more. The small- and medium-scale layer operations are self-funded. Most farmers obtain loans from government banks at a high rate of interest to invest in their businesses.

The present study was initiated with the objective of obtaining baseline information on specific aspects of production systems and productivity in small- and middle-scale commercial layer operations in Laos. It was envisaged that the final outcome would be the identification of constraints faced by layer producers and of areas for possible improvement.

3.2 Methodology

3.2.1 Study area

The survey covered layer farms in the province of Vientiane Capital, Laos. Vientiane is the capital of Laos situated in middle part of the country as shown in Figure 3.1. This province has nine districts, namely Chanthabouly, Sisattanak, Sikhottabong, Xaysetha, Xaythany, Hatsayphong, Naxaithong, Sangthong and Pakngum districts (Figure 3.2). Vientiane Capital was selected as the target area owing to the presence of established small- and medium-scale commercial layer farms. The province has well a developed road network, providing easy access to inputs and markets.

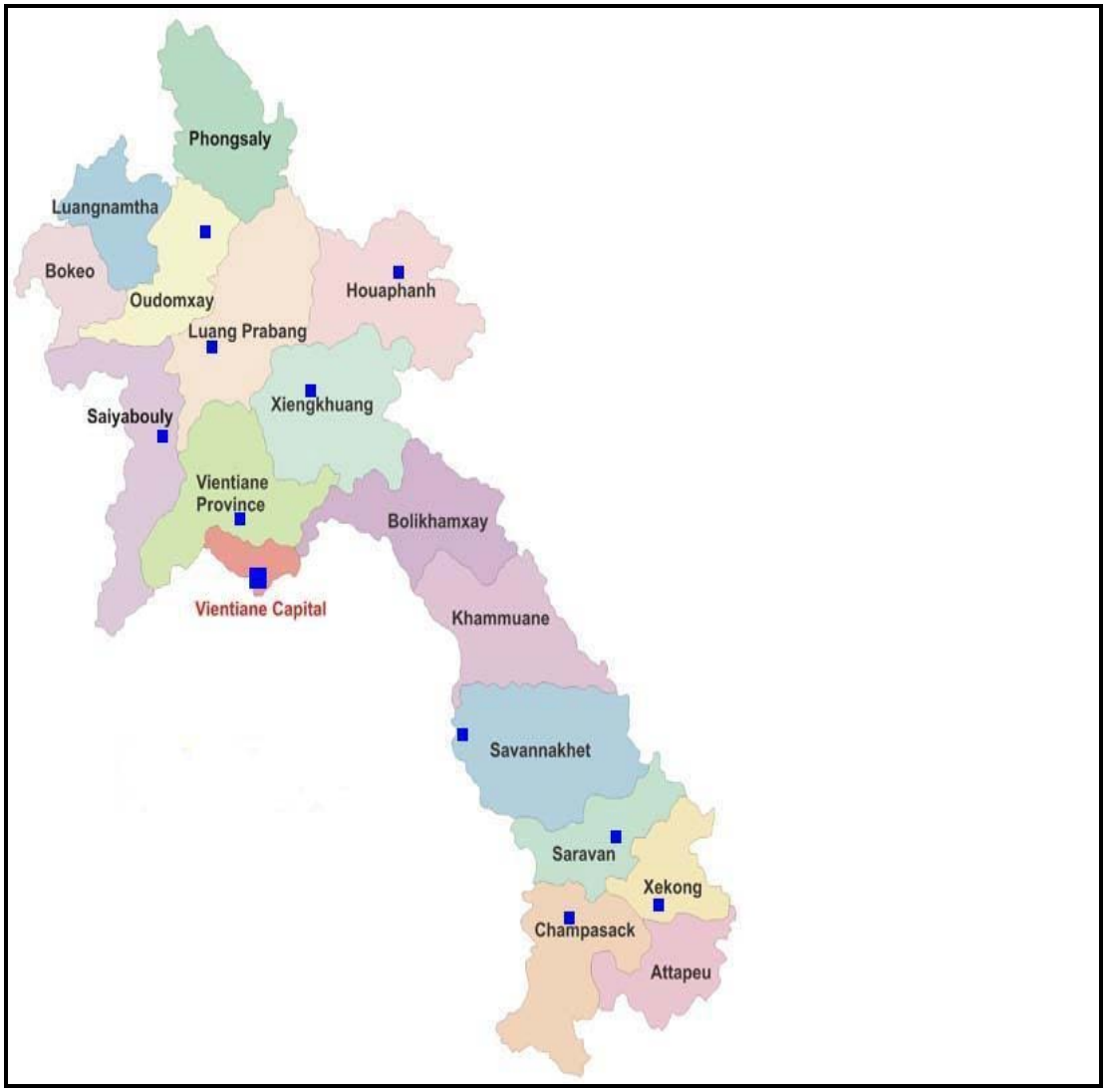

Figure 3.1 Map of Laos, showing the location of Vientiane Capital.

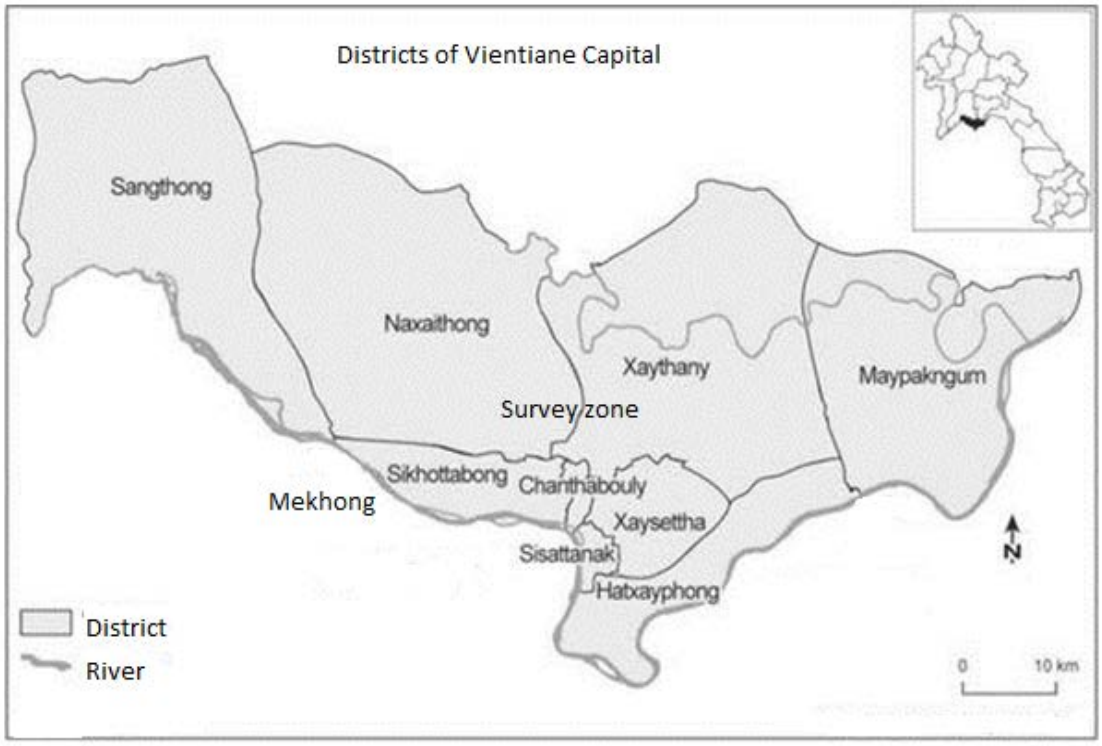

Figure 3.2 Districts of Vientiane Capital.

3.2.2 Preparatory phase

A list of all commercial layer farms in the Vientiane Capital was obtained from the Department of Livestock Production, Ministry of Agriculture and Forestry. Farms located in Xaythany and Naxaithong districts (Figure 3.2) were chosen for the survey, because layer farms are concentrated in these districts. In 2013, there were 121 layer farms in Vientiane Capital, 64 of which are in the Xaythany district and 48 in the Naxaithong district.

Flock sizes between 500 to 5,000 birds were intentionally chosen to represent the small- and medium-scale commercial units. Twenty five layer farms from Xaythany district and ten layer farms from Naxaithong district were then randomly selected as representative samples for the survey.

Before the start of the survey, explanation was given to the officials at the Agricultural Office at the district level to understand the objectives of the study. The

information about the history and infrastructure of the target areas were provided to the interviewer. Moreover, to gain the cooperation of farm owners, the letters of permission were obtained from the Senior Official of respective districts.

3.2.3 Survey phase

The survey was conducted over a 2-month period, during May-July 2013. A single visit, lasting 2-3 hours, was made to each farm. The farm owner was the supposed interviewee, but in cases where the farm used hired labour, both were interviewed – first with the hired labour and then with the owner. The individuals were requested to avoid giving inaccurate answers, when they do not know the answer. Moreover, the farmers were asked whether they have spare time or difficulties in responding to the survey. Anyone with difficulties was not included in the survey.

a) Pre-test phase

Before conducting the actual fieldwork, pre-test interviews were conducted to gain experience and background knowledge of the production systems, and to understand potential problems that may be experienced. The questionnaires were pre-tested in two layer farms. The survey format was then improved in close collaboration with the supervisor (Professor V. Ravindran) prior to the start of the survey. Minor revisions were made as the result of pre-testing. Data from pre-testing were not included in the results. The final version of the questionnaire is provided in Appendix 1.

b) Data collection

The data was collected by a combination of interview and observations. The schedule (date and time) for the visit was first set up with the farmer. Information was collected by the use of questionnaire during the interview. The farm environment was explored, with the permission of the farmer, for at least 30 minutes. Further information was gained through questions during this observation period. If the visit set for the interview was cancelled due to some reason, the interview was re-scheduled.

c) Interview

Interview is a method that an interviewer asks questions to an interviewee for the purpose of collecting data. Semi-structured interviews were conducted; the interviewer asked the questions and then allowed the interviewee to do most of the talking. The interviews were carried out as face-to-face meetings. The objectives of face-to-face conversation of interviewing are not only to get answers to the questions, but also to get the necessary clarifications from them. Each interview lasted for at least two hours.

d) Observations

Observation is a useful tool to acquire qualitative information. Careful observations of farm surroundings and questions to farmers while exploring the farm give further insight of the production system. Observations were made without or with the participation of farmers. Observations without interaction were used to ensure that the answers given are correct. For example, the commercial feeds or local feedstuffs that were used in the farm. The interaction with the farmer was useful to obtain additional clarifications.

3.2.4 The questionnaire

The farmers were asked to provide the information for the previous production year (2012). The questions were presented in two different forms: multiple choice and open-ended questions. With multiple choice questions, questions were asked with a list of possible answers. The questions were read to the farmers and the answers were marked. Open-ended questions were also read to the farmers and their answers were recorded exactly as provided.

The questions were grouped into the following categories: (i) demographic details; (ii) breeds and sources; (iii) management systems; (iv) labour; (v) disease and control; (vi) production parameters; (vii) sales and marketing; (viii) income; (ix) cost of production; (x) extension services; (xi) farmer attitude; and (xii) any other comments. The details are presented in Appendix 1.

3.2.5 Data analysis

After the survey, the questionnaires were collated at Massey University for the analysis and tabulation. Data were sorted and frequency of distribution was calculated. Hen-day production and feed conversion ratio were calculated. Percentage hen day production was calculated by dividing the number of eggs produced for the particular day by the average number of hens and then converting to a percentage. Number of hens in a farm was calculated by averaging total number of hens at the start of the month of survey and at the end of the month. Feed conversion ratio was calculated by dividing the total feed intake of the flock by the total number of eggs produced per year.

3.3 Results

A total of 35 farmers from 11 different villages of Xaythany and Naxaithong districts were interviewed.

3.3.1 Demographic details

a) Age profile

The age profile of the producers is shown in Table 3.1. All producers were over 30 years of age. The age ranges of 31-40 and 41-50 were 31.4 and 20.0%, respectively, of the respondents. Almost half the producers were over 50 years of age.

b) Gender profile

Two-thirds of the producers were males and one-third was females (Table 3.1).

c) Family size

Families with more than 5 people comprised 60%, while families with 4 and 5 people were 28.6 and 11.4%, respectively. In some households, more than one family was living together, especially grand-parents with their children and grand-children, which is typical in most households in Laos.

d) Level of education

The results showed that most interviewees (45.7%) have achieved secondary school qualification and only 14.3% had tertiary education. 28.6% completed primary education, whereas 11.4% had no education.

Table 3.1 Age profile, gender profile and experience in egg production of the producers[1]

Description	Percentage (%)
Age range	
31-40	31.4
41-50	20.0
>50	48.6
Gender	
Male	77.25
Female	22.75
Number of years involved in layer production	
<1	8.6
1-2	11.4
3-5	57.1
6-10	22.9

[1] Total number of farmers interviewed = 35.

e) Number of years involved in commercial egg production

All farms were in operation for less than 10 years (Table 3.1). Majority of farms (57.1%) has operated the business between 3 to 5 years.

f) Special training

Half the farmers (48.6%) had no training in poultry production. The balance (51.4%) only had general knowledge about chicken production and this was obtained from other producers, friends and meetings organised by district authorities.

g) Labour

Majority of the farms (62.9%) used only the family labour, while 14.3% used only the hired labour. About 30% of the farms used both family and hired labour. Of all the labour in the farms surveyed, 20-50% was female labour. Most farms used children as part of the labour force, but usually during non-school time and school holidays. In general, farms with small flock sizes tended to use more family labour while farms with larger flock sizes used more hired labours.

3.3.2 Production systems

a) Flock size

Flock size in individual farms differed markedly (Table 3.2).

b) Replacement stock

Replacement pullets are introduced into layer cages around 16-18 weeks of age. The hatcheries raise the pullets until 16 weeks and sell them to farmers. Some hatcheries are run by local businesses, while some are multi-national Thai companies. There are two large Lao companies (Thongkham and Phoukhong) that supply layers to farmers, while Charoen Pokphand (CP) Laos is the biggest Thai company.

c) Breed

Brown Nick, a strain sourced from H & N International Gmbh (Cuxhaven, Germany) and marketed by CP, was the breed used in all layer farms.

d) Housing

All (100%) farms used open sided houses and cages. On average, 3-4 birds were housed per cage. In general, one-tier cages with a total area of 1,350 cm^2 per cage were used. Cages were made of wood and steel. In some farms, poultry-fish integration was practiced, with layer sheds with slatted floor located above fish pond. This practise has number of advantages. To the fish culture, it reduces the costs on fertilizers and feeds and maximizes benefits. To the layers, it maximises the use of space, saves labour in transporting manure to the ponds and the poultry house is more hygienic.

e) Ventilation

Majority of farms were naturally ventilated. Only 11.4% of farms used electrical fans for ventilation.

f) Source of water

All farmers were dependent on ground water for the supply of water. Water was pumped and stored concrete or plastic tanks.

Table 3.2 Flock size and production parameters in the surveyed layer farms

Farm No.	Flock size	Hen-day production	Egg per bird per year	Feed per bird per day	Feed per dozen eggs	% Mortality
1	1,200	0.75	274	104	1,664	11
2	1,500	0.60	219	85	1,700	19
3	3,500	0.70	256	94	1,611	10
4	1,700	0.70	237	109	2,012	9
5	4,500	0.56	204	77	1,650	11
6	1,650	0.50	183	85	2,040	7
7	2,700	0.75	274	90	1,440	12
8	1,700	0.60	219	110	2,200	13
9	3,400	0.65	237	92	1,698	9
10	2,500	0.50	183	83	1,992	10
11	4,200	0.60	219	75	1,500	9
12	1,200	0.60	219	82	1,640	12
13	3,500	0.80	292	122	1,830	11
14	1,500	0.50	183	72	1,728	8
15	3,800	0.60	219	100	2,000	18
16	500	0.65	237	130	2,400	12
17	1,000	0.70	256	90	1,543	12
18	700	0.60	219	88	1,760	8
19	3,000	0.70	256	108	1,851	13
20	1,500	0.65	237	87	1,606	9
21	2,100	0.75	274	114	1,824	8
22	850	0.75	274	95	1,520	15
23	3,000	0.65	237	110	2,031	10
24	1,600	0.70	256	96	1,646	9
25	2,500	0.80	292	88	1,320	12
26	1,800	0.75	274	90	1,440	12
27	1,300	0.65	237	115	2,123	10
28	4,000	0.75	274	132	2,112	8
29	2,000	0.75	274	150	2,400	10
30	1,300	0.80	292	109	1,635	8
31	3,200	0.60	219	104	2,080	12
32	2,200	0.60	219	75	1,500	9
33	4,800	0.75	274	103	1,648	8
34	1,000	0.65	237	150	2,769	7
35	2,500	0.60	219	73	1,460	15
Mean±SD	2,269±1,158	0.66±0.1	242±31	100±20	1,811±321	11±3
Range	500-4,800	0.50-0.80	183-292	72-150	1,320-2,769	7-19

3.3.3 Feed

a) Source and type of feed

The preference of farmers was to use commercial feeds. Almost three-fourth (77.1%) of the farms bought commercial feeds. Only 22.9% of the farms used local feedstuffs and on-farm mixing. It was observed that all producers belonging to the ethnic group called Yao; they preferred to buy and mix local feedstuffs, such as rice bran and ground maize, on-farm. When on-farm mixing was used, the mixed feeds were often offered along with good quality commercial feed to increase the protein content of the mixture. All feeds were offered in mash form.

b) The potential available feedstuffs

There were number of feedstuffs available in the survey area and these are identified in Table 3.3. Although they have potential value as poultry feedstuffs, several factors limit their utilization at the commercial level. The major limitations are (i) lack of knowledge of the nutritive value, (ii) need for transportation from production areas, (iii) good facilities for mixing feed.

Table 3.3 The list potential feedstuffs available in the survey area

Feedstuffs
Energy sources: maize, broken rice, rice bran, cassava root, sweet potato tuber, taro corm, green banana, plantain and mango seed kernel.
Plant protein sources: soya bean, cassava leaf, leucaena leaf, coconut meal, cottonseed, sesame seed, palm kernel, kapok seed and groundnut.
Animal protein sources: snails, fish, meat and bone meal, blood meal, silkworm pupae, earthworms, termites and insect.

c) Vitamin and mineral supplements

All farms supplemented their diets with vitamins and minerals. These supplements were given with water in most (68.6%) of the farms. In the balance 31.4% of the farms, vitamins and minerals were added to the feed.

3.3.4 Production parameters

a) Hen-day production

Hen day egg production ranged between 0.50 and 0.80 (Table 3.2). Hen day egg production in 60% of the farms ranged between 0.65 and 0.80.

b) Egg per bird per year

Annual egg production ranged widely between 183 and 292 per bird. In 42.8% of the farms, egg production was over 250 eggs per bird per year, while only 8.6% produced less than 200 eggs per year. In most farms (71.4%), eggs were collected twice a day.

c) Feed intake per bird

Daily feed intake per bird varied between 72 and 150 g. Majority of the birds (54.3%) consumed less than 100 g per day.

d) Feed conversion ratio (feed/dozen eggs)

Data showed considerable variation in feed conversion ratio (Table 3.2), which ranged from 1.32 to 2.77 kg feed to produce a dozen eggs. On average, 1.81 ± 0.32 kg feed was required per dozen eggs. Almost half the farms (45.7%) reported feed conversion ratio 1.5 and 2.0 kg feed per dozen eggs.

e) Months of maximum and minimum egg production

Not all the farmers were able to give the answer about the season of maximum egg production. A third of the farmers indicated that dry season was the period of maximum while a third identified egg production was lower during the rainy season.

f) Culling of layers

In general, birds were culled after 18 months of production when egg production rate drops less than 50%.

3.3.5 Diseases

Diarrhoea was the main disease condition and it was reported in all farms. The symptom was yellow foamy droppings and it is usually prevalent during the rainy season (April to August). During the dry season (November to February), the birds are affected by respiratory diseases due largely to change of seasons. Almost half the farmers reported that their birds usually cough during this period. Bird flu is another major disease that can be fatal.

The diarrhoea is treated by adding drugs to feed and water. All farms regularly vaccinated the birds for bird flu and Newcastle disease regularly. Vaccines and drugs were obtained from a variety of sources. 71.4% of the farmers bought from local markets, 17.1% through local agents, 8.6% from Thailand and 2.9% from the Government sources. All farms disinfected the poultry houses prior to bringing in new flocks.

3.3.6 Marketing

Eggs are usually sold in cartons. Prior to sale, farmers stored the eggs in the layer house (51.4%), small warehouses (40.0%) or home (8.6%). The eggs were sold through several avenues, including individuals, retailers, local markets and exporters.

3.3.7 Income

a) Price of egg

Farmers sold the eggs in cartons or trays, each containing 30 eggs. The price of eggs varied depending on the type of buyer. Prices paid by the individuals, retailers and in local markets were US$ 3.14, 2.92 and 3.12 per 30 eggs, respectively.

b) Other sources of income

Extra money was earned from the sale of chicken manure, spent hens and feed bags. The price of spent hen was US$ 3.63 per hen; while the income from chicken manure

and feed bags throughout a year of production was estimated to range from US$ 125 to 1,430 and 12.52 to 62.64, respectively.

3.3.8 Cost of production

Apart from capitol costs, the production cost included cost of pullets, electricity bill, wages (if labour was needed), and vaccines and medication. The price of pullet was US$ 6.3 per bird; the average expenditure of for vaccines and medication for one year production was US$ 282, and US$ 23 per month for utilities. For the farms that hire labours, labourers are paid from US$ 150 to 250 per month.

3.3.9 Extension services

None of the farmers had received extension support from the government, private companies or NGOs. Lao government currently has policies to promote agricultural production as a business. But there are no specific policies promoting egg production.

3.3.10 Problems and farmer attitude

Diseases were the major problem identified by all producers as the major constraint to expansion. Generally farmers were positive regarding the future of commercial egg production in Laos, with 68.6% indicating as good, and 11.4 as excellent. There are no cultural barriers in Laos towards chicken production.

Low price of eggs, high cost of production, and high interest rate on bank loans are the other limitations identified. The high costs of egg farming continue to pose a challenge, making it difficult to compete with the Laos CP Company in local markets. It was noted that the price of commercial feed, drugs and vaccine increase every year, while the price of eggs remain low. Sometimes, the price of eggs is very low as market had been oversupplied and as a result, some farms are forced shut down their operation. Most farmers struggle to repay the high interest on bank loans. Banks in Laos impose a

rate of 13 to 15 per cent a year, whereas banks in neighbouring countries, such as Vietnam and Thailand, charge only 3 to 5 per cent interest annually.

3.4 Discussion

The current survey provided baseline information of various aspects of small- to medium scale commercial layer operations in Vientiane Capital, Laos. Such information on production systems was not previously available. It is hoped that the output from the present study would be useful for use by the Government and relevant sectors to help farmers to improve their production.

The layer farms were small- to medium-scale commercial systems with the flock size from 500 to 4,800 birds. Therefore, it was not surprising that, in the two districts surveyed, all of the layer farms were owned by individuals. This survey found that almost half of respondents were over 50 years old. Generally males operated the layer farms, possibly because they were more educated than females. All farms used open-sided houses. Although this type of house allows good ventilation, some farms (11.4%) used electric fans per house for ventilation, which is especially useful in hot months. All farms used cages, each housing 3-4 birds.

The average annual egg production per bird in the surveyed farms was 242, which is similar to that reported (245) by Badubi & Ravindran (2004) for small-scale commercial farms in Botswana. The FCR of 1.81 kg feed was required to produce one dozen eggs, was also similar to the value of 1.75 reported by Badubi & Ravindran (2004), but is better than the value of 2.71 reported in Kuwait by Al-Awadi et al. (1995). But the FCR in the current survey is higher than the value of 1.58 recommended for modern layers to produce one dozen eggs (Hy-Line, 2000). Although the strain used in Laos is different, current data are suggestive of the potential to improve the performance of layers in Laos. A number of factors are responsible for this low productivity, especially poor nutrition and management. Although the production efficiency levels in Laos were comparable to those from other tropical countries, the performance is low compared to accepted standards. Farmer training is especially needed to ensure that producers understand the importance of good management.

The information on the sources of feed used in layer farms was also obtained. The feeds are sourced mainly from agents who import from Thailand and the CP Laos Company. Although only 23% feed was made on-farm using local ingredients, there is greater interest in the use of locally available feedstuffs. Lack of knowledge of the nutritive value and transportation limitations are the major factors that have limited the implementation of on-farm mixing.

No records are kept of production data by any of farmers. The data recorded during the survey were obtained from memory and observations on-farm on the day of the interview. This is a limitation of the current study. The importance of record keeping, as a mean of improving productivity, lowering costs and increasing productivity, must be emphasised through good extension.

CHAPTER 4

A SURVEY OF COMMERCIAL BROILER PRODUCTION SYSTEMS IN LAOS

4.1 Background

Chicken meat consumed in Laos comes primarily from local chickens. It is common for all households to have few chickens in the backyard for family consumption and extra income. Prior to the outbreak of bird flu in 2005, there were a large number of commercial broiler farms in the Vientiane Capital and other provinces. Bird flu outbreak had a negative impact on the number of farms, with many closing down. However, after the gradual disappearance of bird flu, commercial broiler production is again on the increase in the Vientiane Capital because of increasing urban demand and promotion by the CP Laos Company.

The structure of chicken meat industry systems is completely different from that of the layer industry. The CP Laos Company has played an important role in promoting Laotians to raise chickens commercially. This company has a monopoly in broiler industry and there is no direct support from government. All broiler farms in the Vientiane Capital are under contract with the CP Laos Company. Under this contract system, various conditions in the contract are in favour of the company. Before farmers are contracted, they must have the necessary housing and equipment and propose this to the company. The company provides one-day old chicks, feeds, drugs and medicines and veterinary service in the farm. Essentially, the producers work for the company by supplying the labour and money is paid when company collects the birds in farms. Among farms, there are differences in terms of number of production cycle, broiler breed and payment received.

4.2 Methodology

The methodology during the broiler survey was generally similar to that of the layer survey. But the study area and sample size were different. This survey covered broiler farms only in Naxaithong district, province of Vientiane Capital, Laos as shown in

Figure 3.2. There were 10 commercial broiler farms in Vientiane Capital, all located in Naxaithong district. Annual output varied ranging between 10,000 and 20,000 birds. Seven broiler farms were randomly selected for the current survey. The questionnaire used in the survey is provided in Appendix 2.

4.3 Results and discussion

A total of 7 broiler farms from 4 different villages in Naxaithong district were surveyed. All producers were over 31 year of age. The age ranges of 31-40 and 41-50 were 42.9 and 57.1%, respectively, of the respondents as shown in Table 4.1. All, but one, were males.

Families with more than 5 people comprised 85.7%, only one family with 2 people was interviewed. 57.1% of correspondents have achieved secondary school qualification and 14.3% had tertiary, diploma and primary education had 14.3%. All farms were in operation for less than 5 years (Table 4.1). The majority of farms (57.1%) operated the business between 3 to 5 years. Because households work under control of the CP Laos Company, all farmers received training in broiler management from company.

Table 4.1 Age profile, gender profile and experience in meat production of producers[1]

Description	**Percentage (%)**
Age range	
31-40	42.9
41-50	57.1
Gender	
Male	85.7
Female	4.3
Number of years involved in production	
1-2	42.9
3-5	57.1

Note: [1] Total number of farmers interviewed = 7.

71.4% of farms used family labour only, while 14.3% used hired labour only, and 14.3 shared between family and hired labour. One farmer hired labour to help only for the preparation of the house for the introduction of new stock.

The company provided new stock of one-day old chicks to farms. The number of chicks supplied varied in each production cycle. The three breeds provided were Ross 308 (14.30%), Brown Nick (42.85%) and 3-line crossbreeds (42.85%), but it was noted that these were not provided according to the choice of the farm. The 3-line crossbreeds are imported from Thailand. These birds are hybrids of native chicken (50%), Rhode Island Red (25%) and Barred Plymouth Rock (25%). The 3-line crossbreed haves a higher market demand due to its similarity to local chickens, particularly in their feather colour. According to Jeenduong (2001), 3-line crossbreeds are the most popular among crossbreed-raising farmers in Thailand. This was the reason for the introduction of this bird into Laos by the CP Laos Company.

The flock size and production parameters in the 7 farms are presented in Table 4.2. Annual output ranged from 15,000 to 24,000 birds. The average output was 16,429 and the age at market was calculated to be 8.6 weeks. Birds were sold at a body weight of 1.5 kg because the customers prefer smaller birds. Ross 308 grows much faster than the other two breeds and reaches the market weight earlier. This is a problem because Ross birds weighing over 1.5 kg are often left behind, resulting in losses to the farmer. For this reason, Ross 308 is not a preferred choice of the farmers.

Table 4.2 Flock size and production parameters in the surveyed broiler farms

Farm No.	Breed	Output (birds per year)	Age at market, weeks	Weight at market, kg	FCR, Feed/live weight	Mortality, %
1	3-line crossbred	16,000	10	1.5	2.3	1.2
2	3-line crossbred	24,000	10	1.5	2.3	0.9
3	3-line crossbred	12,000	10	1.5	2.3	1
4	Brown Nick	12,000	8	1.5	2.0	0.8
5	Brown Nick	16,000	8	1.5	2.0	1
6	Brown Nick	20,000	8	1.5	2.0	0.8
7	Ross 308	15,000	6	1.5	1.8	4
Mean±SD		16,429 ± 4,315	8.6 ± 1.5	1.5 ± 0	2.1 ± 0.2	1.4 ± 1.2

As shown in Table 4.2, feed efficiency of modern strain (Ross 308) was superior to the other two, with feed conversion ratio (FCR) of 1.8 (for Ross 308) compared to 2.0 (Brown Nick) and 2.3 (3-line crossbreeds). Modern strains have a better performance because they are specially selected and bred for rapid weight gain and high feed utilization efficiency. The feed utilization of Ross 308 in this study, which were fed commercial broiler diets supplied by CP Laos Company, was better than that reported by Haitook (2006) in a Thai study with (1.8 vs 2.0). This might be due to differences in production systems and diet formulation. The Thai study used a traditional production system and experimental feed formulation, whereas the production system in this study was commercial and well-organized under the control of the company.

The FCR of 3-line crossbreeds in the current survey was better (2.3 vs. 3.1) than that reported by Haitook (2006). Apart from differences in production system and feed formulation, the growth stage of the Thai study lasted 12 weeks. It has been observed that this crossbreed exhibited better performance when receiving better quality diet compared to native chickens (Leotaragul & Pimkamlai, 1999).

All farms were open-sided and, sidewalls were of iron netting and covered with plastic to prevent sunlight entering the shed in the mornings and in the late afternoon. The production system is all-in and all-out. Majority of farms were naturally ventilated. Only 2 farms used electric fan for ventilation.

All farms were dependent on ground water for the supply of water. All farms received the feed from the CP. Feed was offered in mash form. There were number of available feedstuffs in the survey area, such as rice bran, broken rice, cassava, corn, cassava, taro and so on (Table 3.3). However, because of the contract between the farmers and the company, they are required to use only the feed from company. All farms supplemented the feeds with vitamins and minerals, which were given with water.

Mortality was higher in the farm that raised Ross 308 (4%; Table 4.2). Brown Nick and 3-line crossbreeds experienced lower mortality between 0.8 and 1.2%. Ross 308 was found to be more susceptible to the hot environment than the other two breeds. Deaths were related largely to the faster growth rate. According to Chaiyabutr (2004) cited by Haitook (2006), mortality of broilers is high in the tropical countries because of heat stress. On the other hand, native chickens tolerate heat stress better and have good

adaptability to ambient temperature. Daghir (2008) suggested that productive exotic broiler could be made more tolerant to heat stress by mating them with native chickens. In the current study, the overall mortality of 3-line crossbreeds was around 1%, which is lower than the 5% reported by Haitook (2006). The low mortality in this study might be due to regular monitoring by the CP Laos Company.

Disease was not a major problem in the broiler farms surveyed. But diarrhoea can occur and affect the flock during the rainy season. The diarrhoea is treated by providing drugs in drinking water. All farms regularly vaccinated the birds and this was done by CP officials. Farmers inform them immediately if there is any increase in mortality. However, if the mortality is more than 1.5% per flock, farmers are fined by reducing the payment.

Farmers who reared 3-line crossbreeds and Brown Nick received US$ 0.20 per kg live weight, while the payment for Ross 308 was US$ 0.13. Rice husk was used as the litter material. After all birds were removed, litter (rice husk plus chicken manure) is sold to locally for use as a fertilizer in gardens and rice fields. Farmers earned extra money from the sale of chicken manure throughout the year and this was estimated to range from US$ 124 to 1,493. Apart from the capitol cost of buildings and equipment, electricity was a major expense during the production.

The farmers, who gave negative feedback on the future potential of broiler production, wanted to receive chicks more regularly and wanted to raise 3-line crossbreeds and Brown Nick due to higher price received compared to Ross 308. They also wanted the government to support them by providing easy loans, some producers wanted to expand their business, but this was not allowed by the CP Laos Company.

CHAPTER 5

NUTRIENT CHARACTERISATION OF LOCAL FEED RESOURCES

5.1 Background

Much emphasis has been given to the expansion of the commercial chicken industry in Laos in recent years. But a major constraint to further development is the high cost of feed. Currently the farmers rely heavily on expensive commercial feeds imported from Thailand or bought from CP Laos Company.

As identified during the surveys reported in Chapters 3 and 4, vast potential exists in Laos for the use of cheaper locally available feed ingredients to produce quality diets. But there is a paucity of published information on the nutrient composition and limitations of their use in poultry diets. Precise knowledge of the nutrient composition of local ingredients is critical for effective diet formulation. This has been most notably the case with regard to mineral and amino acid composition. Nutritional information on these feed ingredients is available from various tropical countries. While such information could serve as a guide, it is inadequate for accurate feed formulation. Interactions between cultivars, climate, soil, agronomy and other factors could cause appreciable differences in nutrient composition between local ingredients and those grown in other countries under different conditions.

5.2 Methodology

5.2.1 Feed ingredients

Fifteen local feedstuffs (rice bran, broken rice, cassava leaf meal, cassava root meal, full-fat copra, fish meal, green banana meal, groundnut, leucaena leaf meal, maize, sesame seed, snail meal, soybean, sweet potato tuber meal and taro meal), identified as having good potential during the survey, were collected from various locations in the Vientiane Capital as shown in Table 5.1. Prior to shipping the ingredients to New

Zealand, the samples were oven-dried and finely ground at laboratory of Department of Livestock and Fishery, Centre of Standard Control of Animal Production, Vientiane Capital. All the analyses were carried out in duplicate at the Nutrition laboratory, Massey University.

Table 5.1 The list of feed ingredients evaluated.

Ingredient	Botanical name	Comment
Broken rice	*Oryza sativa*	Collected from a local rice mill
Rice bran		
Cassava root meal	*Manihot esculenta*	Collected from home garden as fresh root and dried in the laboratory
Cassava leaf meal	*Manihot esculenta*	Collected from home garden as fresh leaves and dried in the laboratory
Full-fat copra	*Cocos nucifera*	Collected from local market as fresh coconut meat and dried in the laboratory
Fish meal		Bought from local market as dried fish
Green banana meal	*Musa paradisiaca*	Bought from local market as fresh unripe green banana
Groundnut	*Arachis hypogaea*	Bought from local market as hulled groundnut
Leucaena leaf meal	*Leucaena leucocephala*	Collected from the wild as fresh leaves
Maize	*Zea mays*	Bought from a local feed store as ground maize
Sesame	*Sesamum indicum*	Bought from a local market as sesame seed
Snail meal	*Achatina fulica*	Bought from a local market as whole snail with shell
Full-fat soybean	*Glycine max*	Bought from a local market as dehulled soybean
Sweet potato tuber meal	*Ipomoea batatas*	Collected from home garden as fresh tuber
Taro meal	*Colocasia esculenta*	Bought from a local market as corm

5.2.2 Chemical analysis

a) Proximate composition

The dry matter, crude fat, crude fibre and ash contents were determined using standard procedures (AOAC, 2005). Nitrogen was determined by the combustion method using a CNS-2000 carbon, nitrogen and sulphur analyser (LECO® Corporation, St. Joseph, Michigan, USA). The crude protein content was calculated by multiplying N by appropriate conversion factors (Table 5.2).

Table 5.2 Nitrogen-to-protein conversion factors used[1]

Ingredient	
Broken rice	5.95
Cassava leaf meal	5.30
Cassava root meal	6.25
Full-fat copra	5.30
Fish meal	6.25
Green banana meal	6.25
Groundnut	5.41
Leucaena leaf meal	5.30
Maize	6.25
Rice bran	5.95
Sesame	5.83
Snail meal	6.25
Soybean	5.71
Sweet potato tuber meal	6.25
Taro meal	6.25

[1]Conversion factors were from various literature sources. If no specific factor was available, 6.25 was used.

b) Mineral analysis

The samples were wet acid digested with a nitric and perchloric acid mixture, and concentrations of minerals were determined at specific wavelengths for each element (Ca, 393.3; P, 185.9; K, 766.4; Na, 589.5; Mg, 279.1; Fe, 259.9; Mn, 257.6; Zn, 213.9 and Cu, 324.8 nm) by an Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) using a Thermo Jarrell Ash IRIS instrument (Thermo Jarrell Ash Corporation, Franklin, MA). The instrument was calibrated against standards (Junsei Chemical Co., Ltd., Tokyo, Japan) of known concentration.

c) Amino acid analysis

Proximate composition of the 15 feedstuffs is shown in Table 5.3. Cassava leaf meal, fishmeal, groundnut, leucaena leaf meal and full-fat soybeans contained more than 20% protein; of these, fishmeal had the highest protein content. Cassava leaf meal had higher crude protein than Leucaena leaf meal. The main energy sources, such as cassava root and maize, contained lower protein contents. Fat content was higher in full-fat copra, , sesame and groundnuts (65.0, 54.8 and 44.4%, respectively). Fibre contents were lower in broken rice, fishmeal, green banana meal, maize, snail, sweet potato tuber meal and taro meal. Snails had the highest ash content (71%), followed by fishmeal with 18.0%.

5.3 Results

5.3.1 Proximate analysis

Proximate composition of the 15 feedstuffs is shown in Table 5.3. Among collected ingredients, more than 20% of proteins were found in cassava leaf, fishmeal, groundnut, leucaena leaf and soybean; in which fishmeal contained highest protein content, higher than full-fat soybean by 12.6%. Cassava leaf meal had higher crude protein than that of Leucaena leaf meal, whereas the opposite was for nitrogen-free extract. While main energy sources, such as cassava root and maize, were lower than 10%. Fat contents were high for full-fat copra, sesame and groundnut with 65.0, 54.8 and 44.4%, respectively. Broken rice, fishmeal, green banana, maize, snail, sweet potato tuber and taro contained small amount of fibre, showing 0.9, 0.5, 2.8, 3.7, 1.6, 3.6 and 2.8%, respectively. Snails had highest ash content of 71%, followed by fishmeal with 18.0%; while broken rice, full-fat copra, green banana, groundnut and maize had the ash contents less than 5%.

Table 5.3 Proximate composition of Laotian feedstuffs, g/100 g dry matter basis

Ingredient	Dry matter	Crude protein	Crude fat	Crude fibre	Ash	NFE*
Energy sources						
Broken rice	97.8	7.7	1.7	0.9	0.7	86.8
Rice bran	98.1	12.4	14.7	16.4	12.3	42.3
Maize	97.7	9.4	5.8	3.7	1.3	77.5
Cassava root meal	96.9	3.7	1.3	10.3	7.1	74.5
Sweet potato tuber meal	97.9	3.5	0.9	3.6	3.1	86.8
Taro meal	97.7	7.7	1.1	2.8	3.7	82.4
Green banana meal	97.5	3.9	1.6	2.8	3.1	86.1
Protein sources						
Full-fat soybean	97.5	41.8	14.1	13.5	4.9	23.2
Cassava leaf meal	97.0	25.1	8.7	13.6	8.8	40.8
Sesame	98.9	22.2	54.8	3.5	5.2	13.2
Groundnut	99.3	28.9	44.4	14.0	2.7	9.3
Leucaena leaf meal	96.5	21.3	6.1	14.5	7.0	47.6
Full-fat copra	98.7	7.3	65.0	6.3	1.9	18.2
Fish meal	98.0	54.4	24.8	0.5	18	0.3
Snail meal	98.6	17.1	1.6	1.6	71.3	7.0

*Nitrogen-free extract = 100 - (% Moisture + % Protein + % Fibre + % Ash + % Fat).

5.3.2 Mineral analysis

Highest content of calcium was found in snails (Table 5.4) followed by fishmeal. Snail meal also contained higher contents of Fe, Cu, Mn and Zn. Cassava leaf contained the highest content of Zn.

Table 5.4 Mineral composition of feedstuffs, dry matter basis

Ingredients	Ca, g/100 g	Mg, g/100 g	K, g/100 g	Na, g/100 g	P, g/100 g	Fe, mg/100 g	Cu, mg/100 g	Mn, mg/100 g	Zn, mg/100 g
Energy sources									
Broken rice	0.01	0.05	0.16	<0.005	0.14	20	3.00	16.20	21
Rice bran	0.10	0.64	1.16	<0.005	1.42	240	6.40	193	77
Maize	0.01	0.11	0.39	<0.005	0.27	27	1.46	6.80	32
Sweet potato tuber meal	0.09	0.07	1.55	<0.005	0.12	156	7.00	18.20	6.80
Cassava root meal	0.32	0.10	2.60	0.02	0.16	105	4.50	59	26
Taro meal	0.12	0.11	1.67	0.14	0.18	61	4.40	46	46
Green banana meal	0.05	0.12	1.44	<0.005	0.11	30	2.20	54	13.50
Protein sources									
Full-fat soybean	0.19	0.26	0.18	<0.005	0.66	92	15.40	25	59
Leucaena leaf meal	1.68	0.33	1.09	<0.005	0.13	230	4.70	89	13.20
Groundnut	0.07	0.24	0.78	<0.005	0.54	27	13.10	18.20	46
Full-fat copra	0.03	0.10	0.80	<0.05	0.20	53	8.50	18	20
Cassava leaf meal	1.60	0.30	1.70	<0.005	0.41	390	8.00	69	122
Sesame	1.25	0.31	0.49	<0.005	0.52	134	14.40	27	48
Fish meal	4.50	0.16	0.62	2.20	2.50	102	4.60	4.90	69
Snail meal	30.00	0.13	0.20	0.20	0.12	510	20.00	610	119

5.3.3 Amino acid composition

Among the energy sources, rice bran contained higher amounts of lysine and methionine (Table 5.5). Among protein sources, fishmeal contained higher contents of lysine and methionine (Table 5.6). Apart from lysine, methionine, glycine and alanine, fishmeal and soybean had similar amounts of other essential amino acids. Cassava leaf meal displayed better amino acid profile compared to leucaena leaf meal.

Table 5.5 Amino acid content of energy sources, mg/100 mg dry matter basis

Amino acid	Broken rice	Rice bran	Maize	Cassava root meal	Sweet potato tuber meal	Taro meal	Green banana meal
Aspartic Acid	0.70	1.16	0.59	0.23	0.38	1.05	0.33
Threonine	0.29	0.49	0.33	0.10	0.12	0.27	0.12
Serine	0.39	0.60	0.40	0.12	0.14	0.38	0.13
Glutamic acid	1.39	1.78	1.45	0.32	0.34	0.72	0.37
Proline	0.33	0.62	0.71	0.11	0.10	0.28	0.11
Glycine	0.35	0.69	0.41	0.11	0.11	0.35	0.14
Alanine	0.42	0.75	0.59	0.12	0.20	0.37	0.15
Valine	0.48	0.74	0.45	0.13	0.16	0.37	0.14
Isoleucine	0.32	0.46	0.29	0.10	0.11	0.23	0.11
Leucine	0.64	0.92	0.90	0.16	0.17	0.55	0.18
Tyrosine	0.35	0.45	0.33	0.06	0.07	0.30	0.07
Phenylalanine	0.41	0.58	0.39	0.10	0.13	0.39	0.12
Histidine	0.18	0.31	0.26	0.04	0.04	0.15	0.09
Lysine	0.35	0.66	0.40	0.11	0.12	0.31	0.16
Arginine	0.61	0.97	0.48	0.08	0.10	0.45	0.13
Cysteine*	0.17	0.27	0.20	0.05	0.03	0.17	0.06
Methionine	0.25	0.26	0.20	0.06	0.08	0.13	0.07

* From performic acid oxidation.

Table 5.6 Amino acid content of protein sources, mg/100 mg dry matter basis

Amino acid	Soybean	Cassava leaf meal	Sesame	Groundnut	Leucaena leaf meal	Coconut meal	Fish meal	Snail meal
Aspartic Acid	4.78	2.75	1.81	3.70	2.20	0.63	5.55	1.57
Threonine	1.65	1.30	0.79	0.82	1.08	0.24	2.40	0.75
Serine	2.12	1.23	0.98	1.38	1.09	0.31	2.19	0.69
Glutamic acid	7.67	3.17	4.09	5.90	2.57	1.38	10.58	2.14
Proline	2.11	1.38	0.76	1.33	0.95	0.25	2.57	0.71
Glycine	1.83	1.48	1.10	1.75	1.25	0.33	4.21	1.11
Alanine	1.75	1.72	0.98	1.19	1.10	0.30	3.63	0.83
Valine	2.04	1.68	1.06	1.42	1.43	0.40	2.78	0.82
Isoleucine	1.80	1.28	0.79	1.08	1.12	0.25	2.34	0.63
Leucine	3.11	2.48	1.45	2.02	2.06	0.48	4.31	1.21
Tyrosine	1.44	1.12	0.83	1.25	0.96	0.16	1.86	0.63
Phenylalanine	2.13	1.56	0.99	1.62	1.33	0.33	2.29	0.64
Histidine	1.06	0.65	0.53	0.72	0.41	0.15	1.21	0.27
Lysine	2.51	1.46	0.65	1.16	1.25	0.20	4.89	0.84
Arginine	3.23	1.55	2.71	3.75	1.08	0.98	3.65	1.06
Cysteine*	0.62	0.39	0.48	0.49	0.25	0.11	0.47	0.24
Methionine	0.67	0.67	0.70	0.40	0.55	0.13	1.62	0.35

* From performic acid oxidation.

5.4 Discussion

Rice is the staple food in Laos and large quantities of rice milling by-products are available in the country. Rice bran from Laos was analysed to contain 12.4 g crude protein/100 g dry matter basis, which was higher than those reported by Khoutsavang (2005) and Keoboualaphet & Mikled (2003) for samples from Laos. Crude fat content of rice bran (14.7 g/100 g) was within the range of 11 – 18 g/100 g observed by McDonald et al. (2011). The crude protein and ash contents of rice bran were higher than those reported by Khoutsavong (2005), whereas the crude fibre content was lower. Chumpawadee et al. (2007) reported that the crude protein content of broken rice was 7.2 g/100 g, which is remarkably similar to the findings in the current study (7.7 g/100 g). Although broken rice contains low level of protein, it is widely used as supplemental feed for chickens. . In Laos, there are two types of rice (normal rice and sticky rice) and, within each type, there are number of varieties cultivated for home consumption. By-products from sticky rice were collected in the current study. The availability of large amounts of rice bran and broken rice is the reason for their wider use as supplemental feed.

The proximate composition of sweet potato tuber meal was comparable to those reported by Ravindran & Blair (1991). Protein, fat, fibre and ash contents of cassava root meal were higher than those reported Ravindran & Blair (1991). The observed differences of fibre and ash contents might be due to the fact that the peel of cassava root was not removed in this study.

Although hulls of soybean were not removed in this study, the protein content of whole soybean is similar to Asian soybean meal (40-44 g/100 g) reported by Ravindran & Blair (1992). The crude protein of sesame seed was lower than that reported by Cheva-Isarakul & Tangtaweewipat (1993). Sesame contained low levels of methionine and lysine. The results of the current study are congruence with Moorthy & Viswanathan (2009) who reported that fat content of full-fat copra varies from 65 to 72 g/100 g. Groundnut had the crude protein of 28.9 g/100 g; in addition, the crude protein content was lower and poorer in essential amino acids compared with soybean (Table 5.4).

Fishmeal was found to be a good source of high quality protein and had good amounts of minerals (calcium, phosphorus and trace minerals). The highest phosphorus

content among tested samples was observed with fish meal, while the highest calcium content was observed with snail meal. The high calcium content of snail meal is due to the fact the snails were collected with the shell. This resulted in low protein and high ash contents.

CHAPTER 6

CONCLUSIONS

Chicken production is an important economic animal activity in Laos. Most chickens are reared in rural areas and the production system is traditional. Native chickens are usually raised in extensive systems; they scavenge for food and farmers sometimes supply supplementary feeds such as rice by-products, and household residues.

The consumption of chicken meat and egg is on the increase, particularly in the urban areas, due to high demand. Local chickens also played a major role in the protein supply of rural people, but the market demand for native chickens is relatively high. Due to high demand of meat and eggs in the urban areas and low productivity of native breeds, the supply of local chicken meat is not adequate. To meet the demand, investment in commercial-scale farms is necessary. The commercial production systems are found mainly in urban areas. However, the technology for intensive chicken production is not advanced because the majority of farms are small to medium scale. Layers and broilers raised in commercial systems are obtained from local agents and the CP Laos Company, and multinational companies in Thailand. .

In the Vientiane Capital, most layer farms are operated by small- to medium scale commercial producers. Commercial-type feeds, imported from Thailand or produced locally by the CP Laos Company, are used in these farms, which are. The commercial feeds are expensive and increase every year, whereas the price of eggs remain lower and fluctuate between years.

Commercial broilers are produced solely under contract system with the CP Laos Company and, hybrid broilers and crossbred native chickens are used. Because of the requirement of good management and lack of easy credit, local farmers have not been able to invest in commercial broiler production.

The studies reported in this thesis provide base-line information on commercial small-scale layer and broiler production systems in the Vientiane Capital, where these farms are mostly located. This study, in addition to establishing the production standards, has raised several issues needing attention. The results showed that the

productivity of layers was below the breed standards. Layer operations are constrained by number of limitations and these include inadequate livestock (veterinary and extension) services, unavailability of easy credit, poor farmer training, high cost of commercial feeds, lack of on-farm records and lack of research on local breeds and feedstuffs. . The problems faced by small-scale broiler farms are totally different. All farms are run under contract with a multi-national company and there are no incentives from the Government to support local farmers to expand the broiler production.

Feed supply, at reasonable cost, is a major problem for small-scale poultry operators in Laos. The nutrient composition of 15 locally available feedstuffs, which have the potential to reduce the dependence on imported feeds, was characterised in this study. To our knowledge, the present report is the first one to characterise the mineral and amino acid composition of Laotian feedstuffs. While these data highlight the potential of these feedstuffs, they need to be supported by well-planned feeding trials to investigate the optimum inclusion levels in practical diets.

It is clear that the growth of the poultry industry will require a strong research input from Government institutions on local issues. Currently little or no research is carried out on the problems of small-scale poultry farms. In addition to evaluation of local feedstuffs, studies on proper management practices under Laotian conditions are also needed.

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APPENDIX 1

QUESTIONNAIRE OF COMMERCIAL LAYER SURVEY

Village	
District	
Name of interviewee	
Questionnaire No.	
Date of survey	

Note: The answer of interviewee represented by tick (✓)

I. Demographic details

1. Age in years

<20	20-30	31-40	41-50	>50

2. Gender: Male □ Female □

3. Number in your immediate family:

2	3	4	5	>5

4. Number of years involved in poultry production?

<2	2-5	6-10	10-20	>20

5. Level of education

No education	Primary	Secondary	Tertiary	Others

6. Years of schooling

No	<5	5-10	10-15	>15

7. Do you have any special training? If yes from whom_____

II. Chicken production

8. How many birds are kept in the farm per year?

<1,000	1,000-2,000	2,001-3,000	3,001-4,000	4,001-5,000

9. What is the current age of your birds (months)?

<6	6-10	10-14	14-18	>18

10. How many different age groups of birds do you have?

1	2	3	4

11. What is the age of your replacement birds (months)?

<4	4	>18

III. Breeds and their sources

12. What breeds/strain of birds do you use for egg production?

Brown Nick	Leghorn	Rhode Island reds	Lohman Brown	Crossbred	Other (name)

13. Where do you purchase your birds?

Own stock hatching	Locally through agents	Import directly	Others (name)

IV. Management systems

14. What type of housing system do you use?

Traditional	Cages	Deep litter	Slatted floor	Other (name)

15. What type of heating system do you use?

No	Electricity	Gas	Coal	Other (name)

16. Source of water for the birds

Ground water	Borehole	Standpipe	Other (name)

17. Source of feed for the birds

Natural	Local feed	Natural + Local	Commercial feed	Local + Commercial

18. What types of feeds do you use in your farm?

Grain	Mash	Pellet	Mixed	Other

19. What are local feed ingredients that you use?

_____

20. What are the potential available feed in your place?

_____

21. What are the factors that limit the use of available local feed?

_____

22. Do you provide any extra vitamins or minerals for your birds?

□ Yes □ No

If yes what is the source? _____

23. Where do you purchase these feeds?

Locally made	Locally through agents	Local market	Import directly	Other (name)

24. How many kg of feed do you give per flock per day?

<5	5-10	10-50	50-100	>100

25. How many birds die per year?

<100	100-200	200-500	500-1,000	>1,000

26. Which age group is the most affected?

Young birds	Old birds	Mixed

27. At what month of the year do you encounter more deaths?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

V. Labour

28. What percentage of labour is provided by

Family_____

Employed_____

29. What percentage of family labour is provided by?

Women_____

Children_____

VI. Diseases and control

30. What diseases are of importance in your farm, and what are the symptoms?
_____
_____
_____
_____

31. During what months of the year do these diseases occur most?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

32. How do you control these diseases?

□ No control □ Vaccination □ Other (name) _____

33. Do you use any disinfectants in your farm?

□ Yes □ No

If yes, please specify _____

34. Where do you purchase your drugs and vaccines?

Local agents	Imported	Local market	Government	Other (name)

VII. Production Parameters

35. How many eggs are produced on your farm?

Per day _____

Per month _____

36. How often do you collect eggs per day?

□ Once □ Twice □ More than twice

37. In which month of the year do you get maximum egg production on your farm?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

38. In which month do you get minimum egg production on your farm?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

39. How many eggs your family consume?

Per month _____

40. How do you store eggs before being sold? _____

41. At what age do you cull your birds (months)? _____

42. What criteria do you use for culling?

Reduced number of birds	Increased mortality	Other (specify)

VIII. Sales and marketing

43. How many eggs in total are sold per month? _____

44. Where do you sell your products?

Village	Through retailers	Local market	Export directly	Others (name)

45. What percentage of your products is bought by?

Individuals _____

Retailers _____

Local market _____

Exporter_____

Others (Name) _____

46. What percentage of your products is bought by?

Individuals _____

Retailers _____

Local market _____

Exporter_____

Others (Name) _____

IX. Income

47. How much do you sell your eggs for?

Individuals _____

Retailers _____

Local market _____

Exporter_____

Others (Name) _____

48. How much income do you earn per year from the sale of?

Chicken manure _____

Spent hens _____

Feed bags_____

Others (Name) _____

X. Cost of production

49. Total costs per flock of the following:

Feeds _____

Wages _____

Vaccines and medication _____

Water _____

Egg cartons _____

Electricity _____

Birds _____

50. When did you purchase equipments and build your house?

House _____

Equipment _____

XI. Extension services

51. What kind of extension workers provide services to you?

No	Villagers	Government	NGOs	Private company

52. How effective are services provided by extension workers?

Very poor	Poor	Good	Excellent

53. What do you think about the courses provided to farmers in poultry production?

Very poor	Poor	Good	Excellent

54. How could the services provided by the government or others be improved?

_____

_____

XII. Farmer attitude

55. List any three major problems that you encounter which affect your production.

1._____

2._____

3._____

56. What do you think about the future of poultry production in Laos?

No idea	Poor	Good	Excellent

57. Are there any cultural barriers towards your products?

□ Yes □ No

If yes what is it? _____

XIII. Any other comments

_____
_____
_____
___

Thank you for the time you took out to answer this questionnaire.

The confidentiality of your information is assured.

APPENDIX 2

QUESTIONNAIRE OF COMMERCIAL BROILER SURVEY

Village	
District	
Name of interviewee	
Questionnaire No.	
Date of survey	

Note: The answer of interviewee represented by tick (✓)

I. Demographic details

1. Age in years

<20	20-30	31-40	41-50	>50

2. Gender: Male □ Female □

3. Number in your immediate family:

2	3	4	5	>5

4. Number of years involved in poultry production?

<2	2-5	6-10	10-20	>20

5. Level of education

No education	Primary	Secondary	Tertiary	Others

6. Years of schooling

No	<5	5-10	10-15	>15

7. Do you have any special training? If yes from whom_____

II. Chicken production

8. How many birds are kept in the farm per year?

<5,000	5,000-10,000	10,001-20,000	20,001-30,000	>30,000

9. What is the current age of your birds (weeks)?

<1	1-2	2-4	4-6	>6

10. How many different age groups of birds do you have?

1	2	3	4

III. Breeds and their sources

11. What breeds/strain of birds do you use for egg production?

Ross 308	Brown Nick	3-line crossbreeds

IV. Management systems

12. What type of housing system do you use?

Traditional	cages	Deep litter	Slatted floor	Other (name)

13. What type of heating system do you use?

No	Electricity	Gas	Coal	Other (name)

14. Source of water for the birds

Ground water	Borehole	Standpipe	Other (name)

15. What types of feeds do you use in your farm?

Grain	Mash	Pellet	Mixed	Other

16. What are local feed ingredients that you use?

_____

17. What are the potential available feed in your place?

_____

18. Do you provide any extra vitamins or minerals for your birds?

□ Yes □ No

If yes what is the source? _____

19. How many kg of feed do you give per flock per day?

<5	5-10	10-50	50-100	>100

20. How many birds die per year?

<10	10-20	21-50	51-1,00	>100

21. Which age group is the most affected?

Chicks	Young	Mixed

22. At what month of the year do you encounter more deaths?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

V. Labour

23. What percentage of labour is provided by

Family_____

Employed_____

24. What percentage of family labour is provided by?

Women_____

Children_____

VI. Diseases and control

25. What diseases are of importance in your farm, and what are the symtoms?_____
_____
_____
_____

26. During what months of the year do these diseases occur most?

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

27. How do you control these diseases?

□ No control □ Vaccination □ Other (name) _____

28. Do you use any disinfectants in your farm?

□ Yes □ No

If yes, please specify _____

29. Where do you purchase your drugs and vaccines?

CP Company	Imported	Local market	Government	Local agents

V. Income

30. How many US$ per kg live weight you receive from CP _____

31. How much income do you earn per year from the sale of?

Chicken manure _____

Feed bags_____

Others (Name) _____

VI. Cost of production

32. Total costs per year of the following:

Wages _____

Water _____

Electricity _____

33. When did you purchase equipment and build your house?

House _____

Equipment _____

VII. Extension services

34. What kind of extension workers provide services to you?

CP Company	Villagers	Government	NGOs

35. How effective are services provided by extension workers?

Very poor	Poor	Good	Excellent

36. What do you think about the courses provided to farmers in poultry production?

Very poor	Poor	Good	Excellent

VIII. Farmer attitude

37. List any three major problems that you encounter which affect your production.

1._____

2._____

3._____

38. What do you think about the future of poultry production in Laos?

No idea	Poor	Good	Excellent

39. Are there any cultural barriers towards your products?

□ Yes □ No

If yes what is it? _____

IX. Any other comments

_____
_____
_____

Thank you for the time you took out to answer this questionnaire.

The confidentiality of your information is assured.