



Goat production in Laos and the potential of using *Erythrina variegata* as a Feedstuff

**by
Helena Allard
Uppsala 2010**

Svensk titel: Getproduktion i Laos och utfodring med foderträdet *Erythrina variegata*
Minor field study, Bachelor thesis, Basic C, 15 HEC
Supervisor: Ewa Wredle
Department of Animal nutrition and Management
Faculty of veterinary medicine and Animal Sciences
Swedish University of Agricultural Sciences

Title: Goat production in Laos and the potential of using Erythrina variegata as a Feedstuff

Swedish Title: Getproduktion i Laos och utfodring med foderträdet Erythrina variegata

Author: Helena Allard

Uppsala, 2010

Supervisor: Ewa Wredle, Swedish University of Agricultural Sciences, Department of Animal Nutrition and management

Examiner: Kjell Holtenius Swedish University of Agricultural Sciences, Department of Animal Nutrition and Management

Level: Basic C,15 HEC

Degree project in Biology

Kurskod: EX0550

Program: Bachelor in Biology

Electronical publication: <http://stud.epsilon.slu.se>

Key words: Goats, feed science, Laos, Asia, Erythrina variegata, legume trees

Department of Animal nutrition and Management
Faculty of veterinary medicine and Animal Sciences
Swedish University of Agricultural Sciences

Sammanfattning	4
Abstract	4
Introduction.....	4
Goat production in Laos.....	6
Fodder trees.....	7
Conservation of feed from fodder trees	8
Erythrina	9
Nutritive value of <i>Erythrina</i>	9
Effect on productivity	10
Material and methods.....	10
Animals and management	11
Experimental diet	11
Measurement and analysis	11
Results and discussion	12
The potential of using feed from fodder trees.....	13
References.....	14

Sammanfattning

I Laos jobbar en majoritet av befolkningen med jordbruk på ett eller annat sätt. Antalet getter ökar i landet och djuren är en viktig inkomstkälla för många familjer. Under torrperioden är det svårt att hitta foder till djuren och odling av foderträd skulle kunna vara en lösning till problemet. Träden torkar inte ut lika fort som andra växter, till exempel gräs, och vissa foderträd kan även fixera kväve och är därför proteinrika. Bladen från trädet *Erythrina variegata* är ett smakligt foder med högt proteininnehåll och som används som djurfoder i många delar av världen. Om växten ges istället för proteinrikt kraftfoder sjunker produktionen hos många djur, men detta är ändå oftare mer ekonomiskt för djurägare i utvecklingsländer då kraftfoder är så pass dyrt. Träden kan planteras vid gården och bönder besparas därmed tid då de inte behöver gå långa sträckor och samla in foder till djuren. Inga för- eller nackdelar kunde ses med att utfodra *Erythrina variegata* till getter, men växten verkar ändå lovande att använda som foder under torrperioden.

Abstract

Lao People's Democratic Republic (PDR) is a country where the majority of the population works within the sector agriculture in one way or another. The number of goats are increasing and the animals can be an important income source for families. However, during the dry season, lack of feed is a great problem for the farmers. Fodder trees have shown great potential as dry season feeding, due to that the trees often hold green and fresh leaves a long time into the season, compared to grass that dry out quickly. *Erythrina variegata* is a palatable legume tree with a high protein content. The tree is found in the tropics and used for feed production in many countries in the world already. If replacing the protein provided as concentrates in the diets of ruminants, the production of milk or growth will be decreased, but it is more economic to feed *Erythrina* than concentrates for most farmers in developing countries. The trees can be planted at the farm and time other ways used for collecting feed can be saved. No advantages or disadvantages could be seen when feeding goats with various amounts of *Erythrina*. The potential of *Erythrina variegata* as a feed could be very high, and it could be used to promote growth in goats during the dry season. Little research has been done on the use of the plant as feed for animals, especially for goats, and there is a need of more knowledge of how it affects growth rate, organic matter intake and the digestibility of different diets.

Introduction

Lao People's Democratic Republic (PDR) is a country with a tropical climate situated in Southeast Asia. The country had a population of 5.5 million people in year 2005 and 4.2 million of these people worked within the sector agriculture, making agriculture an important income source for most people (FAO, 2005). Lao PDR is a low-income country with a Gross Domestic Product (GDP) of 2490 million US dollar during 2004 and the agricultural share of this was 47.1 % (ESSGA, 2006). The livestock sector is estimated to contribute to 9 % of this (FAO, 2005). Lao PDR imports more than exports. The imported goods consist to a great part of non-alcoholic

beverages, sugar and rice. The country also import milk and to a smaller part pig and poultry meat. The small export consists of coffee, live animals and hides (FAO, 2005).

Rice is the most common crop cultivated in Laos and 85 % of the cultivated land area is used for this matter. About 95 % of the produced crops are rice (FAO, 2005)

Livestock is mainly held in extensive small-holder systems. In urban areas some big commercial pig and poultry farms exist, but they are few (NAFRI, 2005a). Most people in the country own livestock and 89 % of the households have at least one species, but most have several. Many families have 0-4 buffalos or cattle, 2-5 goats, 2-4 pigs and around 20-30 of poultry (Wilson, 2007). Indigenous breeds are the most common ones to use for all species, but in big commercial farms, some exotic breeds are used as well (FAO, 2007b). The most common feedstuffs for livestock are rice paddy and rice brans (FAO, 2005).

Livestock is an important economic insurance for many people and unlike crops, the animals can be sold at any time the household needs money. Shortage of rainfall in the combination of the steep mountain fields in the northern parts of the country can mean economical losses from rice production some years; livestock can then be a very important source of income (Xaypha, 2005). For many households in the north of Laos the livestock contributes to more than 50 % of the income (Nafri, 2005c). The money from selling livestock is often used for sending children to school, medicines or investments in the farm, for example to buy a rice mill or a tractor (Nafri, 2005a). Livestock, especially water buffaloes, is also often used as draught power (FAO, 2007b).

Dry period feeding is a problem in Lao PDR when raising goats because of the lack of available feed at that time of the year. Specially in low-land areas where the fields are used for rice cultivation all year round, this is a big problem. No fallow land is then available for grazing animals during the dry season, as it can be in other areas in the country (Phouthavong et al., 1998). The animals have to walk long distances during the dry period and spend a lot of energy for little amounts of low nutritional feed (Xaypha, 2005). The plants growing at this time has a low digestibility and low crude protein content resulting in a low voluntary intake by goats. The low nutritional value also makes it impossible for the goats to eat sufficient amounts for gaining weight even if the palatability of the feeds is good. The growth of the animals are therefore under this period restricted and it also causes loss of body condition and an increased susceptibility to parasitic and other diseases (Kanani et al., 2006).

Fodder trees have the advantage of being more tolerant to drought than grasses because of their deep root systems which can reach water sources deep below the ground surface. Trees and shrubs tend to be green a long time into the dry season, at which time the grasses could have become like standing hay (Lukhele, 2003). Even in drought years, most fodder trees will grow leaves (Simbaya, 1998).

In the areas surrounding Vientiane in Laos, 60 goat owners were interviewed about the feeds they used for their goats. Very few used the fodder tree *Erythrina variegata* as a feed, probably because of the lack of knowledge about its value as a feed and maybe also availability of the plant (Kongmanila et al., 2008a). In other provinces the use of the plant is more common; in Oudomsay province some farmers utilize *Erythrina variegata* as a feed for their animals (Phouthavong et al, 2009).

This report consists both of a literature review and an experimental part. The use of goats in Lao PDR and the prospects of using fodder trees as feedstuffs in the dry period in animal production are discussed in the review. The aim of the experiment, conducted at the national University of Laos, was to value the fodder tree *Erythrina variegata* as a feedstuff for goats in Laos.

Goat production in Laos

The number of goats and sheep together in Lao PDR were 128 000 in 2005 (FAO, 2005a). Goats and sheep are the least common livestock species in the country but the number is increasing due to a higher demand for goat meat on local markets (Nafri, 2005). In some areas the number of goats has increased rapidly during the last 20 years, and in other areas the numbers are constant (FAO, 2007b). About 500 tonnes of goat meat are produced each year (FAO, 2005). Goats have many advantages, for example, they demand less labour than cattle, leaving time for other work at the farm. Less money has to be spend when buying the animals and in some cases, also their feed (Acharya, 1986). The main part of the goats is found in some upland provinces of Lao PDR where it is custom to eat goat meat (Acharya, 1986). Almost all goats are held for producing meat (Amanullah et al., 2006). The raising systems practiced are very extensive ones, but they are the most suited ones for the sometimes harsh conditions (Acharya, 1986).

The goats often graze freely in fallow crop land and forests (Nafri, 2005). They are held in small groups which are herded by their owner and the animals eat from fodder trees, bushes, shrubs and grass. Most farmers keep their goats close to the house at night in shelters because of the risk of theft, and the animals can also be fed supplementary feed at this time, although most farmers do not provide any feed (Nafri, 2005). Some farmers also form cooperatives and have their goats in bigger common groups. The goats are still owned individually but the farmers share the labour and costs of for example building shelters. The animals can also be in fenced areas during the wet season to prevent damage to crop fields; feed is then cut and carried to them. During the dry season they are often left to graze freely. In some systems, the goats are grazing in big fenced areas during the whole year. Concentrates are seldom used. Some goats are vaccinated and dewormed but most farmers do not have the custom to do this, making especially internal parasites common (Xaypha, 2005).

A big problem when raising goats seems to be the lack of planned breeding. Bucks are not often selected and inbreeding is allowed to happen. Diseases, the tropical climate, low fertility and damage to the crops are other problems as well (Acharya, 1986; FAO, 2007b). Keonakhone et al. (2009) made an investigation among villagers raising goats in Phonexay and Namo districts and they found that another problem was that goats died more easily from diseases than cattle. It also seemed that goats born during the dry period did not die as easily as the ones born during the rain period. Thefts, as well as dogs biting or killing the goats were other big problems stated by the inhabitants of the villages. The goat breed most commonly used in Laos is a native mixed breed which can be included in the Southeast Asian Mountain goat group (Wilson, 2007). They are well adapted to the climate in the country and are relatively fertile. However, they have a low growth rate. The average adult weight is around 30 kg but in some more intensive production systems they can reach a weight of 40 kg (Xaypha, 2005)

Fodder trees

Goats spend 90 % of their total eating time browsing and only 10 % on grazing (Acharya, 1986). This means that leaves and other parts of shrubs and trees make a great part of their feed intake. Fodder trees and shrubs are the only naturally occurring feed available in the dry tropics and have therefore been utilized for a long time. But they could also be used to a greater extent in other parts of the world as the sub-humid and humid tropics (Speedy et al, 1991).

Legume fodder trees contain 12-30 % crude protein of DM, compared to 3-10 % in grass (Gutteridge & Shelton, 1998). Leaves from some species of fodder trees have shown a crude protein content as high as 34 %, even when they have fallen off the branches during the dry period. The dry matter content of different fodder legumes can vary between 20 % and 36 % (Simbaya, 1998). The mineral contents of fodder trees are higher compared with for example grass, as the deeper root system of the trees reach soil which contains more minerals than the upper levels of soil (Mia & Noman, 2002). They contain a lot of sulphur, calcium, copper and iron, but are poor in manganese, zinc and phosphorus (Simbaya, 1998). Tropical soils are often low in organic matter and this is tolerated by fodder trees (Gutteridge & Shelton, 1998) Different types of trees and shrubs thrive in different climates and the yields of the plants could maybe be greater if it was possible to choose among different species according to the climate in an area (Speedy & Pugliese, 1991).

Fodder trees demand little labour compared to grass pastures. When cultivated together with food crops, they tend not to compete for the nutrients contained in the soil as their root systems are going deeper than in most crops used for food (Simbaya, 1998). In addition to feed, fodder trees can be used for other purposes such as fuel wood, building material, natural medicine, food, living fences, as shade for other crops such as coffee or cacao and green manure (Speedy & Pugliese, 1991). Soil erosion can be reduced and soil fertility improved by planting fodder trees and shrubs (Xaypha, 2005). The trees can both be planted as fences around farms or in fallow crop land and then be harvested several times a year (Paterson & Roothaert, 1997). They could also be planted in fenced plots around the house, keeping the livestock out of the plants harm (Xaypha, 2005). When planting fodder trees near the own property, a lot of time can be saved as the farmers do not have to walk long distances to gather feed. The common areas needed for grazing in villages can also be reduced, making the land available for other causes (Kollmair, 1999).

Several species exist and they all have different values as feed. The palatability of a feed is very important for goats, and therefore this must be considered when choosing what tree species to use. The crude protein content has to be high and available to the animal. Some fodder trees have enough protein to be fed as the only protein source, while others have less and are best fed as a supplement to another main source of protein (Amanullah, 2006). Older trees has less crude protein content in the plant parts and the fibre content increases with age, something that also needs to be considered when feeding animals with parts from trees (Acharya, 1986). Some fodder trees contains different antinutritional or toxic substances (Dicko & Sikena, 1992). But fodder trees are rarely used as sole feed and therefore the possible toxic substances are diluted with other feedstuffs, making potential toxic substances harmless to the animal (Simbaya, 1998).

Feeding legume trees to livestock have extra advantages. Studies have shown that goats fed both cereal crops and legume leaves have a higher dry matter intake than animals fed only cereal crops. The digestibility of protein and organic matter also increases when legume leaves are included in the diet (Aregehore & Parera, 2004). Feed conversion, rumen function and the availability of minerals and vitamins in the feed also improves when a carbohydrate rich diet is supplemented with legumes (Kanani et al., 2006). A part of this can be explained by that an N-deficiency in the rumen leads to an, for the rumen microbes, unbalance between available energy and protein. Therefore their synthesis of different nutrients is restricted. When the basal diet poor in protein is supplemented with legumes, rumen microbes can utilize more of the energy contained in the basal feed, and this then is beneficial for the animal itself (Aregehore & Parera, 2004). The use of legume trees instead of urea as a protein supplement has shown better production results, showing that something else than N in the feed also matters for improving the nutritional value of poor feedstuffs (Camero et al., 2001).

Aregehore and Perera (2004a) saw that the voluntary feed intake was higher when supplementing maize stover with *Erythrina variegata*, *Glyricidia sepium* or *Leucana leucocephala* compared to when supplemented with urea. In a study by Ash (1990), the total dry matter intake increased when the diet was supplemented with the fodder tree *Sesbania*. The grass intake increased as well compared to the control diet when *Sesbania* was fed together with it. Addition of molasses could in some cases increase the feed intake of diets including legume trees even more (Aregehore & Perera, 2004a).

The optimal inclusion of parts from fodder trees in the diet of livestock seems to be 40- 60 %, if more is given than that, the productivity of the animals seems to decline instead of increase (Gutteridge & Shelton, 1998). Thi Mui et al. (2001) saw that leaves from jackfruit could replace 50 % of the protein in a diet of chopped sugar cane, grass and concentrate, without effecting weight gain or feed intake. The plant could as well be used as the only protein feed in a diet, but this would cause production losses. This may would be more economic for some farmers, instead of feeding concentrates which often are expensive. *Flemingia* was also tested as a protein source in the study, but showed a poorer potential than *Erythrina*, only 17 % of the protein in the diet could be replaced feeding the plant.

Conservation of feed from fodder trees

Leaves from some tree species used for feed have shown to increase its content of by-pass proteins when dried. In feeding trials, the weight gain has been greater in animals fed the dried leaves compared to animals fed the fresh form. Drying can also decrease some plants contents of antinutritive factors or increase the palatability in some cases (Gutterdige & Shelton, 1998).

When ensiled together with grass, leaves from fodder legume trees have shown to be superior to sorghum silage which is often recommended for silage making in tropical countries.

Erythrina

Erythrina is a species with many varieties. It thrives in tropical low-lands with moderate rainfall of 1000-1500 mm per year (Whistler & Elevitch, 2006). The plant is common through the tropics and also in warm temperate areas such as southern China and South Africa. The variety *Erythrina variegata* is spread along the Indian Ocean from Madagascar to Indonesia. It can also be found in Polynesia, Micronesia, New Guinea and The Marquesas (Gutteridge & Shelton, 1998). The trees grow best in sandy loams but can tolerate many other types of soils, but the pH should be from 4.5 to 8. It needs a lot of sun and do not tolerate shade especially well. The most typical natural habitat for the plant is in littoral forest but it can also be found in coastal forests. The tree drops its leaves during winter, which allow it to withstand long dry periods without water (Whistler & Elevitch, 2006).

Erythrina variegata, also called Coral tree, is widely cultivated as windbreak, shade or support tree to other crops, natural fence and soil improver. In India, it is a very common shade tree for coffee and cacao (Gutteridge & Shelton, 1998). The leaves could also be boiled and eaten by humans. It is typically 10-15 meters in height and is fast growing, often more than 1.5 meters a year. A normal size tree produces 15-50 kg dry matter green fodder annually, depending on growing conditions (Whistler & Elevitch, 2006; Aregehore, 2004).

A plantation of *Erythrina variegata* could be browsed by animals one to two hours per day without the animals damaging the crops (Pezo et al., 1992). The trees should also be regularly pruned and a rotating browsing system must be used in order not to damage the trees. Further, not all of the leaves could be reached by livestock and need to be cut by the farmer (Gutteridge & Shelton, 1998). If cut and carried to goats, the branches of the tree should be hung at the side of the pen or from another object. In trials with *Stylo 184* and *Glyricidia*, the feed intake has shown to be higher when the branches are hung to a wall or similar than if it is fed in a trough. In addition, the whole branches from the tree should be fed and not only the leaves, if only the leaves are fed the feed intake and digestibility decreases (Keopaseuht et al., 2004).

Goats are selective feeders and are known to eat from the most nutritious and palatable feed available at the moment. In a trial where goats were offered leaves from *Erythrina variegata*, jackfruit, mango, fig, jujube and kapok they ate most of *Erythrina variegata*, showing that the plant is a palatable feed for goats (Kongmanila et al., 2008b). In a study by Kibria et al. (1994) the plants leaves were compared to other fodder leaves as goat feed. *Erythrina variegata* had an organic matter digestibility of about 78 %, a high feed efficiency and a high daily weight gain. In a study by Alagesan et al. (2006) where leaves from ten different tree species were compared, an *Erythrina* species together with a plant called *Glyricidia* had the highest digestibility. A high voluntary intake could also be recorded for the *Erythrina* species.

Nutritive value of *Erythrina*

The leaves of the tree contain high amounts of crude protein, 16-21 % of DM, making it a good protein feed for animals (Whistler & Elevitch, 2006). Aregehore and Perera (2004a) reported a crude protein content of 21.3 % when the plant was analyzed for use in a feeding trial. The

protein content is high compared to other legume trees commonly used as fodder, (Whistler & Elevation, 2006). *Glyricidia sepium* and *Leucaena leucocephala* which are legume trees commonly used for feeding purposes had crude protein contents of about 16.1 % and 18.6 % respectively in a study by Aregehore and Perera (2004a). These figures could be compared to the crude protein content of 6.3 % in maize stover, which also was used in the study. For an effective utilization of the N content, the plant has to be fed together with a ready fermentable carbohydrate source such as young grass, sugar cane, grain or molasses. Digestibility of dry matter is 45-60 % (Pezo et al., 1992).

The content of several vitamins is higher than in many other plants. Dicko and Sikena (1992) wrote that browsers that eat from fodder trees in dry tropical Africa seldom get eye inflammation or contract photophobia in the dry period, which both are signs of vitamin deficiency.

Erythrina variegata contains alkaloids, which are toxic, and they are mainly found in the bark and seeds of the plant. These are to the main part, degraded in the rumen and should therefore not cause any harm to ruminants. Alkaloids have been found in milk by animals fed the plant. Therefore, monogastrics should not be fed *Erythrina* if not only in very small amounts. Despite of this, some people in the world use the seeds, ground, in different foodstuffs used for humans (Gutteridge & Shelton, 1998).

Effect on productivity

Pezo et al. (1992) showed a reduced weight gain when goats were fed *Erythrina* as a protein supplement compared to when they were fed soy bean meal or fish meal. Pineda (1986) saw a linear decrease in weight gain for heifers with an increasing amount of *Erythrina* replacing soy bean meal in the diet. The total dry matter intake also decreased with increasing amounts *Erythrina*. It is however more economic for the farmer to use fodder trees such as *Erythrina* as protein source than commercial products as protein concentrates.

When ruminants are fed *Erythrina* as a supplement to grass, their milk yield increases, compared to when they are only eating grass, sugar cane or other feeds poor of protein (Kass et al, 1991). Larbi et al. (1993) saw an increased weight gain in sheep and goats with increasing amounts of *Erythrina abyssinica* in a basal diet with Napier grass. Cuellar et al. (1996) measured an increased milk production in cows when a mixture of wilted *Erythrina fusca* and palm oil was given as a supplement to African star grass instead of a concentrate mixture containing poultry litter, rice polishing, palm kernel cake and distiller's solubles. *Erythrina* also increased the milk yield more than if urea was used as a protein supplement to grass (Pezo et al., 1992). Urea or molasses is common dry period feeds in many developing countries (Kass et al, 1991),

Material and methods

The experiment took place at the Farm of the Livestock and Fisheries Department, Faculty of Agriculture, National University of Laos, Vientiane, Lao PDR.

Animals and management

Forty goats of the local Ma T'ou breed were used for the study. At the start of the experiment they were 3-4 months old and had a weight of 12 to 14 kg. Before the experiment started the animals were treated against parasites and vaccinated against Foot and Mouth disease. The goats were kept individually in pens (figure 1) but with the possibility to see and be in contact with each other. Mineral licks and unlimited amounts of drinking water were provided. Two separate troughs in each pen were used for feeding cassava meal, soy bean meal and guinea grass. The *Erythrina* foliage provided was hung from a stick above the trough. The goats were fed two times a day. At 7.00 a.m. they were provided with half the amount of the *Erythrina* foliage, grass, soy bean meal and cassava meal. At 5 p.m. they were given the rest of the feed. The length of the experiment was 12 weeks and the goats were given their experimental diet one week before the trial period started to be able to adapt to the new diet. The goats were bought from different farmers in the surrounding area and had only been suckling and grazing before they were brought to the research centre.

Experimental diet

The diets given contained different amounts of *Erythrina* foliage, and then the diets were supplemented with different amounts of soy bean meal, cassava meal and Ruzi grass to reach the same content of metabolisable energy and crude protein. The crude protein and energy contents in the diets were formulated to fit a 15 kg goat growing 100 g/day and it translated to 90 g DM crude protein and 5.91 MJ. The diets were changed after 6 weeks to fit the requirements of the goats at the then heavier weight. *Erythrina* constituted 0, 20, 40 or 60 % DM of the daily need of crude protein in the different diets. The 40 goats were randomly allocated to the four diets but were balanced for sex with four goats of each sex in each diet.

The Ruzi grass was harvested in the afternoon from pastures near the experimental unit and was fed fresh. The *Erythrina* foliage was also harvested in the afternoon. Whole cassava was bought from the surrounding area and processed to meal by the staff at Nabong farm. Already processed soy bean meal was purchased.

Measurement and analysis

Parameters to be determined were; feed intake, refusals, growth rate, digestibility, N retention and carcass characteristics. Feed offered and refusals were recorded individually each day during the experiment period. Every week, each feed offered and refused of each treatment was taken to determine DM content. The chemical composition of six samples of each feed taken at different times during the experiment period were analysed.



Figure 1. The goat house with individual pens.

The animals were weighed at the start of the experiment and then a second time two weeks later. Twenty goats were, one week at the time, held in metabolism cages (Figure 2) for collection of faeces and urine. The samples were used to determine N retention and digestibility of the diets.



Figure 2. Collection of urine and faeces.

The animals were slaughtered at the end of the experiment to estimate empty body weight and the weight proportion of muscle, bone and digestive organs.

Results and discussion

The experiment conducted in this study was a part of a Minor field study which was funded by Sida. The scholarship covers an 8 weeks stay for a student from Sweden in a developing country.

However, during the first week of the experiment some goats had diarrhea which required that they were fed a different diet than the experimental one. Later, during the second week, some goats refused to eat and some goats even died. Because of this, many of the goats were taken out of the cages and fed other feedstuffs. The experiment was therefore postponed several times. Due to my limited time of 8 weeks I had no possibility to get any results from the experiment. The results from the study will instead be presented by my local supervisor who continued with the experiment after I had left Laos. Later on, it was confirmed that the goats suffered from a disease from where all the problems arose.

Several changes in the composition of the diets were made during my stay. The amount of Erythrina was lowered and the basal feedstuff Ruzi grass was changed to Jujube in half of the goats' diets. The experiment would then compare, not only the level of Erythrina given in the diet, but also the effect of feeding another basal diet. The goats fed Jujube were included in the digestibility trial but not the growth trial.

While I was in Laos, we (my local supervisor and I) did not know that some goats suffered from

the disease and we had therefore several thoughts about what could cause the diarrhea, lack of appetite and death among the goats. It seemed as that the diet was too monotonous for some goats, but still most animals ate the experimental diet with good appetite. When the goats were let out of the pens, the majority had no problems to start to eat again from what was available from the surroundings. It was mainly bucks that had problems with the feed presented. Their pens were located near other goat pens belonging to another experiment and also the free-ranging goats let out from the cages before and this could have affected their behaviour in some way.

We further speculated that if the goats had been fed together in groups divided according to the amount of *Erythrina* in the diet, perhaps they would have eaten. But on the other hand, this would only give mean figures of feed intake and weight gain per goat. Other feedstuffs than Ruzi grass, cassava meal and soy bean meal could have been fed together with the *Erythrina*, but then again problems with too few feeds for the goats to choose from would probably occur. Goats like to eat many different species of plants, and even if more nutritious and palatable feeds are available, they often choose to eat even from the less nutritious feed (Kongmanila, 2008). If a more palatable feed than Ruzi grass was fed together with the *Erythrina*, then maybe they would not refuse to eat.

The age of the goats was something we thought could have been a problem. They were young and some of them too young to have been weaned yet. They were perhaps more sensitive to some feedstuffs than older goats.

Although the experiment was not successful during my period of stay, I learnt a lot from participating in it. In developing countries, the equipment are often more simple compared to western countries. The equipment in the present laboratory was very simple and many analyzes had to be done in Vientiane, the capital of Laos, or in Thailand. Some experimental designs are difficult to follow. It is more difficult to standardize an experiment, as the temperature almost never is controllable, the feed vary more in quality, the animals used in a trial can come from many different sources and it is often a power failure.

However, although it is not always possible to perform the experiments as they would have been done in developed countries, it is often better to conduct an experiment in the country where the results are going to be used for practical causes. Many times it is not necessary to have very advanced equipment to perform a study.

The potential of using feed from fodder trees

The human population growth and growing demand for meat in Lao PDR is going to limit the available area of grazing land and therefore other means of feeding than grazing is necessary to develop. Cultivation of fodder trees and other forages is a way to improve the production rate of land area (Xaypha, 2005). Legume trees offer a renewable and cheap source of feed protein for poor farmers, other feeds available are often to expensive and hence most goats are left without sufficient amounts of protein (Kanani et al., 2006). I think there is potential to use a lot of plants, not just *Erythrina variegata* that are not yet considered to be feed in developing countries, but could be really cheap means to produce meat and milk. Too much focus on developed countries is the wrong way to go, other animal breeds and also plant species that are adapted to the local

conditions should be used to a greater extent.

At present, only a small selection of species is used for feed, but if more knowledge about the nutritional value and acceptance by animals was available several more species could be used (Speedy & Pugliese, 1991). Not only screenings of the nutritional value are needed, but also feeding trials with different kinds of livestock. A certain plant could show to have high digestibility and be very nutritive and still be neglected by animals for different reasons. Some species could also show to have a low digestibility in screenings, but when fed to animals the rumen passage rate could be high, allowing the animal to eat more and therefore still get enough nutrients (Gutteridge & Shelton, 1998).

Erythrina variegata could be used to promote growth in goats during the dry season. Little research has been done on the use of *Erythrina variegata* as feed for animals, especially for goats, and there is a need of more knowledge of how it affects growth rate, organic matter intake and the digestibility of different diets.

References

- Acharya, R., M. 1986. Small ruminant production in arid and semi-arid Asia. *FAO Animal Production and Health Paper* 58, 148-169.
- Alagesan, A., Mohamed Amanullah, M., Pazhanivelan, S., Sathyamoorthi, K., Somasundaram, Vaiyapuri, E. 2006. Evaluation of Some Tree Species for Leaf Fodder in Tamil Nadu. *Research Journal of Agriculture and Biological Sciences* 2(6), 552-553.
- Amanullah, M. M., Somasundaran, E., Alagesan, A., Vaiyapuri, K., Pazhanivelan, S., Sathyamoorthi, K. 2006. *Journal of Agriculture and Biological Science* 2, 552- 553.
- Aregheore, E.M., Perera, D. 2004a. Effect of supplementation of a basal diet of maize stover with *Erythrina variegata*, *Gliricidia sepium* or *Leucaena leucocephala* on feed intake and digestibility of goats. *Tropical Animal health and Production* 36, 175- 189.
- Aregheore, E.M., Perera, D. 2004b. Effects of *Erythrina variegata*, *Gliricidia sepium* and *Leucaena leucocephala* on dry matter intake and nutrient digestibility of maize stover, before and after spraying with molasses. *Animal Feed Science and Technology* 111, 191–201.
- Ash, A. J. 1990. The effect of supplementation with leaves from the leguminous trees *Sesbania grandiflora*, *Albizia Chinensis* and *Gliricidia Sepium* on the intake and digestibility of Guinea grass hay by goats. *Animal feed science and technology* 28. 225-232.
- Camero, A., Ibrahim, M., Kass, M. 2001. Improving rumen fermentation and milk production with legume-tree fodder in the tropics. *Agroforestry Systems* 51, 157–166.

- Cuellar, P., Rodriguez, L., Preston, T. R. 1996. The forage tree *Erythrina fusca* as a protein supplement for cattle and as a component of an agroforestry system. *Livestock Research for Rural Development 1*.
- Devendra, C. 1993. Nutritional potential of fodder trees and shrubs as protein sources in ruminant nutrition. *Animal Health and Production Paper 102*.
- Dicko, M. S., Sikena, L. K. 1992. Fodder trees and shrubs in range and farming systems in the dry tropical Africa. *Legume Trees and Other Fodder Trees as Protein Sources for Livestock 102*.
- ESSGA. 2006. Food and agriculture indicators, Lao People's Democratic Republic.
- FAO. 2007a. Agricultural Biodiversity in Lao PDR.
- FAO. 2007b. Livestock Diversity in Lao PDR.
- FAO. 2005. Livestock sector brief: Laos, Peoples Democratic Republic.
- Gutteridge, R. C., Shelton, H. M. 1998. Forage tree legumes in tropical agriculture. CAB International, Wallingford 389
- Kanani, J., Lukefahr, S.D., Stanko R.L. 2006. Evaluation of tropical forage legumes (*Medicago sativa*, *Dolichos lablab*, *Leucaena leucocephala* and *Desmanthus bicornutus*) for growing goats. *Small Ruminant Research 65*, 1-7.
- Kass, D. L. 1999. Erythrina research in Costa Rica.
- Kass, M., Benavides, J., Romero, F., Pezo, D. 1991. Lessons from main feeding experiments conducted at CATIE using fodder trees as part of the N-ration. *Legume trees and other fodder trees as protein sources for livestock*. 161-175.
- Keonakhone, T., Ciathong, V., Badenoch, N., Phonachit, P., Chantavong, N. 2009. Livestock groups: Lessons from Phonethong, Phonexay district, Luang Prabang province. URDP Field report 0901.
- Keopaseuht, T., Ty, C., Bounthong, B., Preston T. R. 2004. Effect of method of offering foliages of *Glicirida sepium* and *Stylosanthes guianensis* CIAT 184 (Stylo) to goats on intake and digestibility. *Livestock Research for Rural Development 16*.
- Kibria, S.S., Nahar, T., M., Mia, M.,M. 1994. Tree leaves as alternative feed resource for Black Bengal goats under stall-fed conditions. *Small Ruminant Research 13*. 217-222.
- Kollmair, M. 1999. Indigenous knowledge of fodder tree cultivation in mid-hill Nepal. Fact sheet.
- Kongmanila, D., Preston, T. R., Ledin, I. 2008a. Survey on the utilization of local foliage species

for goats in Xaythanee District, Vientiane city. *Livestock research for Rural development* 20.

Kongmanila, D., Preston, T. R., Ledin, I. 2008b. Selective behaviour of goats offered different tropical foliages. *Livestock research for rural development* 20.

Kibria, S.S., Mia, M.M., Nahar, T.N. 1994. Tree leaves as alternative fodder resource for Black Bengal goats under stall-fed conditions. *Small Ruminant Research* 13. 217-222.

Larbi, A., Thomas, D., Hanson, J. 1993. Forage potential of *Erythrina abyssinica*: intake digestibility and growth rates for stall-fed sheep and goats in southern Ethiopia. *Agroforestry systems* 21. 263-270.

Lukhele, M.S., Van Ryssen, J. B. J. 2003. The chemical composition and potential nutritive value of the foliage of four subtropical tree species in southern Africa for ruminants. *South African Journal of Animal Science* 3, 132- 141.

Lukhele, M. S. 2002. The chemical composition and nutritive value of leaves of indigenous fodder trees. Faculty of Natural and Agricultural Sciences, Department Animal and Wildlife Sciences, University of Pretoria.

Mekoya, A., K. 2008. Multipurpose fodder trees in Ethiopia- Farmers perception, constraints to adaption and effects of long-term supplementation on sheep performance. PhD Thesis, Wageningen University, Wageningen, The Netherlands.

Mekoya, A., Oosting, S. J., Fernandez- Rivera, S., Vander Zijpp. A. J. Fodder tree development and farmers innovative ideas to balance multiple household objectives n the ethiopian highlands. *Agricultural Systems* 96, 184-194.

Mia, D., Noman, M. K. 2002. Farmers preferences and the indigenous practice of fodder trees in the flood plain area In Bangladesh. Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong 4331, Bangladesh.

Nafri. 2005a. Smallholder livestock systems and upland development. *Improving livelihoods in the uplands of Lao PDR*. 71-77.

Nafri. 2005b. Forage options for the LAO upland. *Improving livelihoods in the uplands of Lao PDR*. 86-89.

Nafri, 2005c. Managing feed resources in upland livestock systems. *Improving livelihoods in the uplands of Lao PDR*. 78- 85.

Paterson, R.T., Roothaert, R.L. 1997. Recent work on the production and utilization of tree fodder in East Africa. *Animal Feed Science Technology* 69, 39-51.

Pezo, D. A., Kass, L. Romero, M., Benavides, J. 1992. Fodder production and use. Erythrina production and use- a field manual.

Phouthavong, E. E. K., Phimpachanvongsod, V, Phengsavanh, P. 1998. Assessment of fodder tree legumes in a low-land area of Lao PDR. *Integrated crop-livestock production systems and fodder trees*. 89- 98.

Pineda, O. 1986. Utilizacion del follaje de poro en la alimentacion de terneras de lecheria. Universidad de Costa Rica. Turrialba. Thesis.

Simbaya, J. 1998. Potential of fodder tree/shrub legumes as a feed resource for dry season supplementation of smallholder ruminant animals. National Institute for Scientific and Industrial Research, Livestock and Pest Research Centre, Chilanga, Zambia.

Speedy, A., Pugliese, P. 1991. Legume trees and other fodder trees as protein sources for livestock. Proceedings of the FAO Expert Consultation held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia, 14–18 October 1991.

Thi Mui, N., Ledin, I., Uden, P., Van Binh, D. 2001. Effect of replacing a rice bran- soya bean concentrate with Jackfruit (*Artocarpus heterophyllus*) or Flemingia (*Flemingia macrophylla*) foliage on the performance of growing goats. *Livestock Production Science* 72. 253- 262.

Whistler, W.A., Elevitch, C.R. 2006. *Erythrina variegata* (coral tree), Species Profiles for Pacific Island Agroforestry. Available from <http://www.traditionaltree.org>, 2008-12-16.

Wilson, R.T. 2007. Status and prospects for livestock production in the Lao People's Democratic Republic. *Tropical Animal Health Production* 39. 443-452.

Xaypha, S. 2005. Goat production in smallholder farming systems in lowland in Lao PDR and an evaluation of different forages for growing goats. MsThesis, Swedish University of Agricultural Sciences.