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RESEARCH-EXTENSION APPROACH TO PROMOTE BULB ONION PRODUCTION IN DRY-LOWLANDS WITH SPECIAL REFERENCE TO CENTRAL PROVINCE IN PAPUA NEW GUINEA

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ABSTRACT

Short-day onion varieties were evaluated at Laloki Research Station, Central Province, Papua New Guinea over three years between 1991 to 1993. Potential varieties and planting time have been identified. With an increasing demand for bulb onions in Port Moresby an effective extension approach to promote these varieties and production techniques to the small-scale farmers in Central Province is required.

KEY WORDS: *onion varieties, planting time, effective extension approach, production techniques, farmers*

INTRODUCTION

In Papua New Guinea (PNG) some critics have blamed the Agricultural Research Division of not conducting the right type of research that would be of benefit to the small-scale farming community (Das, 1987). In such a situation the argument is that there are no innovative ideas or techniques to take to the farmers. However, the approach to Agricultural Research has changed over the years. Emphasis has been on the farming systems approach and adaptive on-farm research. Furthermore, station-based research has focused on addressing farmers' production problems, but it seems that the information is not reaching the farmers. This has been attributed to the weak structural linkage between agricultural research and extension (Chamala, 1983; Kesavan, 1983; Chamala, 1987). These are some of the issues that complicate the flow of information from the Researcher to the Extension Agency and the beneficiaries (farmers).

In PNG, Primary Industry Extension Services' decentralization was passed by an Act of Parliament in 1977 with the aim of bringing extension services closer to the rural farming communities. Thus, all provincial Department of Primary Industries (DPI) were responsible for providing extension services. Therefore, research extension programmes of the national Department of Agriculture and Livestock (DAL) may not be fully implemented through the Provincial DPI extension system. The DPI Provincial extension services are based on the farmers' needs and priorities.

Only recently the DAL was directed by the Minister of Agriculture and Livestock to form a working committee to review the current DPI extension system and provide a submission to cabinet to centralize DPI Extension Services. There is a need to re-establish Research-Extension linkage, a problem which probably came about because of the decentralization process.

In this document the various options in designing and disseminating information on bulb onion research results from Laloki Research Station are presented. The approach is designed to stimulate interest within the farming community in the dry-lowlands of the National Capital and Central Provinces to grow bulb onions for the fresh food market in Port Moresby. There is an increasing demand for fresh vegetables to feed the growing population of over 300,000 Port Moresby residents and the surrounding areas.

Overview of the dry-lowlands environment of Central Province

The National Capital and parts of Central Province are classified under the dry-lowlands agroecological environment having a distinct wet and dry season with 92% of the rainfall occurring from December to May and only 8% falling from June to November. Under traditional farming practices crop scheduling is guided by the rainfall pattern and vegetable production is limited in this regard. However, water is in abundant supply from ever-flowing rivers, creeks and underground aquifers. A major constraint is capital and technical know-how in harvesting water for irrigating vegetables during the dry season. Most, if not, all of the farmers would have very little cash to invest in irrigation and basic farm equipment for commercial vegetable production. A high level of production management would be required to ensure quality and continuity of fresh vegetables.

Farmers who are able to produce vegetables all year round have a market advantage especially the highly priced vegetables (provided that quality is up to standard) which are in short supply during the dry season. The difficulty faced by growers to irrigate during the dry season means that vegetables, which could be produced at this time, have a comparative market advantage. Locally grown vegetables are fresh and could be sold at a competitive price. Most retail outlets in Port Moresby demand quality produce and continuity of supply. The returns for high value crops including bulb onion are good. Figures available from a model farm in the dry-lowlands of the Central Province shows that a net profit of over K6,000 could be generated from a 2 hectare crop of mixed vegetables (Sowei, 1993).

Another constraint is the availability of good agricultural land. The land tenure system in PNG is diverse and complicated. Ownership and availability determines the area, which could be developed for vegetable production or any agricultural enterprise for that matter. On average a small-scale commercial vegetable grower in the Central Province would have 4 hectares of suitable land to grow vegetables.

Onion variety selections for the dry-lowlands

Bulb onion varieties selected for production in the dry-lowlands of Central Province produced optimum marketable yields during the dry season, provided that the crop is irrigated. During the wet season, the onion crop can be severely affected by purple blotch (*Peronospora destructor*) a widespread fungal disease in onion.

Having identified the varieties, time of planting and management practices, a pilot programme will be conducted by DAL Food Management Division to extrapolate research results from Laloki Research Station to the farmers' field. A proposed strategy of bringing research results to the farmers is discussed in this report.

Strategies to promote onion production in the dry-lowlands

Target audience

To introduce new onion varieties and promote production methods, the target groups will be the innovative small-scale vegetable growers in the National Capital and Central Provinces.

Extension approach

The extension approach will be conducted using the five-step adoption model proposed by Mortiss (1988). The program will be designed so that the farmers are involved in the decision making process. The approach will be based on group discussions, active participation and practical field demonstrations. This method has been reported to have the most impact in Papua New Guinea (Das, 1987).

1. **Awareness** - The awareness phase has been done through the mass media: PNG Post Courier Daily Newspaper, The National Broadcasting Commission's (NBC) "Tropical Gardener Program", The Independent and through the DAL Newsletter, Didimag and Harvest.

2. **Interest** - During the variety evaluation in 1993, a field day was organized at Laloki Agricultural Research Station for farmers in the area. Interest has been established, as many of the innovative vegetable farmers were quite willing to participate in establishing demonstration plots on their farm.

3. **Evaluation** - The evaluation phase will involve organizing group discussions with farmers to encourage their participation so that they will weigh out the benefits and other problems they might have in adopting the production methods and onion varieties.

4. **Trial** - Selected innovative farmers wanting to test the varieties and production techniques will be provided with free seeds and consultation. These farmers will establish demonstration plots to gain hands-on eperience on how to manage the onion crop.

5. **Adoption** - After establishing farm demonstration plots, farmers will then decide whether to adopt or reject the technology of onion production (production methods and varieties).

Other promotional activities

A number of methods could be used to disseminate research results to farmers to promote onion production. The Research Staff would undertake the following:

(1) Organize onion field days - for farmers and Extension Officers in DAL Food Management Division and the Fresh Produce Development Company (FPDC). The FPDC is a New Zealand Aid funded vegetable development project, providing extension advisory services to the vegetable growers in PNG.

Field plots should be established early April so that the crop will be in at least three different stages - seedling, bulb initiation, full bulb development and maturity for the planned field day.

During the field-day the Researchers and Extension Officers could explain techniques in nursery establishment, production practices, harvesting and curing, handling, storing, grading and marketing of bulb onions. Farmers' participation should be encouraged in discussing the production techniques. The farmers will have to be guided by the Researchers and Extension Officers through different onion production stages.

Demonstrations on farmers' field would be a starting point where the farmers could practice what they have learned during the field day. The Researchers and Extension Officers would monitor their progress and advise them if they have to. The idea is to use the adult learning approach to help the farmers teach themselves. At the end of the day the farmers should then decide whether to adopt or reject the new onion varieties and production methods. The good prices offered for bulb onion in Port Moresby may be an incentive for the farmers to reaffirm their adoption process.

In the initial planning phase notices and posters would be sent out to the mass media. To help promote the onion field-day representatives from the mass media would be invited to cover the event. Also in the planning phase the Researchers and Extension Officers would invite individual farmers. Transport should be arranged to pick-up farmers at a central location. Leaflets and posters should be circulated well in advance. The DAL Publications Section could promote the event through its monthly Didimag Newsletter.

(2) On-farm demonstration plots - during the field day at Laloki Research Station interested farmers would be identified to establish on-farm demonstration plots. This process gives farmers the opportunity in trying out new production techniques and varieties so that they can then decide to adopt or reject the technology.

Extending research results to the farming communities in PNG is very complex. Farmers', limited educational background, socio-economic condition, infrastructure, land tenure and general farmer attitude towards accepting new ideas and technology are some of the barriers facing agricultural development in PNG. However there are indications that farmers are willing to change and improve on their traditional farming practices. Figures available in 1980 show that of the total rural population 8.5% were classified as pure subsistence farmers, 87% semi-subsistence/ semi-commercial and 4.5% were engaged in commercial plantation crops (White Paper on Agriculture, 1989).

(3) Onion information bulletin - to aid in technology transfer or adoption, a simple step-by-step procedure on planning, nursery techniques, field management, postharvest handling and marketing of onion in the form of an information bulletin which could be produced. The information bulletin is written in English but could be translated into the regional dialect, Motu. This bulletin is to be made available to both the vegetable Extension Officers and the growers in the dry-lowlands of the National Capital and Central Provinces. To aid farmers with limited educational background an onion production poster (pictorial form) shoulod be produced with the assistance of the DAL Publications Section.

(4) Audio visual aids - the DAL Publications Section's Video Production Unit have access to equipment and facilities for filming different stages of onion production. Once completed the videotape could be used as a teaching tool in Agricultural Colleges and for farmer training. Copies of the video should also be available at a minimal cost to Extension Officers, farmers, teachers and the general public.

(5) Television and radio broadcasts - almost all the villages situated along potential vegetable growing areas in the dry-lowlands of the National Capital and Central Provinces have rural electricity. The only television station, EM-TV offers some scope for broadcast and would help in developing an awareness or interest for other farmers to attend meetings, field days and visits to demonstration plots and let the innovative farmer explain what he has learned to other farmers.

Another means of communicating information from the Researcher to the Extension Officer and the Farmer is through the Provincial Radio Station. Information on onion production could be broadcast using the regional dialect so those farmers could grasp the message easily.

(6) Publications - *Didimag Newsletter* and *Harvest* are bi-monthly and bi-annual publications respectively. These publications should be used to publish a simplified and translated version of the information bulletin on onion production in the dry-lowlands of the National Capital and Central Provinces. A simplified pictorial poster on various aspects of onion production should be produced with the assistance from the DAL Publications Section and made available to less educated farmers.

CONCLUSION

The success of the approaches outlined to provide information generated from trials conducted at Laloki Research Station would very much depend on how well the message is communicated through to the farmers. It is my belief that approaches such as the field day and the do-it-yourself field demonstration plots should have the most impact because "seeing is believing". The final decision of whether farmers will accept and take-up growing bulb onion depends on the farmers' resources (land, labour and capital); the Researcher and Extension Agents only help the farmers to reach that decision. Another challenge for extension agents is to facilitate the transition of the traditional subsistence farmer taking up commercial or semi-commercial farming practices.

Insufficient funds provided for extension work may also hinder the use of effective approaches such as organizing field-days and on-farm demonstration plots to promote onion production in the area. This is an ongoing problem, which has also contributed to an ineffective Research-Extension-Farmer linkage. The DAL has been mandated to re-establish that vital link so that information gnerated from Research Stations can reach the target aaudience - the farmers.

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LIVESTOCK DEVELOPMENT NOTES: NO. 10

SOME HANDS-ON TIPS IN CALCULATING AND FORMULATING PROTEIN CONCENTRATE SUPPLEMENTS FOR POULTRY

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ABSTRACT

A guide to calculating and utilizing locally available feed ingredients in producing cheap protein concentrate supplements is discussed.

Key words: *feed formulation, protein concentrate supplements,choice feeding, poultry*

INTRODUCTION

There are a number of agro by -products (e.g. copra meal, rice bran, etc..) available in the country which can play a major role in developing feeds for the animals and birds. Also, we grow crops in our food gardens, many of which (e.g. wing bean and yawa banana) can be used as feed sources.

Occassionally, sufficient quantities of these ingredients may be available and one would like to make use of them by feeding them to the birds. This, could be of particular relief during times when the local feed supplier has no feed in stock and, one has to obtain feed from other sources to maintain the birds until the new stocks arrive. This communication is intended to assist when one encounters such suitations, in particular in enabling anyone interested in using a method of feeding known as choice or self - selection feeding method (see Bakau 1988, 1997).

MATERIALS REQUIRED

In addition to the feed ingredients, other materials required include a suitable floor space for mixing the feed, a balance which can give readings in gram, a 100-300 kg slater scale, spades or shovels for mixing the feed, storage bins and storage space or rooms.

FORMULATING PROTEIN CONCENTRATE SUPPLEMENTS

Although this discussion centres around protein concentrate formulation, the principles are essentially the same and can be used in formulating complete rations.

Some general considerations

When all the feed ingredients have been assembled, the next process is to determine the nutrient composition of the protein concentrate supplement. As a rule of thumb, animal nutritionists usually proceed by first considering the protein and energy composition of the feeds. We know that a good protein concentrate supplement is one that contains between 30 to 40% crude protein supplying between 9-10 MJ/kg metabolisable energy, ideally derived from both plant and animal sources. We also know that in a choice feeding system, the birds eat one part protein concentrate supplement to 2-3 parts energy feed sources. Since vitamins, minerals, amino acids, salt, etc. will be added to the concentrate supplement, it is important to add 2 to 3 times more of the recommended amounts of these minor nutrients to the protein concentrate. This is necessary because when the birds eat one part of the protein concentrate supplement, they should eat adequate amounts of these nutrients. Otherwise, the minor nutrients the birds consume will not be enough to maximise their performance.

Several task-groups such as the Agricultural Research Council (ARC; United Kingdom) and the National Research Council (NRC; United States) have collated most of the details of the nutritive composition of common feed ingredients and the nutrient requirements for poultry. Because new data are constantly generated, the most recent publication on the subject should be consulted when formulating the diets. Tables 1 and 2 contain the basic information which one needs to consult before mixing any feed. Note that the nutritive composition of feeds are average values and should be used as a guide rather than as definite values. The same is also true for the nutrient requirement values for poultry. These are values which have been accepted as the best we have got in terms of our understanding of the nutrition of the birds.

Another factor to consider is the cost of the feed ingredients involved. Most high protein feed ingredients (e.g. soya bean and meat and bone meals) are more expensive. Usually, no more than three of such ingredients are used in formulating protein concentrates; two ingredients with high (e.g. meat and soya bean meals) and one with medium (e.g. copra meal and rice bran) protein contents. In addition to protein, these ingredients will also provide energy, vitamins and minerals, but they are in lower amounts so additional sources will have to be added to the protein concentrates.

Calculations

Suppose we have in store soya bean meal, meat and bone meal, copra meal and rice bran. We intend to mix a concentrate supplement which will supply 33 % crude protein and 9-10 MJ metabolisable energy/kg using only three of these ingredients. Two examples will be used to demonstrate how to go about in doing the calculations, and they are as follows:

Example 1

Based on:- meat and bone meal (50 % crude protein), soya bean meal (35 % crude protein), copra meal (20 % crude protein) and vitamins, minerals etc. (assuming they will make-up 4 % of the mixture)

As a general rule we start by considering the least major ingredient. In this case it is the copra meal followed by the soya bean and meat and bone meal.

Copra meal has high fibre (12 %) content. If we use a lot of it (more than 20 %) this will affect the intake of protein concentrate supplement and therefore those nutrients contained in it. We will hence settle for the maximum level (20 %) which can be used without affecting the concentrate intake. Copra meal contains 20 % crude protein, so by multiplying 20 % composition x 20 % crude protein and dividing by 100, we find that 20 % copra meal will supply 4 % crude protein to the concentrate supplement. Since we have planned to mix a 33 % crude protein concentrate, this will leave us with 29 % (33 - 4 = 29) protein which we will have to take out from 76 % (100 % total composition - 20 % copra meal - 4 % vitamins etc. = 76) of meat and bone and soya bean meals.

However, we do not know how much each of these two ingredients should be added to the final mixture. To work these out we will use a mathematical model called Dairymen's Square. It is simply a way to work out how much each ingredient will be required in the end by first converting the amounts into proportions and later expressing them as proportion or part of the composition. In this example, we had intended to make a 33 % crude protein concentrate but will only require to make up 29 % more protein from 76 % of meat and bone and soya bean meals. By dividing 76 into 29 we get 38.2, which is the target protein that will be taken out from 76 % of the two ingredients. Place the protein contents of the two ingredients to the left of the target protein of 38.2 thus:

Meat and bone meal	50	
		38.2
Soya bean meal	35	

The next step is to cross subtract, subtracting 38.2 away from 50 and 35 away from 38.2 and place the differences to the right of the target protein. The square will look like the following:

Meat and bone meal	50		3.2
		38.2	
Soya bean meal	<u>35</u>		<u>11.8</u>
	<u>15</u>		<u>15.0</u>

When the figures to the right of the target protein (3.2 + 11.8 = 15) are added the answer should be the same as the difference of the figures on the left side (50 - 35 = 15); in this case both work out to 15. The figures on right side however, are proportions and not the % composition of the mixture. To determine how much each ingredients should be added to the mixture, for example, meat and bone meal, we have to divide 3.2 by 15 and multiply by the total percent (76 %) of these materials represented in the mixture; thus 3.2/15 x 76 = 16.2 % meat and bone meal.

The same can be done for soya bean meal; thus 11.8/15 x 76 = 59.8 % soya bean meal. It can also be calculated by taking the difference; 76-16.2 = 59.8 % soya bean meal.

We have now determined how much the meat and bone (16.2 %) and soya bean (59.8 %) meals will be incorporated along with 20 % copra meal and 4 % vitamins etc. to the final mixture. However, the question now is has there been any change to the intended protein (33 % crude protein) and energy (9-10 MJ energy/kg) contents of the protein concentrate. To check this out, we will list all the feed ingredients along with their protein and energy contents and check as follows:

Ingredient	Protein Content (%)	Energy Conten (MJ/Kg)	Composition (%)	Calculated Protein (%)	Calculated Energy (MJ/Kg)
Meat and bone meal	50	10.6	16.2	50 x 16.2/100 = 8.1	10.6 x 16.2/100 = 1.7
Soya bean meal	35	10.7	59.8	35 x 59.8/100 = 20.9	10.7 x 59.8/100 = 6.4
Copra meal	20	11.0	20.0	20 x 20/100 = 4.0	11.0 x 20/100 = 2.2
Others (vitamins etc.)	-	-	4.0	-	-
Total			100.0	33.0	10.3

Our calculations show that we are spot-on with what we had set out to formulate with respect to protein (33 % crude protein) and energy (10.3 MJ energy/kg) contents of the protein concentrate supplement.

Example 2

Most of what has been done in the first example will be retained, except that this time we will list all the minor ingredients which will be incorporated in the mixture to produce an adequately balanced protein concentrate. Also, we will take into account the type of energy and protein feed sources which we will offer to the birds. For this example, we will consider cassava root meal and soya bean meal as the main suppliers of energy and protein respectively.

Cassava has a low protein content (less than 3 %) and low levels of sulphur-containing amino acids (methionine, cystine and cysteine). These amino acids besides being necessary for growth are also the sources of sulphur which the birds use in breaking down toxic substances contained in cassava, called cyanoglycosides. In other words, when using cassava as the main energy supplier these two factors have to be considered. Birds can use methionine (essential amino acid) to produce other sulphur -containing amino acids (e.g. cystine). Methionine is commercially produced and can be purchased and incorporated in the concentrates. Previous work suggests a 1 % methionine inclusion rate in the protein concentrate is beneficial for cassava -based energy diets (Bakau 1986). In this example we will also use the same level in our calculation.

Other factors which we have to consider include:

- We want a practical, cheap diet but a nutritively adequate diet. We will only increase the cost of the mixture if we use many types of ingredients.
- Lysine is an essential amino acid (also produced commercially) but is not readily available in some crops such as the grain legumes e.g. soya bean. It is also the reference amino acid in poultry nutrition.
- Table salt besides being the source of the minerals, sodium and chloride, is also an appetizer i.e. it assists in feed consumption.
- Vitamins and minerals are available as pre-

mixes. There is no need to buy small bottles of individual vitamins and minerals for use in mixing feed. Manufacturers of the premixes usually indicate how much should be added to the mixture. The broiler type premixes (rapid growing poultry) contain higher levels of these nutrients than those for layer birds.

We may now proceed to list the ingredients required in making an adequate protein concentrate, using Tables 1 and 2 as guides in determining the nutritive composition of the protein concentrate. Some small adjustments may be necessary but these should not drastically alter the level of nutrients in the protein concentrate. For this example, all the minor ingredients added to the concentrate will be increased from the National Research Council (1994) recommendations by three times.

Thus,

	% Composition
Meat and bone meal	14.0 (16.2 in Example 1)
Soya bean meal	56.2 (59.8 in Example 1)
Copra meal	17.0 (20.0 in Example 1)
Vitamin - Mineral Premix*	7.3 (8.3) **
Salt	2.0 (1.5) **
Lysine	2.8 (3.3) **
Methionine	0.7 (1.0) **

Chemical analysis (calculated)

Crude protein (%)	30.14
Methabolisable Energy (MJ/kg)	8.74
Methionine (%)	1.54
Lysine (%)	3.01

* To be calculated according to manufacturers directions.
** Compositions as recommended (NRC 1994) but the values have been increased approximately three times.

As can be seen from this second example, we have ended -up formulating a 30.14 % crude protein protein concentrate to supply 8.74 MJ/kg metabolisable energy. This is slightly in contrast to the first example, providing 33 % crude protein and 10.3 MJ/kg metabolisable energy. This is quite normal because some adjustments have been made so that a well balanced concentrate can be mixed. When adjusting the proportions, it is always a good idea to consider reducing the ingredients which are expensive. In this example, they are meat and bone and soya bean meals. Both have high protein content and therefore cost a lot. The underlying reason in adjusting the minor ingredients (vitamin-mineral premix, salt etc.) is to enable one to adjust the composition of the major ingredients.

Note that the nutrient levels of the concentrate are based on calculated and not determined values. To get such values the feed ingredients or feed samples have to be sent to a laboratory for analysis.

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Table 1: **Nutrient requirements (feeding standards) for different types of poultry production (adapted from McDonald *et al.* 1987)**

	Broiler starter	Broiler finisher	Growing chicks 0-6	6-12 wks	Pullets 12-18 wks	Laying hens	Breeding hens
Met. Energy (MJ/kg)	12.6	12.6	11.5	10.9	10.9	11.1	11.1
Crude Protein (g/kg)	230	190	210	145	120	160	160
Amino Acids (g/kg)							
Arginine	12.6	9.5	11	7.1	6.7	4.9	4.9
Glycine+Serine	12	11	13.2	9.4	8	-	-
Histidine	5	5	5.1	3.3	2.4	1.6	1.6l
soleucine	9	8	9	5.9	4.5	5.3	5.3
Leucine	16	13	14.7	9.9	8.4	6.6	6.6
Lysine	12.5	10	11	7.4	6.6	7.3	7.3
Methionine+Cystine	9.2	8	9.2	6.2	4.5	5.5	4.6
Phenylalanine+Tyrosine	15.8	14	15.8	10.8	8	7	7
Threonine	8	6.5	7.4	4.9	4.2	3.5	3.5
Tryptophan	2.3	1.9	2	1.4	1.2	1.4	1.4
Valine	10	9	10.4	6.6	5.3	5.3	5.3
Major Minerals (g/kg)							
Calcium	12	10	12	10	8	35	33
Phosphorus	5	5	5	5	5	5	5
Magnesium	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Potassium	3	3	3	-	-	-	-
Trace Minerals (mg/kg)							
Copper	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Iodine	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Iron	80	45	80	80	80	80	80
Manganese	100	100	100	100	100	100	100
Zinc	50	50	50	50	50	50	50
Selenium	0.15	-	0.15	0.15	-	-	-
Vitamins (i.u/kg)							
Vitamin A	2000	2000	2000	2000	2000	6000	6000
Vitamin D_3	600	600	600	600	600	800	800
Vitamin E	25	25	25	25	25	25	25
Vitamins (mg/kg)							
Vitamin K	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Thiamin	3	-	3	-	-	-	2
Riboflavin	4	4	4	4	4	4	4
Nicotinic acid	28	28	28	28	28	28	28
Pantothenic acid	10	10	10	10	10	10	10
Choline	1300	1300	1300	-	-	-	1100
Vitamin B	-	-	-	-	-	-	0.01

Table 2: **Nutritive value of some feed ingredients for poultry (modified from McDonald *et al.* 1987)**

Feed Ingredients	Fresh Basis						Dry Matter Basis	
	Dry Matter (g/kg)	Crude Protein (g/kg)	Ether Extract (g/kg)	Ash (g/kg)	Digest Crude Prot. (g/kg)	Metabol. Energy (MJ/kg)	Digest Crude (g/kg)	Metabol. Energy (MJ/kg)
Green crops and tubers								
Dried grass	921	178	37	77	156	5.82	169	6.32
Dried lucerne	887	145	27	73	123	4.60	139	9.19
Potato meal	913	87	2	32	63	12.1	69	13.3
Cassava	880	30	< 1	35	-	-	-	12.8
Sweet potato	320	39	5	29	-	-	-	12.7
Sago	880	6	4	5	-	-	-	-
Leucaena leaves	915	258	62	172	-	-	-	-
Cassava leaves	906	224	86	99	-	-	-	-
Cereals and by-products								
Barley	891	113	15	27	90	11.1	101	12.5
Malt distillers' dried solubles	949	268	2	172	-	6.82	-	7.19
Brewers yeast, dried	867	425	21	89	374	11.0	431	12.7
Maize	882	82	32	12	67	13.2	76	15.0
Maize gluten feed	897	250	19	53	223	9.75	249	10.9
Millet	856	119	39	29	82	12.0	96	14.0
Oats	876	100	49	27	85	11.1	97	12.7
Rice, brown	907	101	21	8	84	15.0	93	16.5
Rice bran	910	135	130	151	109	-	-	8.4
Rye	846	85	11	19	67	12.1	79	14.3
Sorghum (milo)	867	107	29	18	88	12.2	97	15.0
Wheat	891	104	14	18	84	13.0		
Wheat germ meal	889	248	73	43	198	11.1	223	12.5
Wheat middlings, coarse	874	149	39	42	127	9.75	145	11.2
Wheat middlings, fine	875	177	52	32	150	11.8	171	13.5
Oilseed by-products								
Coconut meal	887	195	67	64	109	6.90	123	7.78
Cottonseed meal, dec.	901	378	61	67	280	10.9	311	12.1
Groundnut meal, dec.	912	454	51	64	408	13.2	447	14.5
Linseed meal	888	341	63	53	300	8.66	338	9.75
Palm kernel meal	900	190	20	40	171	6.74	190	7.49
Soya bean meal	873	499	15	47	428	10.7	490	12.3
Sundflower seed meal, dec.	916	321	27	64	248	8.83	270	9.6
Legiminous seeds								
Bean meal	866	250	13	39	211	10.4	244	12.0
Pea meal	871	271	17	28	206	11.1	237	12.7
Wing bean	980	330	169	41	-	-	-	-
Animal by-products								
Blood meal	869	800	8	35	720	13.0	829	15.0
Fish meal	910	655	42	215	590	11.5	648	12.6
Herring meal	905	740	70	95	666	13.4	736	14.8
Meat meal	902	722	132	38	650	15.7	721	17.4
Meat and bone meal	935	515	112	275	412	11.0	441	11.8
Milk, dried skim	934	340	9	80	275	12.3	294	13.2
Milk, dried whey	937	125	7	85	101	12.0	108	12.8

LIVESTOCK DEVELOPMENT NOTES: NO. 11

PRACTICAL MANAGEMENT SYSTEMS FOR PERI-URBAN BROILER CHICKEN PRODUCTION

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ABSTRACT

Live chickens fetch high prices in urban markets. How farmers living close to these markets can go about servicing them without oversupplying them with live chickens is discussed. Two examples showing different types of schedules for stocking and selling finished birds are also given.

Key words: broiler chickens, peri-urban, live chicken markets, stocking schedules

INTRODUCTION

With increased mineral and petroleum activities and other services associated with these developments, it is important that the productivity of primary producers be increased and a variety of products should be tailored to adequately cater for the needs of the increasing number of people entering the cash economy.

In both small and large urban areas there is a demand for live birds and fresh eggs. Live birds in particular command very high prices in these areas. Farmers living close to these areas therefore can take advantage of this market. However, it is important that such projects should be well coordinated so that the market is not flooded with live chickens. This article intends to highlight a technique in producing meat chickens which Labu Animal Husbandry Research Centre has tested and found to be appropriate for use in peri -urban areas.

THE PROJECT

Small scale broiler projects when managed correctly should provide a source of income for people living close to urban areas and a good nutritious and acceptable product.

Housing and stocking

Houses built of native materials are cheap, easy to build and cool for the birds in Papua New Guinea conditions. The bottom part of the wall (to about 50 cm from the floor) of the house is perhaps the most important part of the house. Besides having to be wind-proof so that the birds can be kept warm, it should also be strong enough to keep dogs, pigs and cats out. Experience has shown that losses due to household pets by far exceed the losses due to poor management or diseases. Walls properly constructed from woven bamboos or rows of pitpit can prevent these animals from gaining entry.

The house and the size and number of rooms (see below) required should be planned before the house is erected. These should be planned according to the number of chickens that will be ordered and how often they will be ordered. We have found that best results will be achieved when every 12 birds were allowed 1 m2 floor space (or 0.085 m2 /bird) and 1 m2 for the feeders and waterers. Ideally, an extra room should be set aside for storing the feed.

Deep litter

The deep litter is essentially a bedding provided to soak up the droppings from the birds. Most importantly, it helps to prevent diseases and provide warmth to the chickens. An earth or gravel floor with a 10 to 15 cm thick layer of sawdust, wood shavings or coffee husk is ideal. If the bedding is too thin the deep litter system will not work as well as it should. It is important that after a year, the old litter is removed from the house/rooms and new material put in. The old deep litter is a very good manure and can be used in food gardens.

Feeds and feeding

Because of their rapid growth rates, broilers, or meat chickens, will not grow well if they are not offered the right type of feeds. In a conventional feeding system, the types of feed used are called broiler starter and broiler finisher. Broiler starter is used to feed young chicks, from one to about 21 days of age. Thereafter, the birds are fed broiler finisher ration until they are ready for market (6 - 8 weeks old). However, for small broiler chicken projects (less than 100 chicks), we have found that the birds will still do well when using broiler finisher only. The only thing is to ensure that until the young chicks reach 18 days of age, all the finisher pellets have to be broken into small pieces before feeding. This is because young chicks have small beaks and therefore cannot eat pelleted feed. Feed must be available all the time. This is the only way the chickens will grow quickly.

One meat bird will have eaten about 4.0 kg of feed by the time it is ready for market. Since feeds are usually bagged in 50 kg lot, one bag can cater for every 12 chickens. The feed must be available at the project site when the chickens arrive. Feed troughs constructed from bamboo are cheap. A bamboo trough measuring 48 cm in length will provide enough feeding space for 12 birds. Young chickens cannot eat or drink from large troughs, so smaller size troughs should be provided.

Drinking water

If the chickens can drink every time they are thirsty, they will grow well. But, if at any stage of their growth there is a shortage of drinking water, the birds will not do well; many will stay small, light or may even die. Because of this, ensure that the project is located near a creek or is sufficiently equipped with tanks to store and supply water.

Bamboo makes very good waterers. To prevent young chickens falling in the water put some stones in the troughs so that the stones are just level with the water. If the chickens jump in the trough, they will stand on the stones and will drink between them. Remove the stones after two weeks. After 4 weeks, it is necessary to raise the water troughs from the ground by tying the troughs to the side of the walls with wire or rope. Make sure the waterers are not too high and all the chickens can reach the water and take a drink. Clean the waterers regularly, and minimize spillage.

Brooding

Young chickens demand special care and warmth during the first two weeks of their life. The process involved in providing such type of care is called brooding. One of the best methods of brooding chicks in rural areas is as follows.

- In the big chicken house, construct a small room of 1 to 2 m2 area with wind -proof walls. The walls must be about 50 cm high. Cover half of the room with jute bags or woven bamboos.
- Find an empty carton and make a few holes in it. A tin fish carton is enough to acco-modate 20 chicks, and a beer carton 15 chicks.
- During the day leave the chicks in the small room with feed and water.
- During the night put the chicks in the box and close it. Leave the box in the small room or if the nights are cold bring the box into the house where people sleep.
- In the morning, open the box and put the chicks back in the room.
- Do this until the chicks can fend for them-selves, at about 2 weeks of age.

Ordering chickens

For a broiler chicken project, order only broiler chickens - no other type of chickens will be successful. Ask that the chickens are vaccinated against Fowl Pox. It will cost a little bit more, but this will help protect them from catching the disease.

When ordering young chicks, order the number of chickens which can be easily sold within a week or two. Experience has shown that it is difficult to sell more than 20 chickens in a week at the project site. One of the common mistakes many people tend to make is to order 50 to 100 chickens at one time. When the birds are ready for market, they find that they cannot sell them quickly, often, having to keep them for a further 2 to 5 weeks before all the birds are sold. By then, the feeds have been used up and the birds start losing weight or die. Some growers buy more feed merely to keep the birds alive which results in a loss.

EXAMPLE 1: A PROJECT PRODUCING 30 CHICKENS EVERY FORTNIGHT (Lowlands)

Housing and stocking schedule

Thirty chickens need 3 m^2 + 0.5 to 1.0 m^2; ie. a floor space of 3.5 to 4.0 m^2 is needed. Chickens will arrive every fortnight and will be ready for market at 7 weeks of age. Five rooms, each measuring 2.5 m x 1.5 m are required plus one extra room (1 m x 1.5 m) for storing feed and the other for the brooder (1 m x 1.5 m). See Figure 1 for the layout of the rooms of the house. The feed room and the brooder are small and therefore can fit in one normal size room.

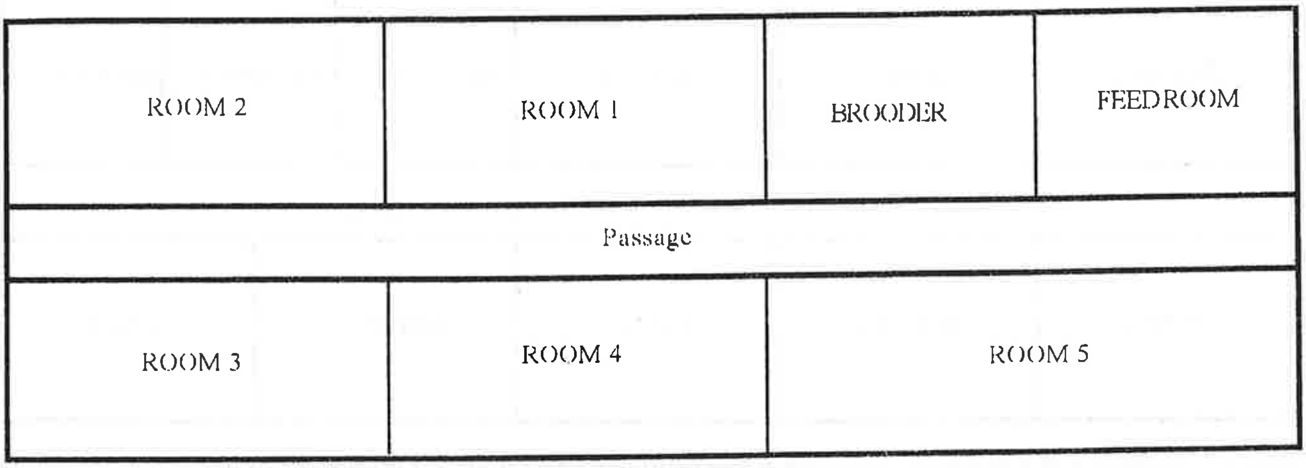

Figure 1. **Diagram of a house to cater for a 30 chicks/batch/fortnight stocking schedule**

Placing of chickens at the begining of week	
1	Chicken Batch No.1 in Brooder
3	Chicken Batch No.1 in Room 1, Chicken Batch No.2 in Brooder
5	Chicken Batch No.2 Room 2 , Chicken Batch No.3 in Brooder
7	Chicken Batch No.3 in Room.3, Chicken Batch No.4 in Brooder
8	Start Selling Chicken Batch No.1
9	Chicken Batch No.4 in Room.4, Chicken Batch No.5 in Brooder
10	Start Selling Chicken Batch No.2
11	Chicken Batch No.5 in Room.5, Chicken Batch No.6 in Brooder
12	Start Selling Chicken Batch No.3
13	Chicken Batch No.6 in Room.1, Chicken Batch No.7 in Brooder, etc.............

Budget for every 30 chicks-batch (based on Lae prices and may fluctuate)

Mortality: 10% or three chickens from each batch of 30 chicks

30 chickens at 85t/chick	=	K25.50
3 bags of feed at K22/bag	=	K66
Transport of feed at K2/bag	=	K6
Total	=	*K97.50*
Sale: 27 chickens at K5.00 each	=	K135
Profit: K135 less K97.50	=	*K37.50 per fortnight*

Note that if the demand exceeds production, always sell the heaviest birds (usually males) in the 6 week old groups and save on the cost of feed.

EXAMPLE 2: A PROJECT PRODUCING 20 CHICKENS A WEEK (Lowlands)

Housing and stocking schedule

Twenty chickens need 2 m^2 + 0.5 to 1.0 m^2 ; ie. a floor space of 2.5 to 3.0 m^2 is needed. Chickens will arrive every week and sold when they are 7 weeks old. Eight normal rooms (2 m x 1.5 m), one feed store room (2 m x 1.5 m) and a normal room to accomodate 2 brooders (1 m x 1.5 m/brooder) or, a total of 10 normal rooms will be required (see Figure 2).

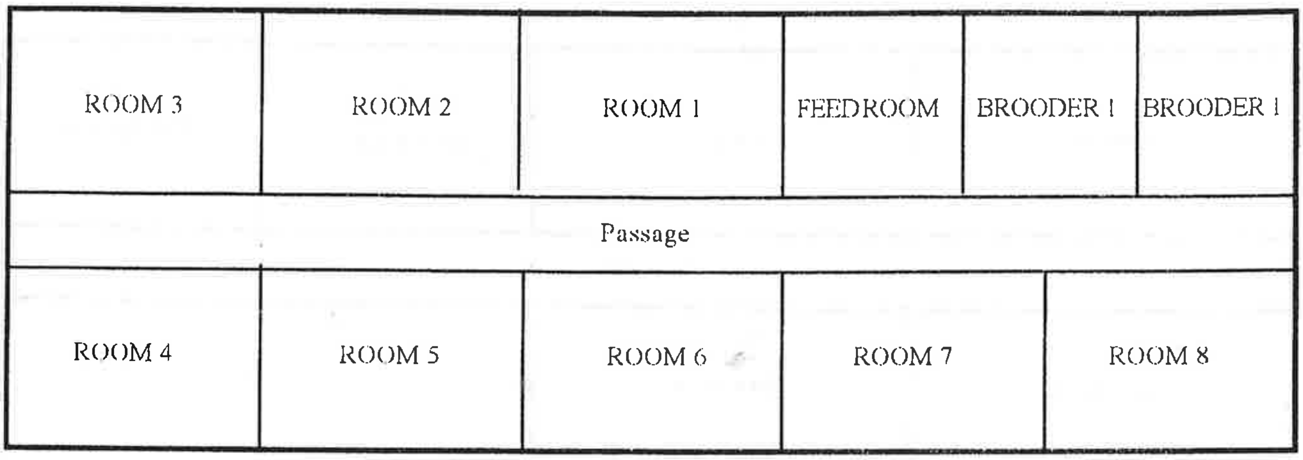

Figure 2: **Diagram of a house to cater for a 20 chicks/batch/fortnight stocking schedule**

Placing of the Chicken at the begining of week

1	Chicken Batch No.1 in Brooder.1
2	Chicken Batch No.2 in Brooder.2
3	Chicken Batch No.1 in Room.1, Chicken Batch No.3 in Brooder.1
4	Chicken Batch No.2 in Room.2, Chicken Batch No.4 in Brooder.2
5	Chicken Batch No.3 in Room.3, Chicken Batch No.5 in Brooder.1
6	Chicken Batch No.4 in Room.4, Chicken Batch No.6 in Brooder.2
7	Chicken Batch No.5 in Room 5, Chicken Batch No.7 in Brooder.1
8	Sell Chicken Batch No.1, Chicken Batch No.6 in Room.6, Chicken Batch No.8 in Brooder 2
9	Sell Chicken Batch No.2, Chicken Batch No.7 in Room.7, Chicken Batch No.9 in Brooder 1.
10	Sell Chicken Batch No.3, Chicken Batch No.8 in Room.8, Chicken Batch No.10 in Brooder 2
11	Sell Chicken Batch No.4, Chicken Batch No.9 in Room.1, Chicken Batch No.11 in Brooder 1
etc.................	

Note that if the demand exceeds production, always sell the heaviest birds (usually males) from 6 weeks old groups and save on the cost of feed.

Budget for every 20 chick-batch (based on Lae prices and may fluctuate).

Mortality: 10% or two (2) chicken from each batch of chicks

20 chickens at 85t/chick	=	K17
2 bags of feed at K22/bag	=	K44
Transport of feed at K2/bag	=	K4
Total	=	*K65*
Sale: 18 chicken at K5 each	=	K90
Profit: K90 less K65	=	*K25 (K50 per fortnight)*

HEALTH AND DISEASE CONSIDERATIONS

Because there is a constant flow of birds in and out of the project, the danger of disease outbraeks (e.g. coccidiosis) is relatively high. However, as we have experienced, such a situation will arise if:

- the deep litter is not adequately managed e.g. not thick enough (less than 10 to 15cm)
- the house is not adequately ventilated
- no control on people going into the sheds
- poor standard of bird management
- infected chicks are used
- the sheds are continously stocked without a break.

Poor management of the deep litter is by far the main cause of disease problems. Spillage of water tends to be the main source, and therefore should be kept to minimum. Always add a thin layer of new bedding material (e.g. wood shavings) over the old one when the new batches of chicks are stocked, and remove the hard ôcakedö litter. After a year of production the old litter should be removed and the sheds allowed to remain empty for a month or two. These measures should minimize any chance of diseases occuring.

FURTHER READING

Bakau, W.J.K (1985). Some suggestions for improving management on small semi-commercial broiler projects. *Harvest* 11: 71 -74.

LIVESTOCK DEVELOPMENT NOTES: NO. 12

PRACTICAL MANAGEMENT SYSTEMS FOR BACKYARD AND SMALL SCALE LAYER CHICKEN PROJECTS: PART 1 - COMPLETE FEEDING SYSTEM.

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ABSTRACT

A guide to better management of layer chickens for maximum production and profitability using a complete feeding system is outlined. Examples of development cash-flow for a deep litter system and a cage system are also presented.

Key words: *layer chickens, backyard farming, complete feeding system, deep litter system, cage system*

INTRODUCTION

Backyard or small scale egg production ventures are not only satisfying side activities but are also profitable businesses if managed correctly. This is particularly so when considering the less tapped road-side markets available in and around small and large urban centres in Papua New Guinea. Large scale producers could not service these markets because of their unpredictability, but have tapped into them now and then when there is excess production.

These markets can be well serviced by backyard or small scale egg producers, as seen in other developing countries such as Indonesia and the Philippines. However, for these projects to be successful a well coordinated and technically sound extension service is required. This article intends to provide some advice and information on better ways in looking after layer chickens as a business.

TYPE OF CHICKENS

There are two types of chickens which can be used for this project:-

- *Egg producing hybrids or types*: These are specifically bred egg producing birds and can be purchased from Ilimo Farm (Port Moresby), Highlands Products (Lae) and Christian Leaders Training College (Mt. Hagen). These type of chickens are also available from Australia and New Zealand but one would have to obtain an import permit in bringing these type of chickens into the country.

- *Australorps* (black chickens): These are dual purpose chickens supplied previously by Labu but are no longer available. The current stock available is an Australorp - Rhode Island Red cross and is available from Niugini Table Birds (Lae), and is sold as unsexed.

The Australorp chickens consume more feed and produce less eggs than the hybrid chickens. However, because they are heavier than the hybrid chickens, they command a higher sale price for both males when they reach 14-16 weeks of age and the females at the end of laying. It is important that all the chicks ordered have their beaks trimmed and are vaccinated against Fowl Pox and Marek's diseases.

MANAGEMENT OF THE PROJECT

The Deep Litter System

This system can be used throughout the growing and laying periods or during the growing stage of the cage system birds.

Housing: The house can be built using bush materials with deep drainage all round the building and adequate overhang to keep rain water out. The roof of the house must be water proof. It is possible to build houses which will last long using bush materials. Sago or kunai leaves are good for the roofs. While bamboo, pitpits and sago blinds can be used in walling the house instead of wire nettings (Figure 1).

commencement. It is important that the roof of the house should be high enough to allow good ventilation to prevent heat stress. That is heat stress causes drop in egg production and increases incidence of wet droppings. Roofs about 1.8 m high at the eaves should be sufficient for native material houses. Corrugated iron roofs should be much higher, at least 2.5 m high at the eaves.

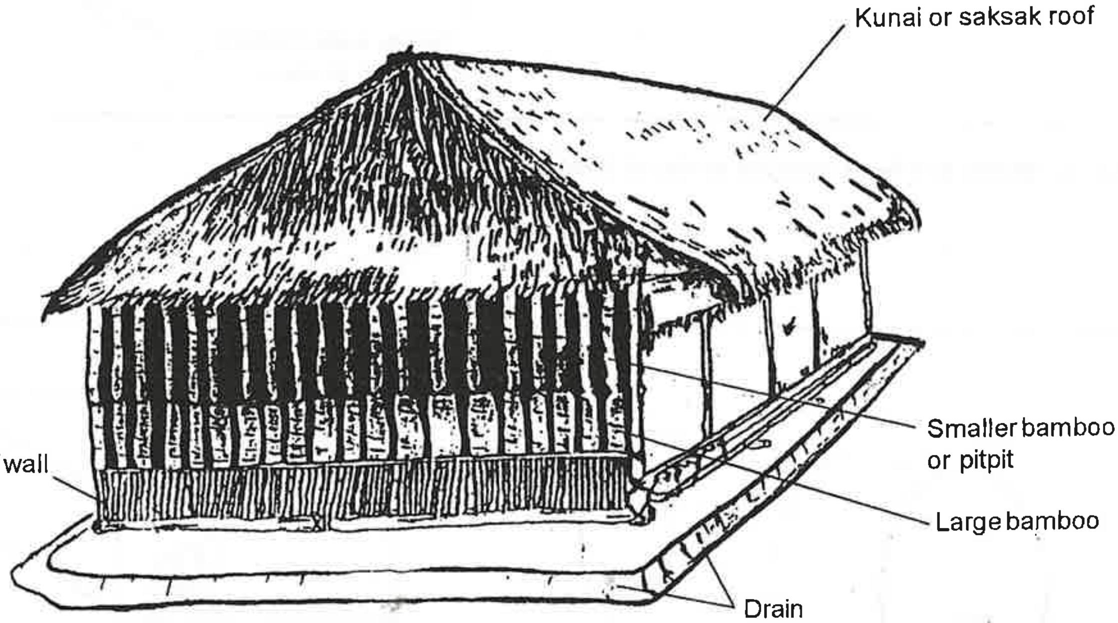

Figure 1. **A native material house suitable for housing layer chickens.**

Native material houses are cool and are more suited for Papua New Guinea conditions than houses with iron roofs. The only problem is that bush material houses require frequent maintenance and have short life span (only 4-5 years).

The size of the house should be adequate to house the required number of adult hens. Allow 3 m^2 for every 10 hens or 0.3 m^2 floor space for each hen. An extra space of about 0.5 m^2 should be allowed for water and feed troughs. A house measuring 3 x 6 m is adequate for 50 hens. Projects using the deep litter system will require two houses. The first will be for housing the first stock while the other will be used to house the incoming replacement stock. The second house can be built later but must be erected within the first year of the project's

Feed and Water Troughs: Suitable feeding and drinking troughs should be ready before the chickens arrive. Bamboo troughs are cheap and easy to make. Use small size bamboo troughs for young chicks, especially when the chicks are in the brooder. For the waterers, put some stones in the bottom to prevent young chickens from drowning or getting wet. For bigger birds, use big strong bamboos and split a section between the two inter-nodes with a width about the length of a match box. The opening should be made big enough for the head of an adult hen to reach feed or water (Figure 2).

Construct sufficent number of feed and water troughs to reduce the workload in refilling them. Ideally, the troughs should be arranged along both sides of the

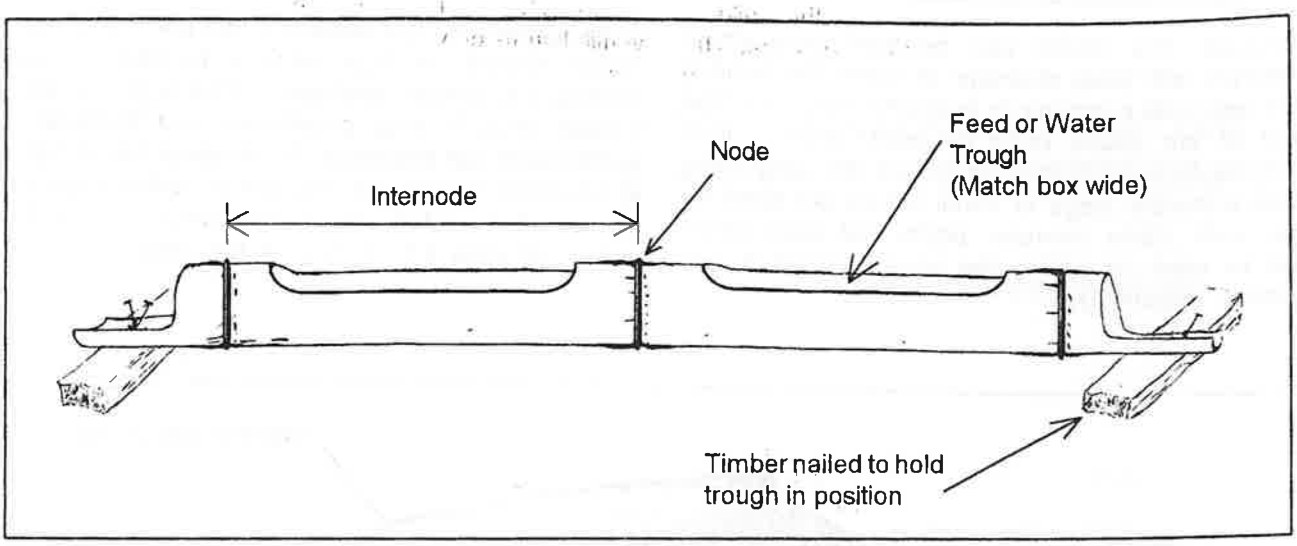

Figure 2. **Water and feed troughs made of bamboo.**

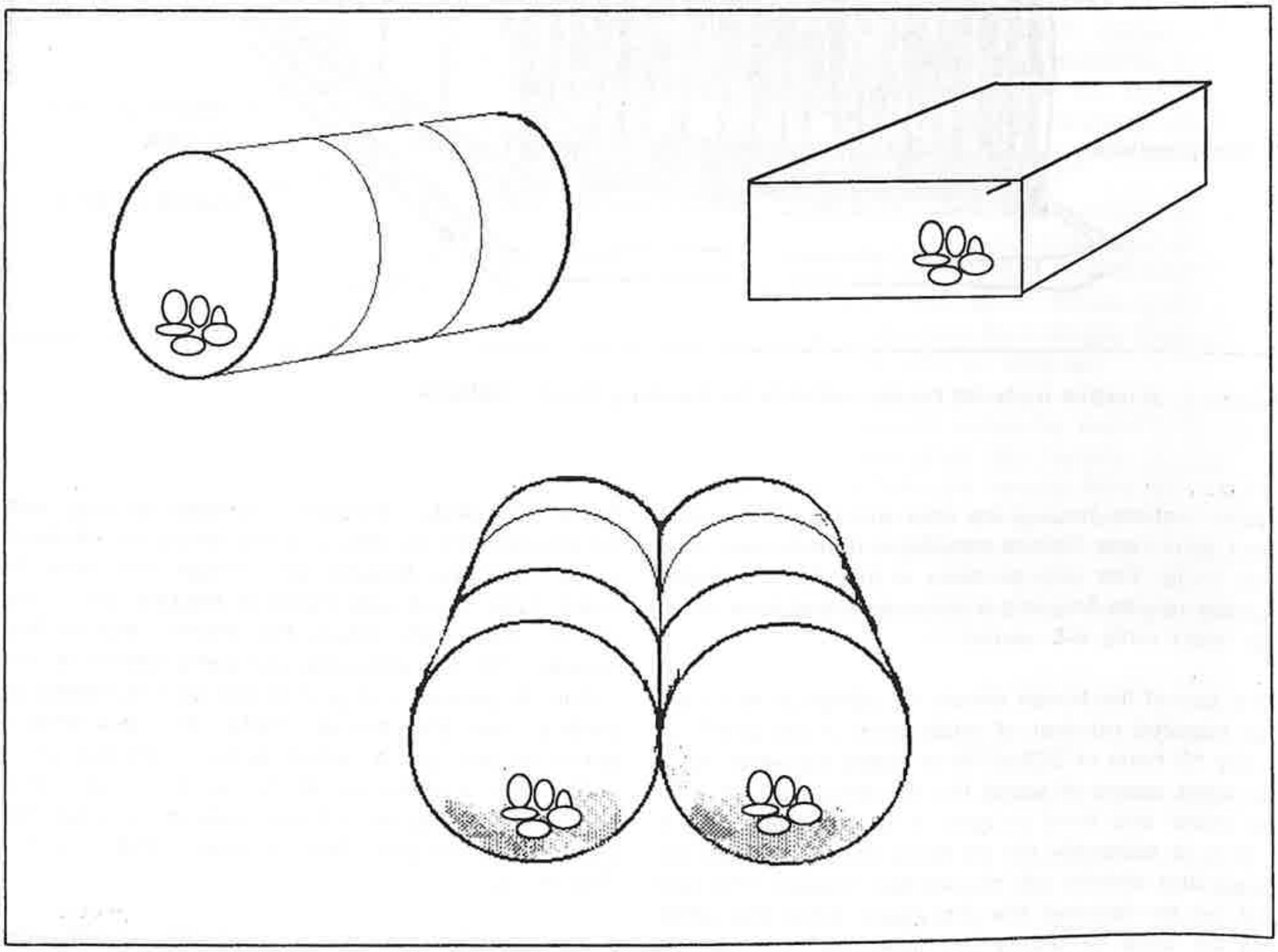

Figure 3. **Types of nests suitable for use in layer chicken production.**

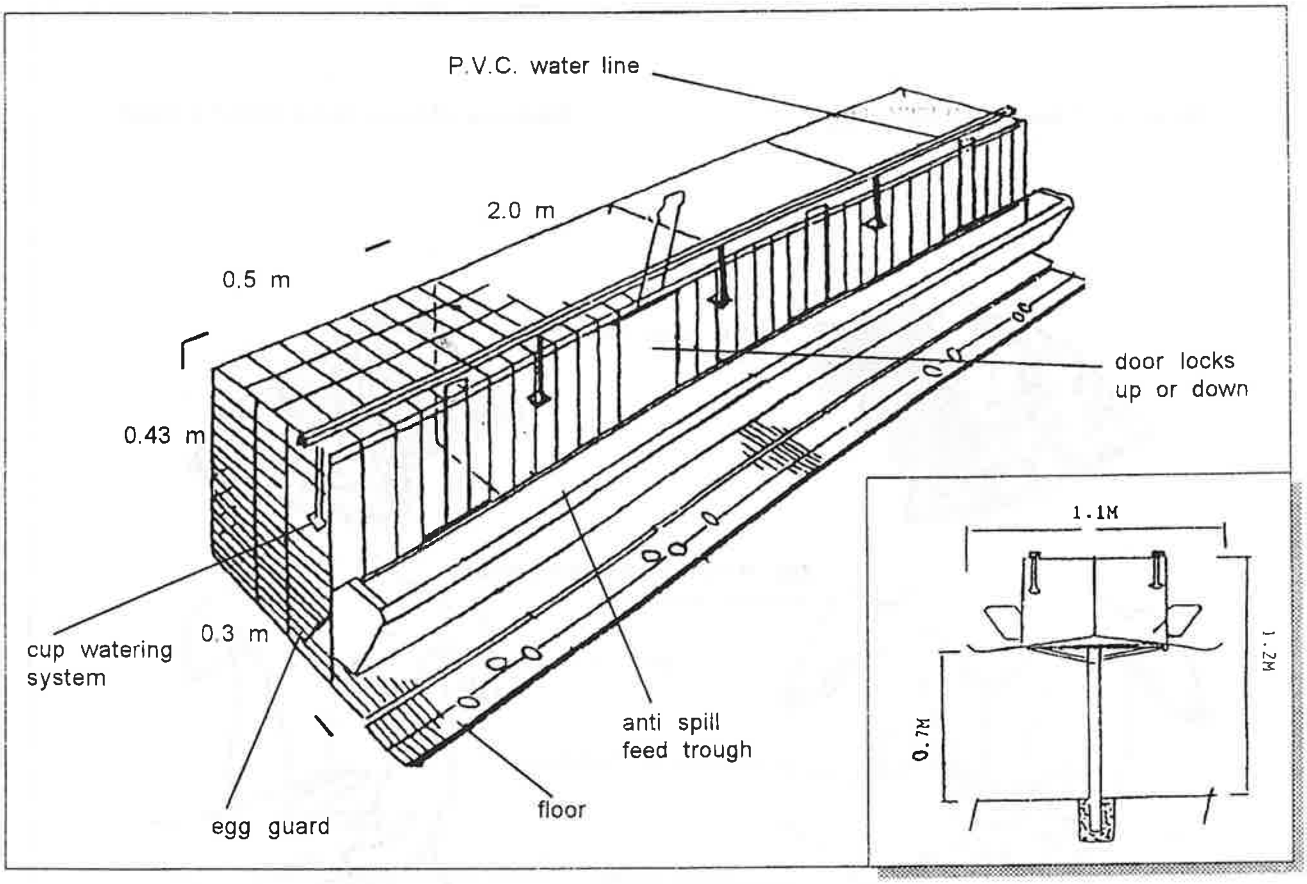

Figure 4. **A back to back single cage unit suitable to accomodate 16 - 32 hens.**

house, with one side for feed and the other for water. To allow ease of removing and cleaning the troughs, make short troughs using sections with 3 to 4 inter-nodes. Nail or tie the troughs onto a piece of flat timber to hold them in position to reduce spillage. To prevent wet conditions under the water troughs, it is best to have the troughs over a patch of coarse gravel below. The gravel patch should be slightly higher than the surface of the deep litter - deep litter should not be put on top of the gravel.

Perches: Chickens prefer to sleep and roost high above the ground. A limb of a tree with some small branches will make a good roost for the birds. The important point, however, is to make sure that the roost is positioned clear from the feed and water troughs. This is to prevent the droppings from falling into feed and water. The litter under the roosts should be turned regularly to mix with the droppings.

Nests: For production of clean eggs and to prevent breakage and the habit of egg eating, nests should be provided. Nests can be made of bush materials, old wooden boxes or old 20 litre drums. One 20 litre drum is sufficent to cater for 6 hens. When single compartment nests are used, they should be 25 cm high with a strip of timber, 6 to 8 cm wide, nailed at the front lower part of the nests to prevent the eggs from rolling out. A single nest of this type can cater for 4 hens. Commune nests can also be used. They can be made from bush materials too. They should measure 50 cm wide and 2.4 m long with two holes on each side for the hens to enter and leave. Construct a removable top to allow ease of egg collection. One such nest can serve between 35 to 40 hens. Clean bedding material such as dry kunai grass, wood shavings or coffee hulls should be put inside the nests. Figure 3 shows some of the type of nests that can be used.

Brooding: Day old chickens can be brooded in the same house as described above. There are a number of ways in looking after young chicks. The easiest way is to construct a small room with woven bamboo or sago and covering it with old juke bags, leaving a small gap about 30 cm wide at the top

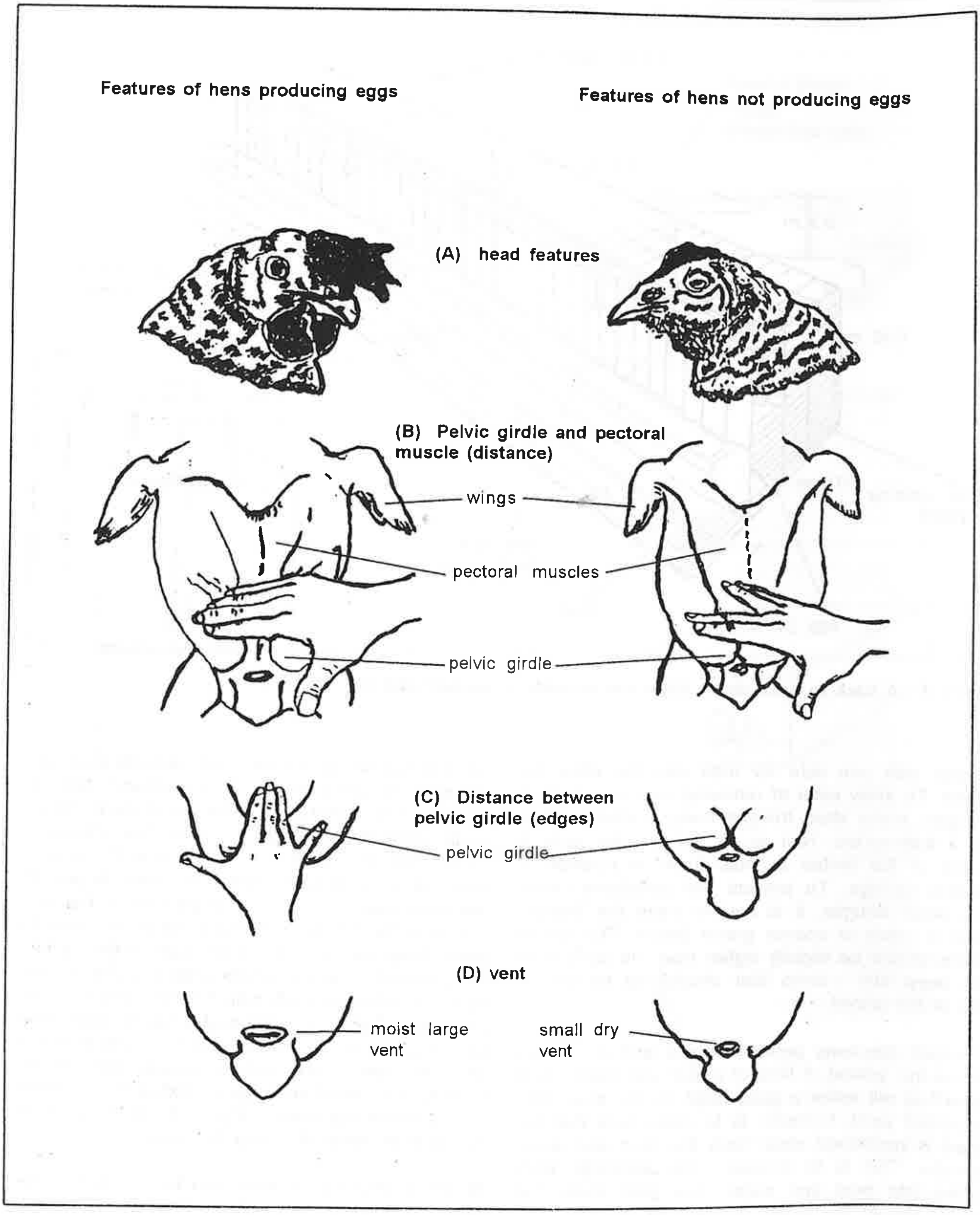

Figure 5. **Some features of hens that are producing eggs (left) and those not producing eggs (right).**

for ventilation and light. The size of the room depends on the number of day old pullets ordered. A room measuring 60 x 60 cm is good enough to brood 10 pullets, or 1m2 room to accomodate about 30 pullets. One kerosene lamp can provide enough warmth for 20 chicks or 2 for 50 chicks. When such heat sources are used, they should be placed directly under the opening (gap) at the top of the brooder. A small bamboo feed or water trough is adequate for 20 chicks to eat or drink out of it, or two for every 50 chicks in the brooder. Always make sure that the lamp (heat source) does not go out, particularly during the nights. In the coastal areas, the lamp(s) should be kept burning continously for the first 7 days, and then only during the nights for the next 7 days. In the highlands, however, a further 7 nights of additional heating is necessary because of the cold temperatures during the nights.

Alternatively, secure an empty cardboard box (tin fish, beer carton, etc.) and make a few holes in it. During the day, leave the chickens in the small room as mentioned above and give them feed and water. During the night, put the chickens in the box and close it. Leave the box in the small room or if the nights are very cold (highland areas), carry the box inside the house where people sleep. In the morning, put the chickens back in the small room and give them feed and water. Continue doing this until the chicks are ready (2-3 weeks later) to fend for themselves.

It is important to note that young chickens can go without feed and water for up to 24 hrs, and will make up for this when they are available. Whereas, when the young chicks are subjected to a cold stress for only 2 hours, many of them will not cope well with the shock and will die, even when the warmth is restored.

The Cage System

The husbandry practises are essentially the same as those used in the deep litter system, especially at the age (up to 20 weeks of age) when the pullets are about to lay their first eggs. It is only during the laying period that certain practises will differ slightly. The house for the cage system although is basically the same as that for the deep litter system, the roof has to be a bit higher (about 2.5 m at the eaves) because the cages are raised above the ground. The size of the house also depends on the number and size of the cages required. The type of the cage shown in Figure 4 is a back to back single type cage system. Such a cage, about 1.2 m long, can accomodate between 16 to 32 hens in the four compartments. Note, always allow 2 m width under the eaves for a single row cages and 3.5 m for two row cages. The initial cost of buying the cages and erecting them is high, but the cage system is easier to manage and the increase in egg recovery should offset the cost of the cages in the long run.

FEEDING

In a complete feeding system, compounded (or commercial) feed are fed during both growing and the laying periods. Different types of feed are fed at different stages of the pullets growth. Table. 1 shows the different types of feed and the amount of each feed the birds would consume.

Table 1: **Type of feeds the pullets and the hens consume at different stages of production**

Age in Weeks	Type of Feed	Protein (%)	Feed Consumption (kg/pullet or hen)
0 - 6	Pullet starter	20	2
6 - 22	Pullet developer	15	8
22 - 74	Laying crumbles	16	45

Although these feeds provide most of the nutrients, whenever possible, green feeds (e.g. leucaena and kaukau leaves) should also be provided to improve the color of the yolk. Extra calcium in the form of chipped oyster shells should also be provided, especially during the period when egg production is very high (25 to 40 weeks of age). Give extra calcium in a separate trough or sprinkled on top of the feed if the birds are reared in cages. Sand or very small stones should also be given because they help in grinding feed into fine particles which helps in the digestion process.

MEDICATION

Caged birds are not frequently medicated compared to those in a deep litter system. However, if the deep litter is kept dry, the chickens vaccinated (against Marek's and Fowl Pox diseases) and good management practises are followed, there should be less problems with outbreak of serious diseases. It is, however, advisable to keep a small quantity of coccidiostates and deworming medicines, as they may come handy from time to time. Drugs for treating these diseases are available and can be purchased from the local suppliers (e.g. Farmset Pty Ltd). Always follow the manufacturer's recommendations carefully when using these drugs, or if possible, consult a veterinarian even before buying the drugs.

EGG PRODUCTION

The hens will start laying when they are about 22 weeks of age. If good management practises have been followed during the rearing period, all the pullets will be uniform in size, weight and maturity and will start laying about the same time. Make sure that the nests are provided or the pullets transferred to their laying cages 2 weeks before they commence laying. The number of eggs laid will be few at first but will increase rapidly until the birds reach their peak, at around 30-32 weeks of age. After peaking, the egg numbers will remain constant for a while before declining and about 74 weeks of age increasing number of hens will cease to lay.

CULLING AND STOCK REPLACEMENT

When the hens reach about 74 weeks of age their egg production rate declines that it is not economical to keep them any longer. To continue with the project, a replacement stock should be purchased as one day old when the first batch of pullets are 52 weeks or 12 months old. A second house is needed to raise these pullets. When the replacement birds reach laying stage (about 22 weeks old), older birds should be culled or sold.

Culling or removing from the flock unproductive birds is an important process in the management of layer flocks. This is because hens that are not laying eggs will cost a lot of money in feeding them; as a hen eats about 30 kg of feed in a year.

Hens which are not laying eggs throughout the laying period should be culled immediately. This should be employed when the hens are about 28 weeks of age; the time when the hens are just about to reach their peak egg production. A hen that is laying eggs will look active, the comb and wattles are large and bright red in colour, the breast muscles are full and round, the distance between the two pelvic bones is about 2 or 3 fingers wide and the vent is large and moist. Hens that look pale with small pale comb and wattles, thin V shape breast muscles, narrow distance between the two pelvic bones and small dry vents are not laying eggs and therefore should be removed from the flock. Figure 5 shows the general characteristics of body conformation of hens which should or should not be culled.

The developmental cash budgets (see Appendices A-C) show that the projects will generate cash surplus after the first year of operation in deep litter and cage systems, respectively. The annual return rates are small but slightly higher in the cage system.

FURTHER READING

BAKAU, W.J.K, R. E. ABDEELSAMIE and **W. E. NANO** (1997). Practical financial and record keeping procedures in managing a chicken project. *Harvest* (1&2): 34-38 *Livestock Development Notes No: 8.*

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Appendices

BUDGETING

Projecting the cost and income of a layer chicken project is an important part of any business and should be done before "a toea" is even spent (see Bakau *et al.* 1997).

Budget for a 50 layer chicken project

A. *Basic Assumptions*

(1) Deep litter; 2 identical houses will be built, each measuring 3 x 6 meters. Native materials will be used except for some items, costing K50.00 per house. One house to be built first and the other within the first 12 months.
(2) Cage units; costs of the houses are the same. In addition, cost of the cages and installation of K70.00 per unit housing 24 birds; 2 units are required.
(3) Life span of the houses - 5 years.
(4) Brooders, waters and feeders to be made from bush materials. 2 lamps will be purchased costing K10.00
(5) Cost of day old pullets including freight, vaccination against Fowl Pox and Marek's diseases and beak trimming - K1.20 each.
(6) Type and quantity of feed to purchase are as shown in the Table 1. Cost of feeds are as follows:
- Pullet Starter 42 toea per kg
- Pullet Developer 37 toea per kg
- Laying Crumbles37 toea per kg

(7) Cost of transport of feed - 3 toea per kg
(8) Mortality rate estimated at 10% during pullet stage and 1% per month (12%) during the laying period.
(9) Egg production is estimated at 190 eggs/hen on deep litter and 210 eggs/hen in cages.
(10) Wholesale price of eggs at K1.80 per dozen for ungraded eggs.
(11) Sale price of spent hens - K4.00 each.

Capital Expenditure

Deep Litter	2 Shed at K50.00 each	K100
	2 Kerosene Lamps	K 10
Total capital expenses (deep litter system)		K110
Cages	2 cage units at K70.00 each	K140
	50 Gallon tank	K100
	Hand pump	K 20
Total capital expenses (cage system)		K260

Annual running costs

First year

Pullet starter (2kg x 42 toea x 50 pullets)	K 42
Pullet developer (8kg x K0.37 x 50 pullets)	K148
Layer crumples (25kg* x 37 toea x 45 hens)	
* feed for 6 months only	
Total feed costs	K606
Cost of transport (1625 kg of feed @ 3 toea/kg)	K 50
Day old pullets (50 @ k1.20/bird)	K 60
Kerosene (14 liters @ 60 toea/litter)	K 8
Medication	K 20
Total first year running costs	K744

Second and subsequent years

Pullet Starter (as above)	K 42
Pullet Developer (as above)	K148
Laying Crumbles (45 kg* x 37 toea x 45 hens)	K749
* full year feeding	
Total Feed Cost	K939
Cost of feed transport (2525 kg x 3 toea/kg = K75.75)	K 76
Day old Pullets as first year	K 60
Kerosene	K 10
Medication	K 20
Total second year running costs	K1105

Annual returns

First year

Deep Litter	45 hens x 100 eggs* = 4500 eggs	K675
	* 6 months egg production	
Cage	45 hens x 120 eggs* = 5400 eggs	K810
	* 6 months egg production	

Second and subsequent years

Deep Litter	45 hens x 190 eggs* = 8550 eggs	K1281
	40 hens cull at K4.00 each	K160
	* full year egg production	
Total		K1441
Cage	45 x 210 eggs* = 9450 eggs	K1422
	40 hens cull at K4.00 each	K160
	* full year egg production	
Total		K1582

B. *Developmental cash flow (Deep litter system)*

	Year 1	2	3	4	5
Receipts					
Sale of eggs	675	1281	1281	1281	1281
Sale of culls	-	160	160	160	160
Total cash receipts	675	1441	1441	1441	1441
Capital expenses					
Sheds	100	-	-	-	-
Lamps	10	-	10	-	10
Total capital expenditure	110	-	10	-	10
Running costs					
Feed	606	939	939	939	939
Transport	50	76	76	76	76
Day old pullets	60	60	60	60	60
Kerosene	10	10	10	10	10
Medication	20	20	20	20	20
Total running costs	746	1105	1105	1105	1105
Annual cash surplus (Deficit)	(181)	336	326	336	326
Cumulative cash surplus (Deficit)	(181)	155	481	817	1143

C. Developmental cash flow (Cage system)

	Year 1	2	3	4	5
Receipts					
Sale of eggs	810	1422	1422	1422	1422
Sale of culls	-	160	160	160	160
Total cash receipts	810	1582	1582	1582	1582
Capital expenses					
Sheds	100	-	-	-	-
Lamps	10	-	10	-	10
Cages	140	-	-	-	-
Tank	100	-	-	-	-
Pump	20	-	-	20	-
Total capital expenses	370	-	10	20	10
Running costs					
Feed	606	939	939	939	939
Transport	50	76	76	76	76
Day old pullets	60	60	60	60	60
Kerosene	10	10	10	10	10
Medication	20	20	20	20	20
Total running costs	746	1105	1105	1105	1105
Capital & Running costs	1116	1105	1115	1125	1115
Annual cash surplus (Deficit)	(306)	477	467	457	467
Cumulative cash surplus (Deficit)	(306)	71	538	985	1452

DEVELOPMENT NOTES: NO. 13

PRACTICAL MANAGEMENT SYSTEMS FOR BACKYARD AND SMALL SCALE CHICKEN LAYER PROJECTS: PART II - CHOICE FEEDING SYSTEM.

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ABSTRACT

A guide to better management of layer chickens to improve production and profitability using a choice feeding system is outlined. The wisdom of choice feeding, and the factors involved in the preparation and presentation of feeds using the feeding system are also discussed.

Key words: *choice feeding, laying hens, backyard farming,*

INTRODUCTION

As stated in PART I, small scale poultry egg production is a viable business if managed correctly (Bakau *et al.* 1998). Using conventional methods of feeding birds with commercially formulated complete rations is one option, but there is another method which is just as good as the conventional method and is easy and more appropriate to use. This method is called choice feeding and is ideal for conditions such as those we have in Papua New Guinea, particularly in year-round high temperatures.

THE WISDOM OF CHOICE FEEDING

Before the fowl was domesticated and developed extensively for commercial use, it sought its feed sources to supply all the nutrients for growth, maintenance and reproduction by scavenging the territory it lived in, usually covering a large area. A free range fowl retains this ability to find feed sources. What it eats from the wild tends to consist of seeds, nuts, fruits, earthworms, insects, bugs, snails, pieces of coral, limestone, shells etc.. We now know that the fowl has very few taste buds and its desire to eat is driven by the need to satisfy its energy appetite. When this has been satisfied, it seeks to satisfy other appetites, most notably, protein, vitamins, minerals and other appetites. Hence, when the fowl covers a large area in search of seeds, nuts and fruits it is actually trying to satisfy its energy appetite and it eats earthworms, insects and bugs for it's protein appetite. These feeds also contain variable amounts of vitamins and minerals, usually in very low amounts and therefore the fowl has to eat a lot of other feed sources, such as succulent green grasses and shells to obtain the vitamins and minerals it requires. For the laying hen however, besides having to satisfy energy and protein appetites, it has to also satisfy its calcium appetite, an important requirement for egg production.

The digestive tract of the fowl therefore is designed to cope with such feeding behaviour. When the fowl finds food it eats it quickly, filling up the gizzard, and then stores the excess in the crop for later use. Whole food has to stay in the gizzard for some time to be grounded into fine particles before it passes down the alimentary tract. When this process is disturbed, as is the case when pre-ground feeds are offered, the gizzard in particular will shrink in size and become paler in colour, as the gizzard muscles become thin because of the lack of activity. This is a common feature in modern chicken production because ground feeds are used. Interestingly, evidence to date suggest that fowls with shrinking gizzards are more susceptible to coccidia, organisms responsible for causing coccidiosis, than those with more muscular gizzards. Present compounded poultry feeds (complete grounded and mixed feeds) are by no means the ultimate or appropriate for the fowl. Rather they are made more for our convenience than for that of the fowl. These feeds are made for the average performing birds, not catering for the low and high performers. In other words, the low performing birds are wasting the feed while the high performers can not get enough and therefore are producing below their capability.

This is not likely to happen in a choice feeding system, as the system allows the birds to eat according to their need to maintain their body functions and to grow and reproduce. Another important aspect about the system is that it allows the birds the opportunity to adjust their feed intake when the temperature increase beyond the comfort zone of 20 to 25°C. This is a particularly important consideration in rearing poultry in areas of high temperature, such as those we experience in Papua New Guinea. In such environments, choice fed birds are able to reduce their energy intake to avoid being "cooked from inside" but continue to maintain their protein intake, and thus maintain growth. This does not happen when the birds are reared on a complete feeding system. In this system the birds simply crowd around water troughs and do not eat until later in the day when the temperature drops to the comfort mark.

In many ways, the choice feeding system utilizes the natural feeding behaviour of the fowl by not limiting the fowl's ability to choose. That is the fowl is now presented with a method of feeding which is nutritionally and economically advantageous.

MANAGEMENT OF THE PROJECT

Any type or strain of chicken can be reared using this system of feeding. The type of houses, feed and water troughs, perches, nests and other basic management considerations are essentially the same as those used in a complete feeding system. The differences are:

- The bird needs to be trained early to recognize the different types of feed that will be offered throughout the life of the bird. Similarly, it should be trained early to distinguish how these types of feed will be presented to it, usually as separate energy or protein sources, so that it can develop appropriate feeding behaviours.

- Protein sources are usually presented in the form of a protein concentrate mixtures, which will also contain vitamins, minerals and other supplements e.g. amino acids, fatty acids or antibiotics.

- In the case of layers, besides the energy and protein sources, an additional calcium source has to be provided.

- There is no need to grind or pellet cereals such as sorghum, millet or wheat. However, it is still recommended to crack hard maize seeds.

Training of pullets

Modern pullets are produced in artificial environments, having being hatched in incubators and brought up without the mother hen's care and training to survive in adult life. With this in mind, the most important aspect of reaping the benefits of using a choice feeding system is to train the pullets early to distinguish the different forms and types of feed that they will be eating throughout the rest of their lives, as if they have been reared naturally.

The time when chickens learn the most is from one day old to about 14 weeks of age. Thereafter, they do not learn well and therefore it would be unfair if one was to expect benefits from using the feeding system when the birds were not allowed the opportunity to learn before they reach 14 weeks of age.

Choice feeding training involves no complicated formulas or procedures. All that is required is to place before the chickens two sets of diet; one being mainly an energy source and the other being mainly a protein source. The latter also provides minerals, vitamins, amino acids and other minor nutrients. The protein concentrate supplement is likely to be unchanged but it is possible to change the energy feed sources. If that is to be the case, then, allow the birds a minimum of 14 days to eat each of the different types of energy feeds the birds are likely to eat throughout their productive life. Once the birds begin to develop the desired feeding pattern, usually when they eat at least twice as much energy feeds as protein concentrate supplement, both feeds can be added together in a feed trough without having to offer each source separately.

This is practically possible with whole cereals or chipped and dried root/tuber crops. It would not be possible with wet (boiled) feeds, as such feed when mixed with dry protein concentrate will make the concentrate go bad within a short time.

Feed troughs

Since the bamboo is naturally partitioned, it is an ideal type of feed trough to use in training the birds to develop the desired feed pattern. Cut out a straight section of bamboo with at least 4 to 6 internodes between the two ends. This will be sufficient to construct 5 to 7 troughs, sufficient to cater for 20 to 50 pullets respectively.

Secure along one side of the house the feed troughs and along the other the water troughs. Or, alternatively, construct a length wise support structure in the centre of the house and secure the bamboo feed and water troughs on either side of the structure. Such support structure can be made from planting small posts, adequently distanced to support one cut-out bamboo length. If gutter troughs can be obtained, they can be also used and should be arranged in a manner similar to the bamboo troughs.

Preparation of feeds

Tuber/root crops such as cassava, sweet potato and taro kongkong should be chipped into small pieces, boiled or dried before they can be given to the birds. Young birds particularly can not handle big clumps of these feedstuffs. Whilst cereals, such as sorghum, can be offered without having to ground them but, for maize they should be cracked if they are dry as the young birds will have problems in eating them.

Presentation of feeds

During the early period of rearing the pullets, before they commence laying, at least 3 out of 5 or 4 out of 7 troughs should be filled with the energy feed sources and the reminder with the protein concentrate supplement. However, when the pullets commence laying, the middle trough should be emptied and filled with oyster chips instead. The other 2 or 3 troughs on either side of the trough containing oyster chips will now be filled with protein concentrate and energy sources either seperately or in a sequence. Ensure the troughs are cleaned every second day if boiled (wet) feeds are used.

The same applies if gutter troughs are used. Partition the troughs so that different sources of feed can be offered and maintained separately until the pullets develop the appropriate feeding behaviour, consuming about 2-3 times more energy feed sources to protein concentrate. Thereafter there is no need to worry about the feed mixing, as the birds have already learnt to distinguish the feeds and will eat accordingly.

Feeding of pullets

As mentioned earlier, the pullets can be choice fed as early as one day old or later, but not after they are over 14 weeks of age. If the pullets were to be choice fed from day one, then there is no need to buy commercial pullet starter and developer feeds. But if free choice is started later, then these feeds have to be purchased and fed to the pullets as outlined in Part I (Complete feeding system).

The amount of protein concentrate and energy feed source consumed will depend on a number of factors, including;

- stage of pullet growth,
- environmental temperature,
- length of training the pullets receive,
- nutrient content of the feeds,
- texture and palatability of the feeds,
- anti-nutrient content of the feeds.

Shown below (Table 1) are the approximate amounts of energy feed source and protein concentrate supplement each pullet will consume during different stages.

Table 1. **Approximate intake rate of energy feed source and protein concentrate suppliment of pullets in the growing and laying stages**

Stage	Age (wks)	Energy (kg)	Protein concentrate	Grit (kg)	Total (kg)
Growing	0-20	9	3	0.1	11.1
Laying	21-74	27	9	2.0	38.0

During the laying stages, green feeds such as sweet potato leaves can be also offered, as they help improve the yolk colour. Grit, in the form of very small stones, can be added when the pullets are young, but it is not necessary when the pullets have started to lay eggs and when limestone or oyster shell chips are being used as a calcium source.

BUDGET FOR A 50 LAYER PROJECT

Basic Assumptions

1. A deep litter system will be used. Two identical bush material houses will be built, each measuring 3 x 6 m. A K100 per house is required to cater for other necessary items. One house will be built first and the other within the first 12 months. The houses will last 5 years.
2. Brooders, waterers and feeders will be made from bush materials.
3. Day old pullets - K1.20 each
4. Mortality, 0-20 wks, 10%: 21-74 wks, 12%
5. Cost of feed;
   - Energy feed sources, self grown and prepared at no cost,
   - Protein concentrate, based on meat and bone meal, soya bean meal and rice bran at 39 toea/kg,

- Calcium source, self provided at no cost.
6. Egg production - 190 eggs/hen (deep litter)
7. Cost of transport of feed - 3 toea/kg
8. Wholesale egg prices (ungraded) - K1.80/dozen.
9. Sale of spent and cull hens - K4/hen.

Details of estimates for the cash flow (Kina)

Capital Expenses
2 sheds at K100 each 200

Annual Running Costs

First year

Protein concentrate (0 - 21 wks) 3kg x 39t x 50 pullets 59
Protein concentrate (21 - 74 wks) 4.5* kg x 39 x 45 pullets (*Feed for 6 months only) 79
Total feed cost 138
Cost of transport of feed 353 kg of protein concentrate at 3t/kg = K10.59 11
Cost of 50 day old pullets at K1.20 each 60
Other associated costs 20
Total first year running costs **229**

Second and subsequent years

Protein concentrate (0 - 21 wks) 3 kg x 39t x 50 pullets 59
Protein concentrate (21 - 74 wks) 9 kg* x 39t x 45 pullets (*Full year) 158
Total feed cost 217
Day old pullet cost 60
Transport cost - 555 kg of protein concentrate x 3t/kg x 3t/kg 17
Other associated costs 30
Total second and subsequent years running costs 324

Annual Returns
1. First year - 45 hens x 100 eggs = 4500 eggs or 375 dozens at K1.80/dozen 675
2. Second and subsequent years - 45 hens x 190 eggs = 8550 eggs at K1.80/dozen 1283
3. Spent hens - 40 hens at K4.00/hen 160

Total annual returns 2118

Development cash flow

	Year 1	2	3	4	5
Receipts					
Sale of eggs	675	1283	1283	1283	1283
Sale of spent hens	-	160	160	160	160
Total cash receipts	675	1443	1443	1443	1443
Capital expenses					
Sheds	200	-	-	-	-
Total capital expenses	200	-	-	-	-
Runing costs					
Feed	138	217	217	217	217
Transport	11	17	17	17	17
Day old pullets	60	60	60	60	60
Other cost	20	30	30	30	30
Total runing cost	229	324	324	324	324
Annual cash surplus	246	1119	1119	1119	1119
Cumulative cash surplus	246	1365	2484	3603	4722

The project has a cash surplus from the first year onwards. With half of the feed being self-provided, the cost of feed is markedly less and thus increase return rates. Note that the same can be realized even using a cage system, despite the additional cost for the cages. That is, the costs of the cages will be offset from increased recovery of eggs when cages are used.

FURTHER READING

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DEVELOPMENT NOTES: NO. 14

RECOMMENDED MANAGEMENT FOR 1000 BROILER CHICKEN PROJECTS

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ABSTRACT

Poor performance of contracted broiler growers (1000 - 5000 broiler chickens per batch) in Morobe Province was investigated. Poor management was identified as being largely responsible for the problem. An alternative management system is recommended.

Key words: *broiler chickens, management systems, contracted growers*

INTRODUCTION

In Morobe Province, about 45 farmers (though less presently) are contracted by Niugini Table Birds Pty Ltd to raise 1000 - 5000 broiler chickens per batch for its processed chicken operation. However, for some time the farmers were faced with poor performance and low returns, largely because of high mortalities experienced during and after the brooding periods and lower growth rates. Labu Animal Husbandry Research Centre, based in Lae, Morobe Province, investigated the reasons for such poor performance and found the causes were of management nature and widespread. To avoid poor flock performance and lower returns from reasons similar to those found in the investigation an alternative management system is recommended.

CAUSE(S) OF THE PROBLEM

The following management problems were identified;

Housing

The growers build their houses with bush materials and wire netting. All the birds were reared on deep litter with floor space of about 0.1 m^2 per bird. The housing is adequate. However, it was found to be not secure and, thus, thefts and attacks by predators were commonly experienced.

Water Supply

Most projects have no water supply close to the chicken houses, so water is usually carried from a long distance. This hard work, particularly during the last three weeks of the growing period is discouraging. Bamboo water troughs were used in most projects, but they can hold very little water for such numbers of birds and, therefore, need filling about every two hours. Other growers used 20 litre drums partly buried under ground. Though water was available all the time, waterer space was inadequate, and therefore, many chickens could not drink when they needed to, especially during the hot times of the day.

Feeders

An adjustable self feeder, with a tube and tray which could be dismantled, were used in all projects. This self feeder has several disadvantages in that the wire connecting the tube with the tray often disconnects and, as a result, causes considerable wastage of feed. The tray is also shallow (only 5 cm high), so the feed tends to overflow from the tray causing wastage.

Brooding

Brooding of day old chickens was left to the farmer's resources. In most cases, the chickens were confined to a small area of the house without additional protection. The temperature during the day was within, or slightly less than, the optimum

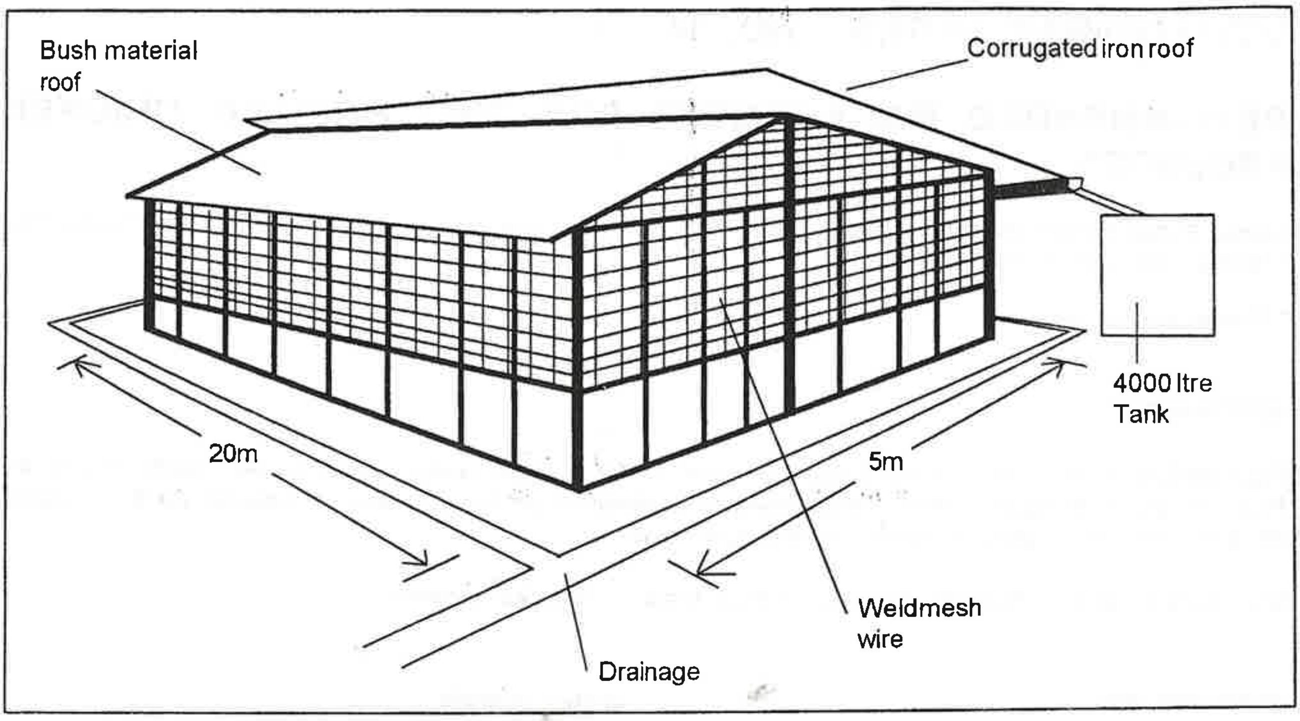

Figure 1. **Type of house suitable for rearing broiler chicken in peri-urban conditions.**

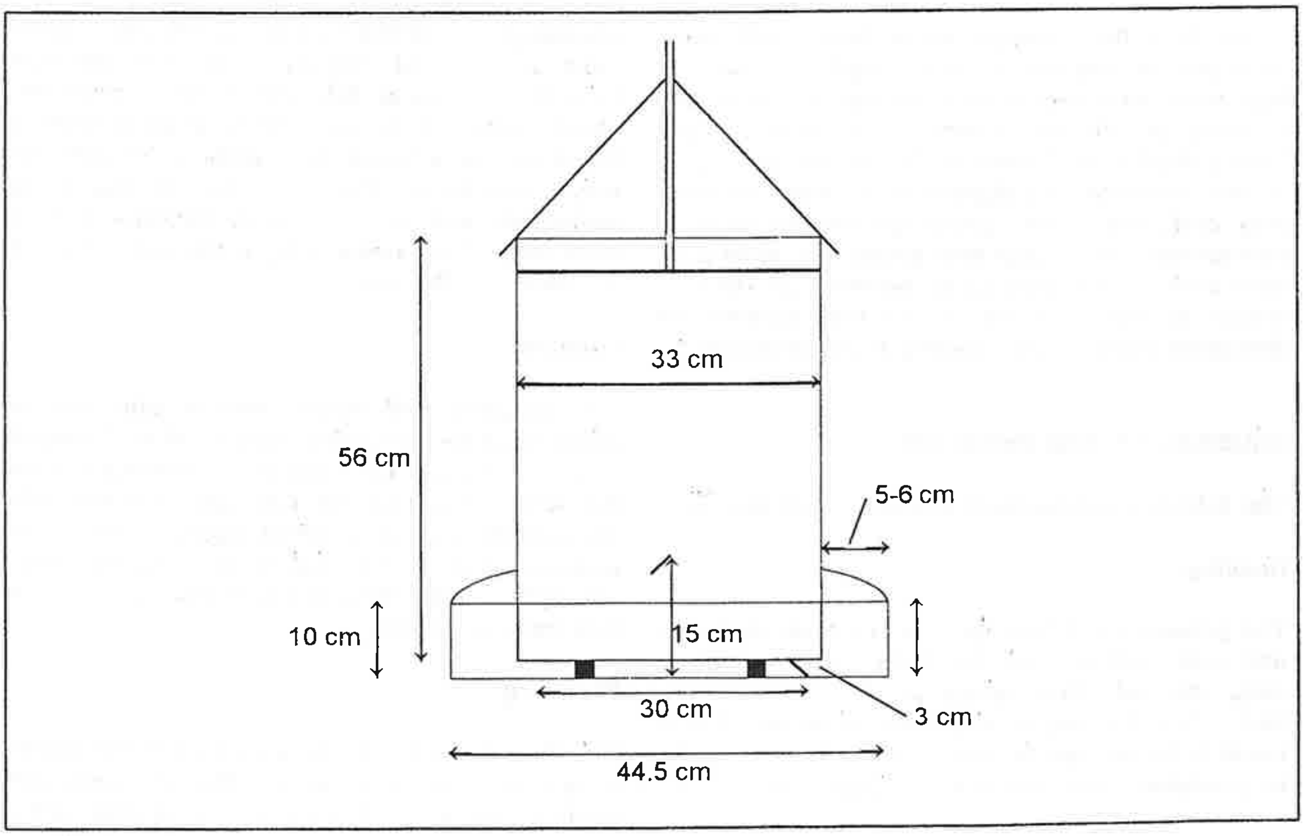

Figure 2. **A model self feeder suitable for raising broiler chickens.**

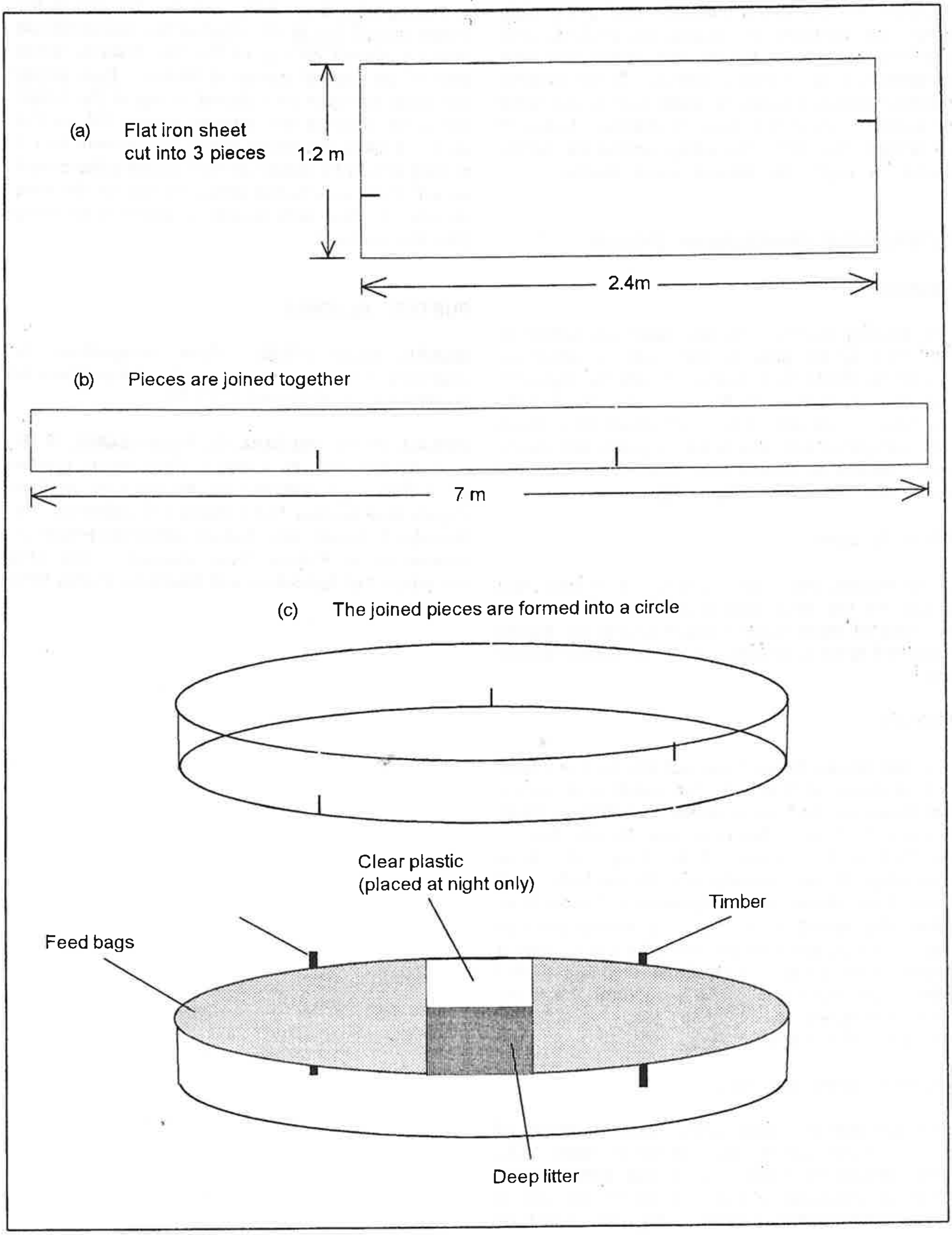

Figure 3. **Type of a cold brooder suitable for brooding 250-300 chicks.**

requirements (30-35°C). However, during the night when the temperature drops to 19-22°C, the chickens were subjected to cold stress and high mortality due to chilling occurred. Some farmers provided kerosene lamps for extra heating, but failed to provide enough kerosene to maintain lamps lit all through the night. Crowding around the lamps during the night also caused some deaths.

ALTERNATIVE MANAGEMENT SYSTEM

Housing

The housing design to remain essentially similar to that used by the growers, but some modifications should be made to increase security by replacing the wire netting with 5 cm x 8 cm security weldmesh. One side of the roof should be covered with corrugated iron sheets with a gutter and down-pipe installed to collect rain water from the roof into a 4000 litre tank (Figure 1).

Water Troughs

Water troughs should be made of 1.8 m long blind gutter, 15 cm wide and 8 cm deep. Sufficient numbers of these water troughs should be placed inside the shed to provide 2.5 cm of waterer space/ bird.

Feeders

The self feeder found most suitable is a modified one as shown in Figure 2. It consists of a circular tray measuring 44.5 cm diameter and 10.0 cm deep. A cone 30.0 cm, diameter and 15 cm high is revetted to the centre of the tray. A barrel measuring 33 cm diameter and 56 cm high is set firmly 3 cm above the tray by means of three legs. When the barrel is placed at a central position above the tray, there will be about 5-6 cm of feeding space at all points. The whole unit is provided with a sire handle to allow suspension from the roof when necessary. One self feeder is sufficient for every 50 chickens.

Brooders (Cold Brooder)

The brooder is constructed from a sheet of galvanised iron 6.8 m long and 50 cm wide. The sheet should be made into a ring with the two ends overlapping about 1.2 m to provide a surrounding for the chickens. The ring could be expanded to a larger size as the chickens grow older. Two pieces of bush timber measuring about 4 m long should be placed on top the ring at the centre and 60 cm apart. Another two pieces should also be placed on top of the ring towards either side of the central pieces of timber. Four empty jute bags cut open and placed on top of the timber will cover most of the brooder except the central area. A clear polythene sheet 90 cm wide and 3 m long should be placed at night covering the central area to form a complete enclosure for the chickens (Figure 3). One such brooder is sufficient for every 250-300 chickens.

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GENERAL INFORMATION ARTICLE

MAN-MADE SATELLITES AND THE CHANGING WORLD OF COMM-UNICATIONS

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What is a Satellite?

Astronomers define satellite as a celestial body that reflects light from the sun and rotates around a planet. Therefore, two types of satelites can now be recognised: natural and artificial or man-made.

Since the 1950's with the launching of Sputniks by the Russians, we have man-made satellites rotating around our planet Earth. they are actually "electronic systems" with high technology equipment on board, circling the Earth and obtaining data for establishing "electronic links" among different geographic points.

Positioning of Satellites

Since an artificial satellite is an object rotating around the Earth, it must be positioned in an orbit around the planet. To do this, it has to be carried into an orbit either by the "space shuttle" or a rocket. Rockets are propelled by the thrust generated by gasses produced during a "combustion process".

The necessary elements to produce the combustion are loaded and stored in the rocket's "deposits" at very low temperatures. The upward thrust in the rocket depends on two main factors:

i) Velocity at which the gases are expelled from the nozzle (from the "burning chamber").
ii) The amount of "fuel" that "burns".

Figure 1, shows a sketch of a propulsion system of a rocket. The oxidant agent and the "fuel" are mixed and placed in the combustion chamber, where the mixture is burned. At high temperature gases expand and are expelled through a nozzle generating characteristic clouds of vapour and smoke during a rocket lift off.

The first satellites were placed in orbits near the Earth. For example the Score experimental satellite placed in orbit around earth by United States in 1958, was in an elliptic orbit, with a minimum distance to Earth of 185 km and a maximum distance of 1470 km.

Since the satellite, rotates around Earth, in order to "capture" its radio-electric signals, the rquired antennae have to follow its path in the sky. To do that, it is required to point a large antenna capable of following the trajectory of the satellite, located far away from it, and therefore not visible on the horizon. This is a complicated matter.

The above problem has been solved by using the concept of geo-stationary orbits allowing a satellite to remain in a fixed position relative to Earth. As a result of this, the antennae that required to send or receive radio-electric signals to or from a geo-

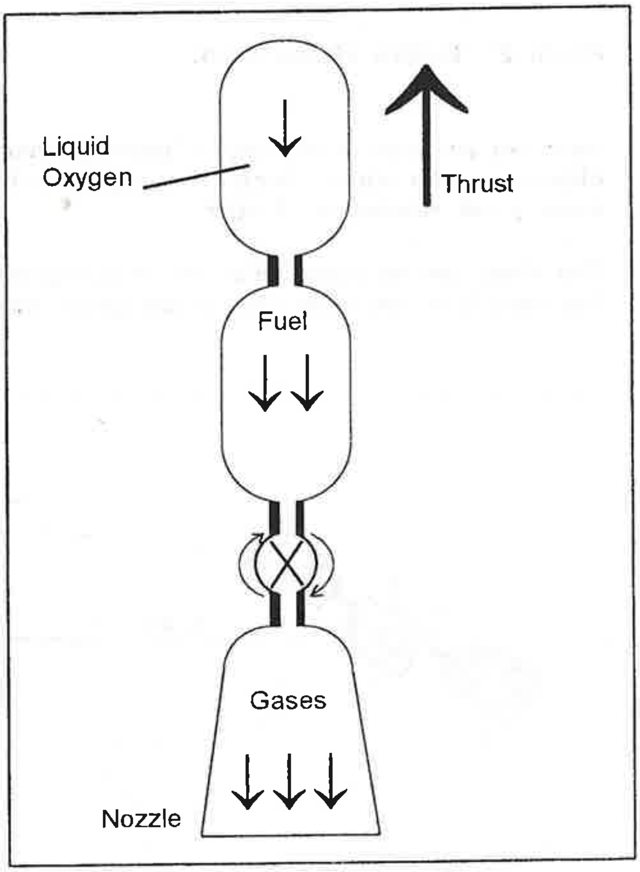

Figure 1. **Rocket's Propulsion system.**

stationary satellite can remain in a fixed position without the need for corrections or adjustments unless we change to a different satellite. If this is required, then we need to modify its "direction" toward the sky.

Now, the Earth has an elliptic orbit around the Sun and rotates on its own axis as shown in Figure 2.

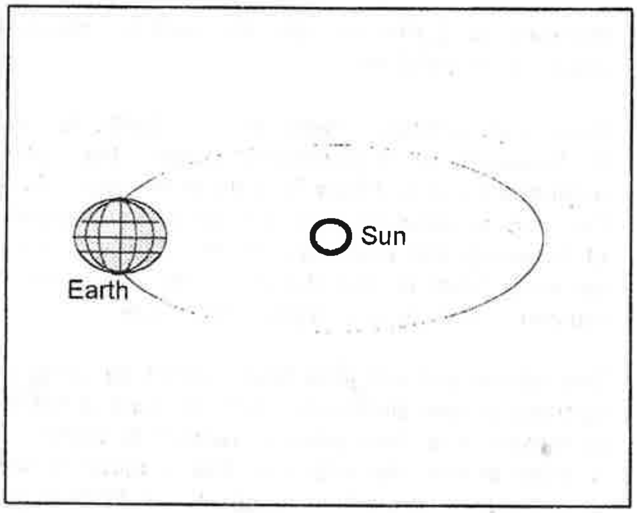

Figure 2. **Earth's elliptic orbit.**

How can we have in the sky a "geo-stationary" object, i.e. An object located always on the same point relative to Earth?

This effect can be achieved as shown in Figure 3. The satellite is not really fixed in the space (sky), but travels with a very high speed, about 11000 km/hour and at an altitude of about 36000 km. With this velocity the satellite follows and completes a circular orbit once every 24 hours. This is the time in which the Earth rotates on its axis, therefore, it seems that the satellite is fixed in the sky relative to a point on Earth, even-though an observer on Earth and the satellite are moving with a high speed.

Since this is not a scientific paper, we will not discuss any mathemathics involved. We can only say that when an object is moving around Earth there are two forces acting on it: a repulsion force and an attraction force exerted by Earth on the object.

When both forces are equal there is a stable orbit with a specific radius and specific time period. For the specific case we are interested in, we could prove that for a satellite to rotate around our planet once every 23 hours, 56 minutes, and 4 seconds (time needed for Earth to rotate on its own axis), it is necessary to place it at an altitude of 36 000 Km and to have a velocity of 11000 km/hour. Knowing this the next question to ask is:

On what geographic points are the Geo-stationary satellites placed?

In principle, we could answer this question by saying that any geographic point is good, or that a location directly above the country that will be using that satellite is ideal. However, the answer is very different indeed: all geo-stationary satellites are placed over the Earth's Equator, (the equator is the maximum circle that "divides the Earth in two equal

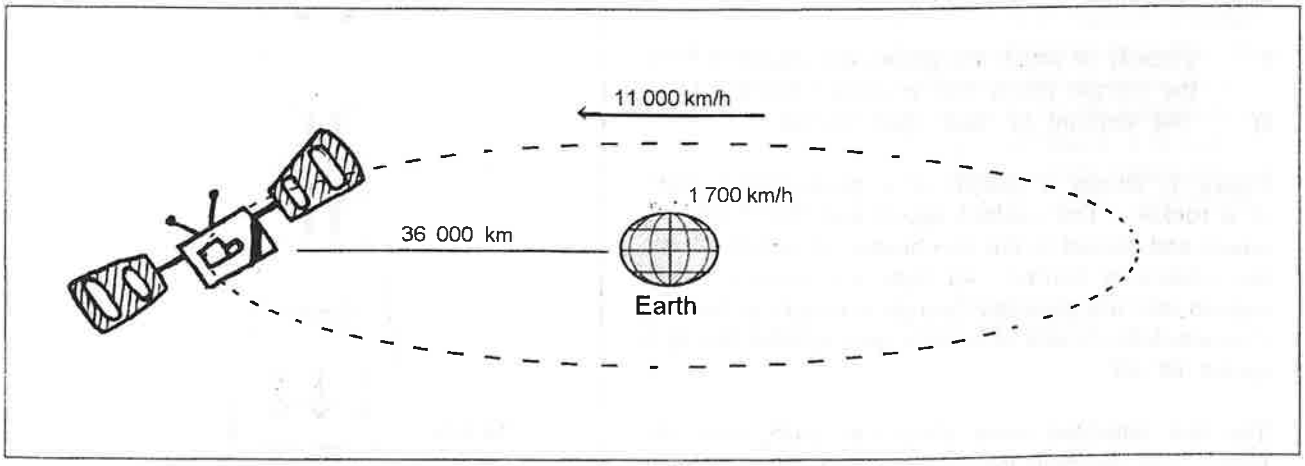

Figure 3. **Geo-stationary Satellite.**

parts" and is located at the same distance from both geographic poles).

If the satellite's orbit is **not over the equator**, the direction of the satellite would be different from the Earth's rotation (and from an observer on Earth), as it can be seen in figure 4, therefore the satellite

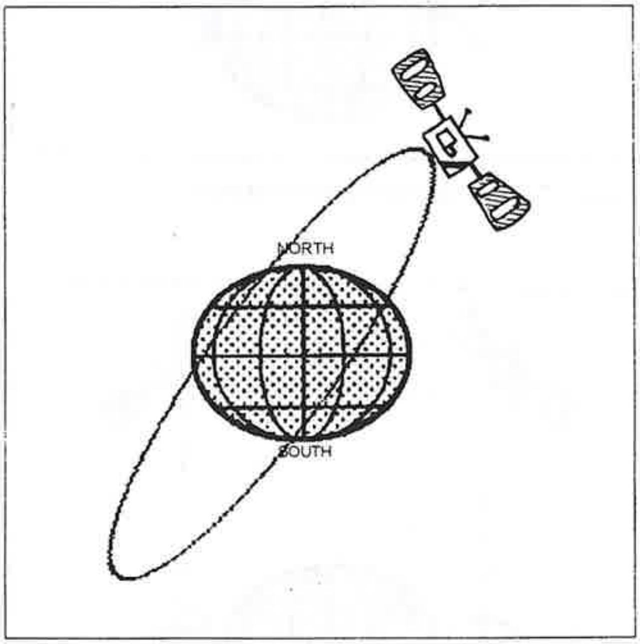

Figure 4. **Non-geo-satationary satellite.**

would not remain stationary; it would even disappear sometimes from the observer's line of sight. In order for that not to happen, the satellite would have to be placed at a different altitude and rotating at a different velocity which in reality would be almost impossible.

Therefore, the only possible location for an orbit of 24 hours duration is about Earth's equator, because in that orbit the satellite will be travelling from East to West, in exact synchrony with Earth's motion. It will therefore remain geo-stationary (fixed with respect any point on the planet).

The Geo-stationary orbit is also called **Clarke's Belt** since in 1945 Arthur C. Clarke pointed out that all points on Earth could be covered by using only three geo-stationary satellites. Due to this fact we could say that the satellites are basically TV receivers tuned to signals sent from Earth via big parabolic antennae.

The signal received by the satellite is amplified to increase its power and then re-transmitted back to Earth to be received by parabolic entennae located in big cities and that we can also find in some places in PNG. The number of these antennae is decreasing due to the cable TV increase in popularity during the 1990s.

A transmission from a satellite is somewhat similar to a "shadow" from a light source in the theather when the scene is in darkness and the actor is followed with a light ("torch"). Where here with a "plate" (satellite's parabolic antenna) a specific area of the surface on Earth is "illuminated" (radio waves and light waves have a lot in common). This area covered by the "plate" (satellite's antenna) is called the shadow of the satellite. Satellites used for TV broadcasting are powerful enough, for their signals to be received by using only small parabolic antennae.

What is a Satellite used for ? or Why do we need satellites?

Is it not possible to send/transmit TV signals in a straight line from the transmitter's antenna to the receiver's antenna instead of sending them up to the sky (satellite) and then back to Earth? What is it that we cannot have in conventional TV system where we can use a simple radio-TV transmitter with all the world's antennae pointing towards it?

The first question would make sense if the Earth was a flat surface, and since this is not the case, there are some transmission problems associated with its spherical shape. The high frequency waves travel in a straight line, and they can not be bent, so, they can not follow the shape of the planet.

As it can be seen in figure 5, a signal that is transmitted by antenna A can reach another antenna B, but since our planet is spherical, it cannot reach

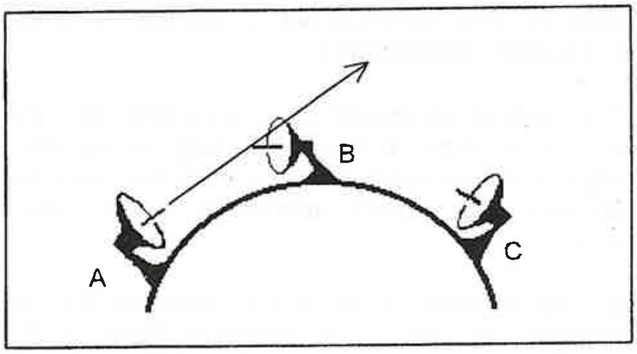

Figure 5. **Ground transmission among several points.**

antenna C. In other words, if antenna A is a transmitter, its signals follow a straight line. Antenna B and C are receivers, and even-though antenna B receives the signal without any difficulty, this does not happen to antenna C, since it is "hidden" from the line of sight of antenna A.

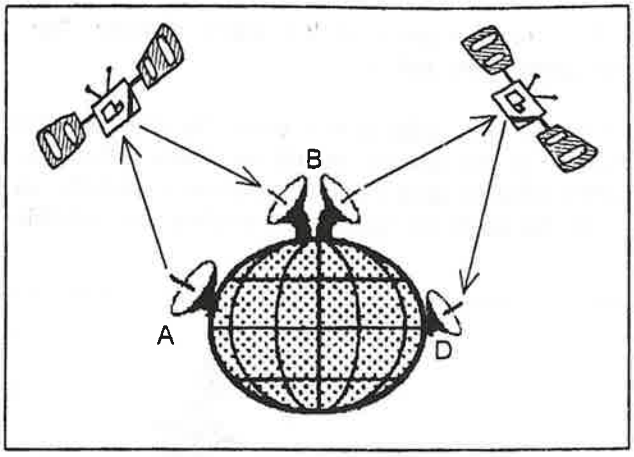

Figure 7. **Two satellite transmission.**

Therefore, the major requirement for ground transmissions, is that both antennae, transmitter and receiver, must "see each other", since signals that have been transmitted 'beyond" the line of sight (beyond the horizon), of a receiver antenna, can not be received. Due to this restriction, receiver antennae are usually placed in high mountains or high towers built to increase the "line of sight" of the antenna.

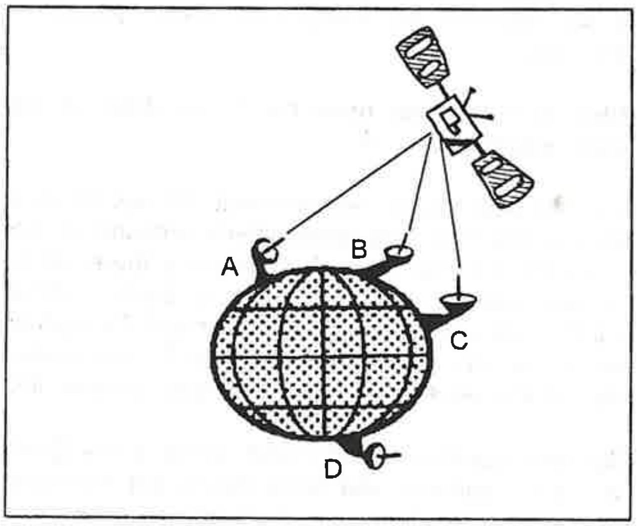

Figure 6. **Transmission via a satellite.**

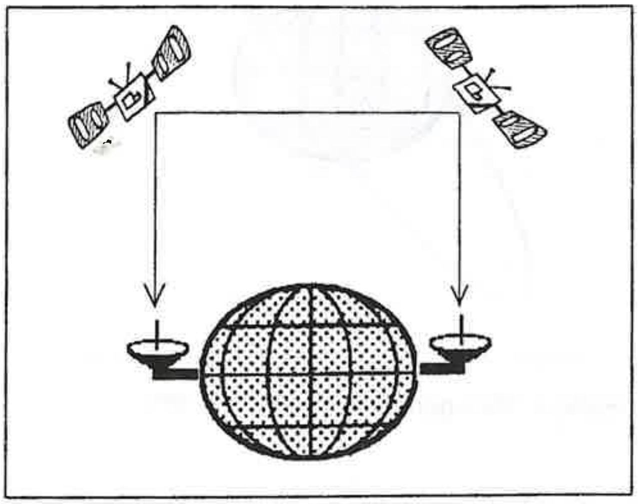

Figure 8. **Direct link between two satellites.**

Figure 6 shows how this distance limitation problem can be overcome. Antenna A can now communicate with antennas B and C via a satellite. However, antenna D can not receive any signal with this satellite configuration.

This problem is solved by using more than one satellite, as shown in figure 7. Using two satellites, antenna A can reach antenna D in two satellites, Antenna A can reach antenna D in two "single jumps".

We would have a direct link between the two satellites, of course, as shown in figure 8; this would decrease the total signal path from A to D, but this would bring other problems, such as;

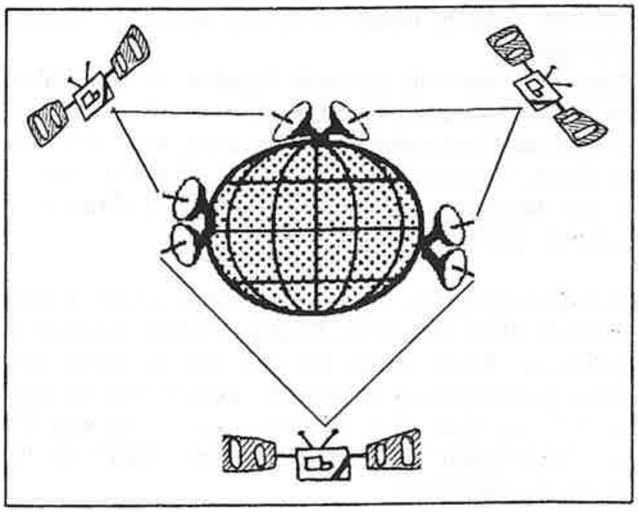

Figure 9. **Three satellite configuration.**

difficulty to achieve a very good accuracy in the orientation between the two satellites.

After many studies, it has been found that three geo-stationary satellites are necessary, (located at 120° apart), to cover the entire surface of the planet, as it was predicted by Arthur C. Clarke in 1945. This satellite configuration is shown in figure 9.
One of the problems with the RF signals from the TV Channels is that they are absorbed by the Earth and other solid objects, therefore, when we are dealing with long distances,the signal is usually "weak" when it reaches its destination. Thus, re-transmitters are usually needed to "repeat' transmissions from point to point.

So, the advantage in using a satellite is that only one -re-transmission (performed in the satellite), is needed to cover long distances. Moreover, it is always possible to re-adjust (change the orientation), the receiver antennae, to receive different satellites" signals.

Since the first commercial model was launched in 1965, the communications satellite has become a linchpin of global communications. Satellites now carry about one third of the voice traffic between countries and essentially all the television signals between countries. Much of the voice traffic handled by satellites, is to countries that have no access to fiber-optic cables, which are the preferred medium for carrying telephone calls.

At the present time, large communications satellites put into geosynchronous orbits are used to carry voice traffic, therefore, a time delay of a quarter of a second is created when the signals travel to and from the satellite, during a phone conversation. Although not everybody finds this delay irritating, communications satellites are increasingly being used to carry TV signals and data rather than voice traffic.

All of this is about to change. A completely new type of satellite communications system will begin operations very soon. Basically these new networks will provide cellular phone service via satellite. Among other unique characteristics, these new personal communications satellite systems will be based on a relatively large number of satellites in orbits considerably lower than geosynchronous ones; they will therefore introduce less delay into telephone conversations. A second type of system will be used primarily for handling data, such as connections to the Internet.
A few years ago cumbersome dish antennae were needed to obtain a satellite connection faste than simple telephone service cost was high. Those limitations are disappearing. The coming torrent of high-speed data "from space" should soon be a colossal boom for everybody around the world. it will be specially important in developing countries such as India, Brazil, China, Pacific Countries, which do not have extensive fiber-optic networks.

During the past six years, wireless services and satellites have been experiencing record growth. Today they can provide a telephone-line transmissin at a very low cost. Moreover, the most rapidly growing type of telecommunications service is direct broadcasting satellite (DBS) television, which uses geosynchronous orbiters to beam signals to more than 20 million people worldwide.

Specially in developing countries, space-based telecommunications systems will change our lives during the next two decades, providing rapid access to information of all types. Of special interest, are applications int he areas of medicine and education, as "tele-health", and tele-education services and video tele-conferencing that could be provided to remote areas in those countries.

CONCLUSION

Over the next five to six years, four to five of the new voice-type satellite systems (personal comm-unications ystems) and possible upward of a dozen of the data-oriented satellite systems will go into operation. In addtion, some of the already proposed systems will operate at very high frequencies in radio bands not previously used for satellite communications. The technical challenges and risks are significant.

The new personal communications satellite systems are trying to combine some of the attributes of cellular telephone systems with those of traditional satellite communications into a single global network. Traditional cellular systems uses a band of radio waves with frequencies between 800 and 900 Megahertz, and the new personal communications systems will operate at about twice this frequency, but both systems function in the same manner. In the new systems the satellites will be, orbiting cellular base stations, with which the mobile phones will communicate directly.

One advantage of these personal communications satellite systems will be an unobstructed path between the satellite and the subscribers, allowing operations at lower power levels. Recent studies show that systems operating at higher, intermediate-circular-orbit will enjoy an advantage, as the satellites are visible at higher elevations and cross the sky slowly.

Many different systems are proposed, but only five appear to have some promise of being developed. Four of them are U.S. based and have already received licenses from the U.S. Federal Communications Commission; the fifth is an enterprise spun off from the International Mobile Satellite Organisation (Inmarsat), a treaty organisation similar to Intelsat.

The development of those new fleets of satellites will affect some of us profoundly. By the year 2000 it will be possible to call home from essentially anywhere on this planet by using a handheld terminal similar to today's cellular phones. We would never be out of touch, no matter where we are. Universal service will become possible, for those who can afford it, even in places where none now exists. This planet will soon be a place where not just communications, but all kinds of information will be available for everyone, everywhere.

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GUEST ARTICLE

GREENHOUSE GAS MITIGATION: A PROSPECT FOR ESTABLISHING CARBON OFFSET INDUSTRY IN PAPUA NEW GUINEA

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Introduction

One of the most prevailing global concerns to which we are a part is climate change and its effects on global, regional and local weather patterns, sea level rise and how these changes will affect our environment and socio-economic survival in the future. This global climate change has been going on over centuries, but became more so after the industrial revolution, in particular through the burning of fossilized fuels such as oil, gas and coal causing what is known as the greenhouse effect.

Causes of Greenhouse Effects

This greenhouse is the result of gases in the atmosphere trapping the sun's warmth and raising the temperature on earth by about 33°C. This is a natural process, without which the earth would be much colder and inhospitable to plants and animals, including humans. However, over hundreds of years man's activities have substantially increased the atmospheric concentrations of greenhouse gases, such as carbon dioxide, especially in recent times compared with pre-industrial times. This human induced warming is known as the enhanced greenhouse effect. Scientists studying greenhouse effects have concluded that the continually growing emissions of greenhouse gases will accentuate the natural greenhouse effects. Thus, resulting in wide ranging potential impacts on the natural environment and national and global socio-economic systems.

The most important greenhouse gases are carbon dioxide, methane and nitrous oxide. Also making a relatively small contribution are various halocarbons, products of the chemical industry. These include the chlorofluorocarbons, better known for their prime role in ozone depletion, and the perfluorocarbons, a group of potent greenhouse gases.

Projections of Global Warming

Global emissions of the main greenhouse gas, Carbon dioxide have grown from about 2 Gt (or billion tonnes) of carbon a year in the first half of this century to the current estimate of over 7 billion tonnes a year due to human activities. Further increases are inevitable, at least in the short term.

In deriving the projections for global warming, the Intergovernmental Panel on Climate Change (IPCC) looked at six scenarios for future carbon dioxide emissions based on a wide range of assumptions about population and economic growth, land use and technological changes and energy use. Its lower estimate has emissions rising slightly until 2025 and then falling to 5 Gt a year by 2100. At the other extreme, emissions keep rising at a fairly steady rate, reaching 35 Gt a year by 2100.

Based on these scenarios, the IPCC concludes that global mean surface air temperature is likely to rise between 1°C and 3.5°C by 2100. With all the scenarios put together producing an average rate of warming probably greater than any seen in the past 10,000 years.

Implications

What this means is that the effects of global warming will vary around the globe. Temperature increases are expected to be greater towards the poles than nearer the equator, and over land than at sea. While rainfall is expected to increase in some areas and decline in others, predictions for particular regions are still highly uncertain.

In addition, it is expected that there will be a number of impacts of the changes in the climate, including the following:

- reduction in biodiversity as plants and animal species not adapted to the changed conditions in a region may die out;

- changes in the intensity of droughts and floods, and the availability of water for domestic, industrial and other uses;

- changes in agricultural productivity, which is expected to increase in some areas and decrease in others;

- threats to human health due to increase in geographical range of insects that carry diseases such as malaria; and,

- increases in the intensity and duration of heat waves.

Situation in Papua New Guinea (PNG)

PNG is highly vulnerable to the impacts of climate change as it encompasses more than 17,000 km of coastline, 600 islands and has almost 2,000 coastal villages and a rural coastal population of about 500,000 making it vulnerable to sea level rise and other weather-related manifestations of climate change. Our fisheries and marine resources, although currently abundant and at least less exploited, could prove susceptible to temperature and other changes. Our terrestrial ecosystems are particularly diverse and complex, and the impacts of climate change on them are not well established and understood.

The IPCC's projections of average sea level rise from 15 - 19 cm by 2100 due to global warming, with sea levels continuing to rise beyond this time frame. The extent of the rise will vary around the world. In some areas, problems caused by rising seas may be intensified by an increased risk of storm surges. The populations of some delta areas and low-lying islands will face increased danger from flooding and being submerged under water. Other likely impacts include erosion of shores and associated habitats, and increased salt levels in estuaries and freshwater aquifers in coastal margins.

International Concerns

At the 1992 United Nations Conference on Environment and Development (UNCED) meeting at Rio, world leaders, including PNG, signed a landmark international agreement, known as the "*Framework Convention on Climate Change*" (FCCC). The purpose of this agreement was for the parties to the Convention to begin developing strategies to mitigate the effects of atmospheric pollution on the global climate. Under the FCCC terms, industrialized countries are committed to the goals of balancing their greenhouse gas (GHG) emissions at 1990 levels by the year 2000 and also to assist developing countries in mitigating their longer-term emissions' trends.

This FCCC promotes two types of mitigation strategies to achieve a GHG balance. The first strategy consists of emissions reduction efforts involving energy conservation and conversion to renewable energy sources. The second strategy involves the protection and enhancement of GHG sinks such as the large areas of forests and coral reefs. The FCCC does not set country-specific obligations or seek to quantify broad emissions reduction goals; rather it establishes a general organizational, procedural and technical support framework. Thus allowing each party the flexibility to determine how to pursue its own commitments, the specifics of which are to be set forth in their respective National Action Plans.

The FCCC also contemplates that the parties to the Convention will initiate Joint Implementation (JI) projects that seek to reduce or sequester GHG emissions. The Convention also states that the Parties can reduce emissions either individually or jointly.

Further, according to the FCCC, the Parties "*shall adopt national policies and take corresponding measures*" to limit their emissions of greenhouse gases, with the ultimate objective of "*stabilizing GHG concentration in the atmosphere at a level that would prevent dangerous human interference with climate system.*"

US Initiative on Joint Implementation (USIJI) for reducing Greenhouse gas emissions

Given the high level of industry interest, the US has taken the lead in supporting the concept and implementation of JI projects. The Clinton administration has established a program; known as the US Initiative on Joint Implementation (USIJI), which had an allocation of some US$1 billion over a five year period to support pilot projects involving US companies or other entities (including NGOs) in other countries. This USIJI is one element of the US Climate Change Action Plan (CCAP), that the Clinton Administration has taken to implement in respect to the FCCC strategy for reducing emissions of greenhouse gases.

The emission reductions are achieved by projects such as fuel switching from fossil fuels to renewable energy sources (e.g., wind, hydro, solar, biomass) and improved energy efficiency. Greenhouse gas storage, or sequestration, is achieved through forest conservation and reforestation.

The aim of this USIJI is to:

(i) encourage US private-sector investment and innovation in the development and dissemination of technologies and procedures for reducing or sequestering emissions of greenhouse gases;

(ii) promote cost-effective projects that encourage technology cooperation and sustainable development projects in developing countries and emerging economies;

(iii) promote a broad range of projects to test and evaluate methodologies for measuring, tracking and verifying costs and benefits; and,

(iv) encourage participating countries to adopt more complete climate action programs.

The FCCC and the USIJI create an unique opportunity for developing countries to help assist in mitigating GHG emissions, while simultaneously harnessing the emerging interest in a carbon market to support sustainable development and biodiversity conservation of the forest resources.

PNG estimated GHG emissions

PNG is a relatively small source of GHG emissions, and its primary source is currently coming from the change in land-use patterns. According to the World Resources Institute (1994) report for the period 1994-95, land-use change in 1991 accounted for 29 million tons of carbon dioxide emissions, while energy and industrial-related emissions accounted for only 2.2 million tonnes. Methane emissions in PNG are estimated at around 10,000 tons per annum from a combination of solid waste disposal and livestock. All of these figures must be viewed as highly uncertain. However, we will shortly know our GHG emission levels when the present GHG inventories are finalised.

Hydropower provides the mainstay of PNG's electricity requirements, and the potential for expansion is quite enormous. Increased export-oriented exploitation of the country's oil and gas reserves, however, could increase our energy-related emissions over time. The same can be said for the growing transportation sector.

As PNG is a signatory to the United Nations Framework Convention on Climate Change, we have an obligation to prepare annual GHG inventories of our emissions of greenhouse gases according to international Guidelines. Some of the things that are required in these inventories include:

- establishing emissions patterns and trends;
- providing a starting point for the compilation of emission projections which was in 1994;
- providing essential information for the development of sectorial GHG mitigation measures and highlighting sectors requiring particular attention. For PNG we have identified six areas: agriculture, land-use changes and forestry, energy, industrial products, solvents and other products use and wastes;
- identifying potential sinks whose enhancement could provide offsets for emissions from other sectors;
- providing information/data to assist in assessing the effectiveness of mitigation measures; and,
- providing for comparison of PNG's GHG emissions vis-à-vis other parties to the FCCC.

Mitigating GHG emissions

At a seminar on GHG mitigation (or carbon offset) projects held in April 1997 in Port Moresby, a number of issues were raised and discussed. These include the policy initiatives taken by industrialized countries on reducing greenhouse gas (GHG) emissions such as the USIJI, and the realization by companies and industries emitting GHG that by 2008 they will be legally required by their host countries to reduce the quantity of their emissions. Such an obligation will, to an extent, be very costly, but there is a less costly alternative provided by developing countries. International emissions trading mechanisms are emerging, in which companies could invest in projects in developing countries that reduce GHG emissions e.g., carbon, and in return obtain "*carbon credits*" which they could use to trade off against the emissions they produce in their own countries. This new market place thus offers an economic opportunity for developing countries to obtain money through reduced impact logging, reforestation, afforestation, agro-forestry, solar, hydro, wind and biomass power generation, as well as other new technologies that may be developed in the future, which can account for carbon savings. While reducing greenhouse gas is voluntary at present, companies now know that by year 2008 it will become mandatory, as endorsed by all parties following the Kyoto meeting of the Conference of the parties (COP). The race is now on to find the best model agreements for carbon offset projects.

One of the major greenhouse gases is carbon dioxide, and this carbon is released into the atmosphere by biomass that is left to rot on the forest floor as a consequence of logging or being burnt for shifting cultivation. American power companies, seeking to be involved in model carbon offset arrangements, are now funding projects in South America for example, that log more selectively, enabling carbon to be saved, or preserve national parks from being cleared for agriculture. PNG could easily tap into this new trading mechanism. Right now PNG is well ahead of many South Pacific countries in having already had formal Government to Government approval with the United States on a carbon offset project. This will enable similar projects to fast track. With the United States already on line, Australia, the Netherlands, Japan and other European countries who have already set up their own carbon emissions trading offices will soon follow.

These carbon-offset projects are an investment, which reduce projected greenhouse emissions to the atmosphere or increases the projected biological uptake of greenhouse gases from the atmosphere. Thus, the GHG mitigation projects are modification of conventional energy supply sources, energy utilization techniques, and land use patterns which have the greatest capacity to serve as project opportunities (Saulei, 1998). Generating electricity or power from non-polluting sources, such as the wind, hydro or solar energy supplies a GHG mitigation service. For example, a new wind electric generating facility produces both electricity and avoids carbon emissions relative to fossil fuel alternatives. Increasing the efficiency of capturing, transporting, generating and utilizing conventional energy provides a form of greenhouse gas mitigation by accomplishing more economic production with the same or fewer, overall greenhouse gas emissions.

In Papua New Guinea the forestry sector may provide the most obvious opportunities for carbon offset projects financing conservation of biodiversity.

PNG carbon trade project

The case for PNG is quite obvious. With over 100,000 ha of forests being cleared annually by shifting cultivation and a further 14 million ha of forests presently available to industrial logging interests, the scope for positive impact is quite substantial. For biodiversity conservation advocate, these GHG policy initiatives may offer new sources of finance for funding the implementation of management activities (Parsons and Saulei, 1998; Saulei, 1998).

Already one formal attempt has been made in PNG. In early 1995, the UNDP / DEC Biodiversity Conservation and Resource Management Program undertook the first comprehensive attempt to develop a carbon offset investment prospectus for a PNG Forest Management initiative. The prospectus was part of a sustainable forestry project associated with an integrated conservation and development project in Lak, New Ireland Province (Stuart and Sekhran, 1996). The project comprises a total of some 23,400 ha divided into the following uses: 9,400 ha conserved forest, 12,000 ha reduced impact logging and 2,000 ha reforested forest, was allocated for this purpose. The implementation of the project would have lowered local carbon emissions to the atmosphere by reducing the relative amount of dead matter left on the forest floor. The prospectus was designed to raise funds from outside parties to help implement the proposed project, in return for verifiable GHG savings. Unfortunately, the substantial efforts to develop this initiative were not sufficient to overcome the pre-existing economic, business and cultural hurdles at the project site. The project did not go ahead because industrial logging had taken away the resource base needed for the sustainable forestry project.

The Lak carbon offset project would have earned an estimated US$2 million, at that time of the project inception, for the local landowners by saving around 3.78 million tones of carbon over a sixty year period (Stuart and Sekhran, 1996). However, using the recent carbon trade value of US$10 a tone, this would have amounted to some US$30 million over the same period.

While it did not proceed, the Lak initiative was a valuable experience in this new field. PNG, to this day is still the only country in the Asia-Pacific region to have "*in-development*" status from the US Government for a carbon offset forestry conservation proposal. As such, PNG is now the country best placed in the whole region to establish a carbon swap forestry conservation project with the USIJI.

Other similar projects

There are two major examples of forestry conservation carbon swap projects fully-funded Carbon Swap Forestry Conservation Projects and these are the Mercado Project in Bolivia and Rio Bravo Project in Belize (Stuart and Sekhran, 1996). Both projects involve The Nature Conservancy, the environmental non-government organization from the United States, which also assisted in the Lak sustainable forestry project. This environmental NGO is currently one of the stakeholders for the Josephstaal FMA timber concession area in Madang Province.

The US$8.78 million Mercado Project involves expanding the boundaries of the Mercado National Park threatened by poaching, logging, and unplanned agriculture, providing technical assistance to low-impact local logging firms, establishing commercial orchid farms, supporting an eco-tourism program, and assisting local landowners in alternative sustainable income generating activities. The US$7 million funding for the project has been sourced through the American Electric Power company, which is one of a number of American private utilities which believes that it is worthwhile to invest in establishing the feasibility of carbon offset projects. The project estimated that it could offset as much as 14.5 million tonnes of carbon over thirty years. A local Bolivian environmental NGO and The Nature Conservancy are assisting the company.

The US$2.6 million Rio Bravo Program in Belize involves five United States private electric power companies and The Nature Conservancy. The project will rescue a 14, 000 ha parcel of land from unsustainable agricultural clearance for biodiversity conservation. It also includes a sustainable logging project. The estimated carbon savings are 5.2 million tonnes over the next forty years.

In a seminar held in 1997 on GHG mitigation, the question about the future market for carbon was raised. To answer this we can give an example of what the Costa Rican Government is currently doing. The Government has in fact gone ahead making its own deals with private landholders for carbon savings, packaging them up and selling them overseas. Theoretically, groups working in small sustainable logging projects in PNG could also have their projects' carbon savings verified, bundled up as a package and also sold overseas if a buyer could be identified. At the moment, however, there is no real world market in carbon. Nevertheless, there is a market for model carbon projects. At the end of 1997 COP meeting at Kyoto, a Protocol was reached (Kyoto Protocol), which made the situation become clearer, where industrialised countries have agreed to a legally binding reduction of their overall GHG emissions by 5.2% to that of the 1990 levels, which will become effective by 2008. Thus, what this meant is that by agreeing to this Kyoto Protocol, such countries will force their respective companies to comply by reducing their carbon emissions. It is estimated that reducing emissions in countries like the United States could cost companies in excess of US$100 a tonne. In Costa Rica, they are already selling carbon savings at US$10 a tonne. At this point, a market will emerge, if the countries involved agree to allow it to happen.

Although PNG is one of the signatories to the UNFCC, to date we have no policy framework targeted specifically at climate change concerns. Despite our official recognition of the need to address the environmental issues facing our country, we are obliged to get our acts together to implement some of these conventions we have signed, including climate change. It may require us obtaining external assistance from Global Environment Facility or GEF in order to strengthen our institutional and technical capabilities needed to comply with the country's obligations under the UNFCCC, and to produce PNG's first national communication.

PNG's Obligation to UNFCCC

As a step towards implementation of our UNFCCC obligation, our Government through UNDF has drawn up and implemented a Climate Change Assistance project aimed at developing methods, building capacity and strengthening national institutions to assess the socio-economic and environmental impacts of climate change. The project is also aimed at increasing the capacity of our Government to identify and evaluate policy options and plan for adaptation to possible climate change. This project is being funded through the World Bank/UNDP - Global Environment Facility (GEF), which was signed early last year and has been implemented.

From what I have said above, it is very clear that we have to fulfill our obligations to the numerous International Conventions, including the climate change. The Climate change issue of greenhouse gas mitigation is very important to us as it provides our people the opportunity for implementing forest conservation and development strategies and at the same time providing financial benefits, especially to the resource owners, compared with the current destructive and exploitative development of our forest resources.

In order to benefit from GHG mitigation investments we need to source assistance for establishing our baseline data that can be verified by certification. We need to market our potential in GHG investments to industrialized countries. However, whatever agreement we reached, we need to take into account our capacity requirements for implementing GHG mitigation projects.

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PERFORMANCE EVALUATION OF FLXI BIO-GAS DIGESTER FOR PRODUCTION OF METHANE AS DOMESTIC FUEL

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ABSTRACT

An FLXI bio-gas digester made out of very strong rubberized fabric was installed at Physics Field Station Facility at UPNG. Chicken waste and water were used in equal amounts as slurry for anaerobic digestion to produce methane gas. Initial results indicated that the combustible gas was produced along with a combination of other gases as perturbations to the production of methane.

KEY WORDS: *chicken waste, anaerobic process, combustible gas*

INTRODUCTION

Bio-gas is a renewable energy resource which is produced as a result of biological fermentation of organic materials such as agricultural wastes, manures, animal and human excreta and the organic effluents etc in an anaerobic (oxygen-deficient) environment. The fermentatioin produces a mixture of methane (CH_4)/carbondioxide (CO_2) and other methanogenic gases reducing the organic materials to a slurry waste. The left over waste contain high concentrations of nutrients which make them highly effective as fertilizers (Srivastava, 1997).

Production of bio-gas in the rural sector of many developing countries has helped them indirectly to (i) improving the general sanitation and, therefore, reducing the community health problems: (ii) saving women from the drudgeries of collecting wood-fuel; (iii) protecting forests and deforestation; (iv) reducing pollution from smoke; (v) providing low-level employment opportunities and (iv) increasing agricultural yield by the application of bio-gas fertilizer etc. The basic technologies used for the conversion of organic materials to bio-gas are quite soft, environmentally clean and economical to establlish, operate and maintain. These are particularly well-suited for use in agricultural areas where the organic feedstock is more readily available.

Currently, a large number of bio-gas digesters are in operation with several of them being in China (approx. 1.3 million), India (approx. 1.3 million), South Koria (approx. 30,000) and Brazil (3,000); in addition to a few tens of hundreds in other developing countries. All of these utilize two basic designs: the fixed dome (Chinese) and the floating cover (Indian) concept. Yet another design which has been developed recently by an Indian Company in the form of a bag digester, was used at the Physics Field Station on Waigani Campus for experimental purposes and will be discussed in this article.

THE PROCESS

Anaerobic digestion is a process in which the anaerobic bacteria are able to exist through degradation of the general carbohydrate material. The process is partly dependent on temperature and partly on the C/N (Carbon/Nitrogen) ratio in the fuel stock material. Usually, higher the temperature, faster is the digestion with optimum temperature range being 30-40^{0}C for methanogens (methane producing bacteria). For the C/N ratio, the optimum range is from 20:1 to 30:1. A ratio higher than 30:1 restricts the microbial process due to lack of nitrogen for cell formation while too low a ratio increases the shift towards ammonia toxicity.

Generally, the tropical and sub-tropical regions with large numbe rof animal stock and with predominantly agro-economies find a more suitable environment for bio-gas production.

AN EXPERIMENT

During the middle of 1997, a new flexible and easily transportable bag digester was experimented for the production of combustible methane gas under a project sponsored by UPNG. The experiment was conducted using chicken waste as intake for the anaerobic process.

Messrs Ilimo Poultry Products Pty Ltd provided us a free supply of chicken waste which was transported to the Physics Field Station in appropriate bags. Messrs Swastik Rubber Products Ltd of Maharashtra. India provided us the FLXI Bio-Gas plant at subsidized rates for research purposes.

pegs. Next. the inlet funnel was positioned on the tripod and the outlet was positioned on the "Y" stand. The level of the outlet was kept at about 75 cm which was approximately the same at which the plant was expected to rise aster filling with the slurry. The plant was then ready for filling.

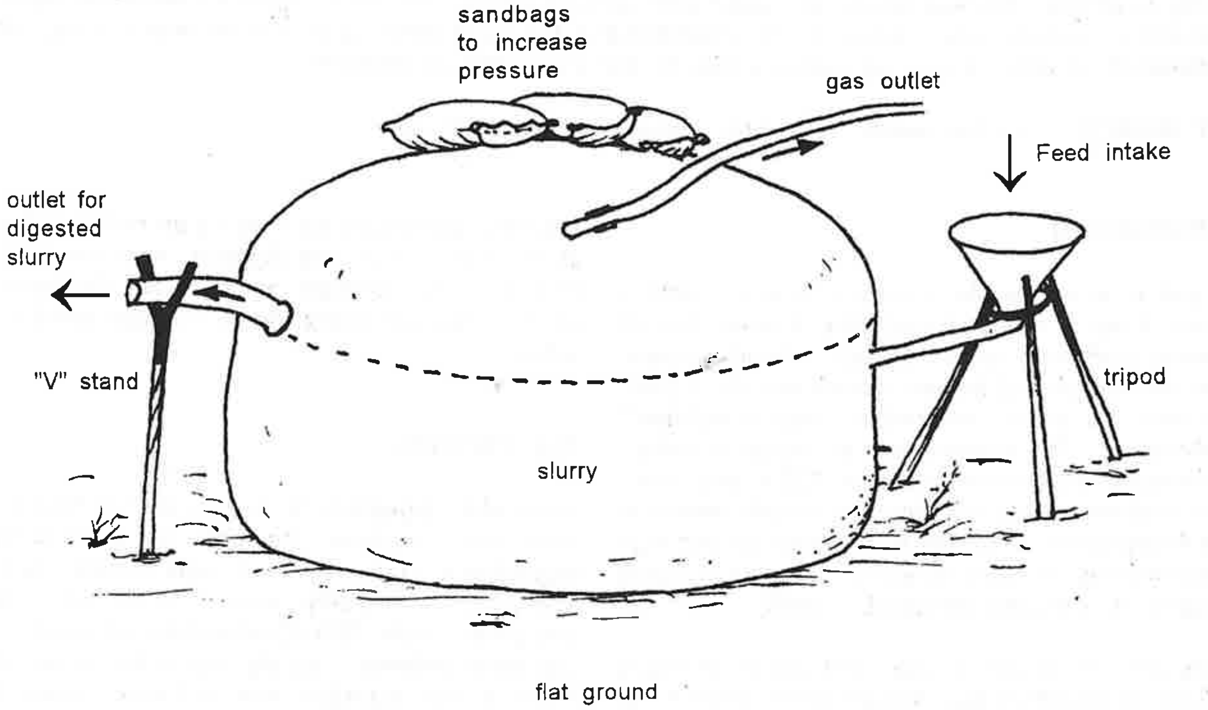

Figure 1. **FLXI Bio-gas Digester.**

The plant was made out of very strong rubberised fabric and was a compact and a highly flexible system for the generation of bio-gas. The bag digester system was of 3m^3 capacity and is shown in figure 1.

System Installation

The system shown in the figure as above was first laid on a level ground without the slurry inside. It was made sure that the ground was flat and did not have any sharp projections or stones. This was to protect the flexible bag from tearing during the filling operations. The straps which were provided on the bottom of the plan were then pulled in opposite directions and were tied to the wooden

The slurry was prepared by mixing equal amounts of chicken waste with water and was poured into the plant by means of a bucket through the inlet funnel till it rose to the height of approximately 75 cms from the ground. It was ensured while preparing the slurry that the grass, straw, hay twigs, stones are all removed from the mix and that all wrinkles, folds, etc., are in the middle while filling the slurry so that the plant remains upright and does not tilt. The inlet was then tightly closed as also the gas outlet with the stopper.

A flexible gas pipe was used between the plant and the rigid burner point. This was to ensure that the gas outlet immediately outside the plant slants upwards so that any moisture which is produced would fall back intot he plant and not choke the gas pipeline. A stop valve was also fitted to the distributor pipe immediately after the flexible hose pipe.

Observations

It was observed that within about two to three days, the gas had actually started to form. We had to place a few sand bags on top of the plant for pressurising the gas through the pipe. The gas had actually bulged the holder against the weight of the sand bags.

In the beginning, for roughly about 18 to 20 days, the gas was supposed to be rich in CO_2 and was of no use to us. This had to be let out everyday by removing the gas outlet stopper. It was important because any pressure build-up would have ejected the slurry out of the plant.

We had observed the build-up of pressure from the gas outlet to be slow in the beginning because of not enough sand bag pressure from the top. It had however, increased when more bags were added on top.

The gas that was generated from roughly about three to four weeks onwards, would have had methane in it. This was tested to be so but only after a lapse of about five weeks. The period for the production of methane can vary due to variations in daily temperature and also with the type and the quantity of the feedstock. In Port Moresby during the operational months of June to August and with chicken waste as our feedstock, we had found the hydraulic retention time to be roughly about five weeks for initial total slurry of 4500 kg. The useful gas under these condition would have been generated in approximately three to four weeks time.

Our intention for the experiment had not been to use the gas that was produced for any working purposes in as much as to test its production through the bag digester. The combustible gas was successfully produced and was tested to flare up when ignited through the matchstick. The pressure was not large enough to produce a continuous flame at the top of bunsen burner. It did, however, indicate that the anaerobic process had generated a low pressure gas effectively with operations through flexible bag digesters.

The gas sample was also taken for analysis through the 'Fourier Transform Infrared Spectrophotometer' to check for its constituents under the carbon chain. The sample was found to contain a mixture of other methanogenic and carbon chain gases besides the combustible methane gas. This had indicated that the intial production of CO_2 in the early stages may not have been fully eliminated, thus, hampering the combustion process to some extent.

RESULTS

A number of important and somewhat new features have now hecome available from the experiment which was conducted on bio-gas production using the flexible bag digester. These results are likely to form the basis for any future works on the commerical size installation of bio-gas plants in Papua New Guinea.

It is now quite apparent that the FLXI bag digesters can be successfully utilized for the production of bio-gas in Papua New Guinea. The digesters which come in ready to install units up to $4m^3$ size, could even be custom-built for bigger sizes and require no masonry or metal work etc. These are fairly easy to operate with simple pouring of slurry, do not need any protective painting or masonry repair work and are extremely cost-effective.

Another advantage, which although was not required for our project, is when we need to transport the bio-gas from the generation plant to the consumers. This can be done easily with the availability of a compact, lightweight and collapsible balloon. The balloon comes in various sizes and the whole operation can become similar to LNG cylinder distribution outlets with filling plants located centrally.

For the bag digesters to operate efficiently, we have also found that the feed-stock should be fed into the bag semi-continuously with the feed displacing an equal amount of slurry removed from the outlet. Since the plant is flexible, care should also be taken to remove the skum which is a thick dry layer formed on top layer of the slurry, by jolting the plant daily. This increases the gas production.

In terms of sizes, bio-gas digester have been developed to cater for a wide range of bio-gas demand but in general, the community-size plants of capacity greater than $40m^3$ work out to be more efficient than the household plants due to their economies of scale and better associated operation and maintenance.

GENERAL REMARKS

Bio-gas is available only at quite low pressures compared to other commonly used gases, eg, propane, brutane, etc. The stoves, therefore, for burning bio-gas efficiently must be designed in a manner so that the ratio of the total area of burner parts to the area of injector orifice in somewhere between 200 to 300:1. There is a general need, in fact, for improving and standardising he bio-gas burner (V.V.N. Kishore, 1993).

The other and perhaps a more important factor to be considered is the availability of the feedstock for digestion. In PNG, chicken and the pigs waste are the only animal waste resources which can be made readily available. In our experiment with the chicken waste, we have found that it can be gainfully employed to produce bio-gas. Similar experiments, however, have to be carried out using the piggeries waste.

In general, there is a need to develop designs utilizing alternative feed materials such as crop residues. This would significantly enhance the potential for bio-gas production for smaller countries with less number of animals. The agricultural waste that should be experimented in PNG is baggasse (waste from the Ramu Sugar Ltd) and coffee husk from coffee plantations which is plentiful in PNG.

Last but not the least, the bio-gas manure which comes as a by-product fromt he production of methane, is considered to be a good quality fertilizer. However, if suitable methods of processing the biogas manure to saleable product can be develped, the entire economics fo the bio-gas system can improe significantly.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the UPNG Research Committee for providing the necessary funds for the purchase of the FLXI bio-gas bag digester from the Swastik Rubber Products Ltd., Maharashtra, India.

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GENERAL INFORMATION ARTICLE

LIGHTS AND LASERS

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INTRODUCTION

The main objective of this article is to briefly explain Laser and how it works. The laser is one of those great achievements/inventions that man has to his service. Its applications are numerous: used in microsurgery, thermonuclear fusion, telecommunications, holography, etc. One of the most popular applications is in the "world of sound and video", with the compact disks, CD-ROMS and DVD (digital video disk), which is based in a laser systems/device for reading information.

What is laser?

"Laser" stands for: Light Amplification by Stimulated Emission of Radiation. In other words, the laser is a radiation source, or light beam composed of three basic parts: an active medium, a "pumping" system and a resonant cavity. Its principle of operation, as its name implies, is based in a physical phenomenon which is "stimulated light emission".

Discovery of laser

The first "strong theory" about lasers was in 1960 when the laser technique (stimulated light emission) was perfected after the discovery of stimulated emission by Albert Einstein. It is also important to mention the main difference between a laser and a conventional light source: the light emitted by laser is concentrated, and the beam of light can be directed to a specific objective, while the light emitted by a conventional light source is diffused or spread in all different directions, as shown in figure 1.

ABSORPTION AND EMISSION

The atom is a "system" that posses a specific level of energy. If this "system" is subject to a radiation (excited by "packets", or quantum of light), its level of energy will increase because the electrons that are small "particles" (very small mass), can easily "jump"from an orbit near to the nucleous (orbit of slow velocity / spin) to another orbit far away from the nucleous (fast velocity orbit); under these conditions we can say that the atom is in an excited state.

On the contrary, when the electrons go back to an orbit closer to the nucleous, the atom gives up an amount of energy, (as photons). Under these conditions we can say that the atom is again in its "basic" state (non-excited state). This is illustrated in figure 2.

In figure 2, part A, there is an atom in an initial state, with certain level of energy; this atom posses an electron in a certain orbit. If this atom releases a photon, the electron will "jump" toward an orbit closer to the nucleous. This is because the emitted photon represents a small loss in the electron's energy, therefore, it is now easier for the nucleous to attract the electron even more, (the energy of the nucleous attracts the electron,

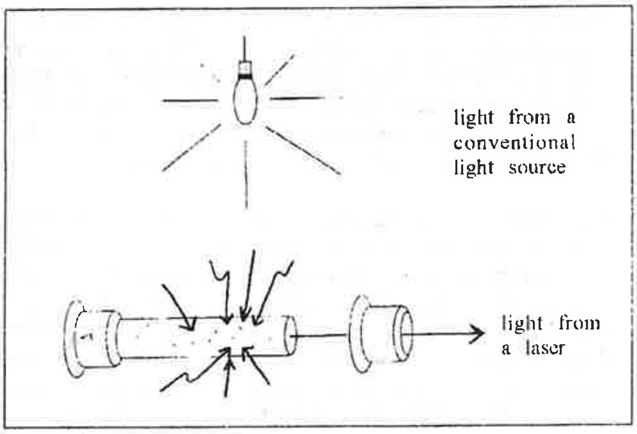

Figure 1. **Laser and conventional light source.**

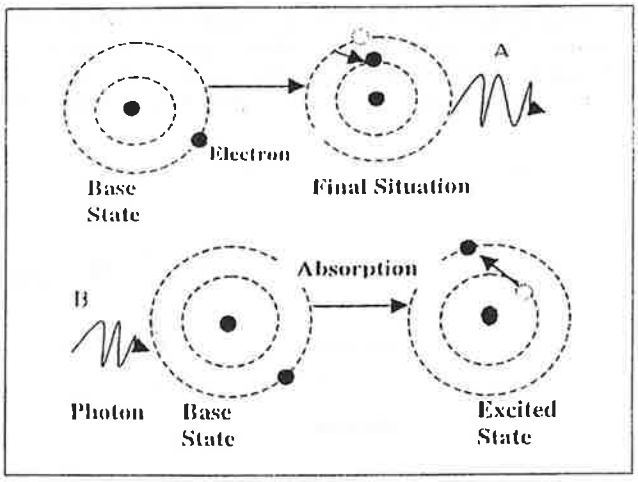

Figure 2. **Photons Emmision and Absorption's phenomenon.**

but the electron's velocity around an orbit, allows it the possibility of escape; there is a centrifugal force along with a centripetal force toward the interior of the atom. The interaction between these two opposite forces determines the distance of the electron's orbit around the nucleous). This is the phenomenon known as "emission", and it is the basic principle for the existence of light, since each emitted photon is really, emitted light.

In figure 2 part B, the inverse situation is illustrated. The energy level of the atom is increased, due to the arrival of a "packet" or quantum of energy. This phenomenon is known as "absorption". When this situation occurs, the initial amount of light decreases and the atom changes its initial state (non-excited state) to an excited state because it has gained energy, allowing the electron to move further away from the nucleous.

CONVENTIAL LIGHT SOURCES

Conventional light sources are simply, a candle, an incandescent lamp, the sun, etc. They produce light basically because their internal atoms have been excited beyond their stable state, therefore, their electrons are "jumping" to low energy level orbits, releasing during this process enough photons to produce light.

For example, the energy source for the incandescent light is the electrical current (which is only a huge amount of electrons) flowing from one point to another. During this flow, these particles collide against the electrons of the incandescent material of the device, making them to migrate to an orbit of higher energy level; but since this new state is not very stable, sooner or later the electrons will return to their normal orbit, releasing a photon during this process.

With the electrons back in their normal orbit, there is always a possibility of the arrival of a "travelling" electron and a collision that will send it back to a higher energy level. This process will repeat again and again while there is electric flow through the device's material. This same process occurs in the case of a candle, except that the source of energy in that case is the combustion of the material.

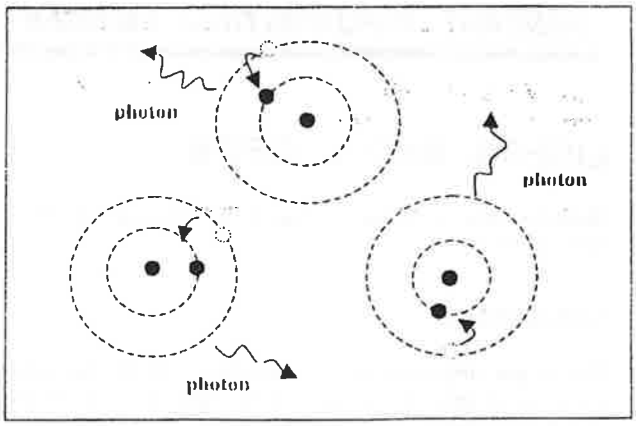

Figure 3. **Spontaneous emission.**

Light produced by these sources is called "incoherent light", because it is produced as a "group of waves" that reinforce or cancel among themselves, depending on their travelling direction, as shown in figure 3.

The incoherence of this type of light is "spatial" because the light is randomly emitted by atoms located far away from one another, therefore, it arrives to one point, following different optical paths.

The incoherence is also in time (temporal) because, it is light emitted at different frequencies, characterizing it as polychromatic. In summary, light generated from conventional sources is spatial and time incoherent; on the other hand, light emitted from a Laser is spatial and time coherent. In other words; light from a laser is emitted as a beam of only one color; and light from other sources is propagated as radiation in different directions and is multicolored (polychromatic).

INDUCED EMISSION OR STIMULATED EMISSION

In this case, we have an atom in an excited state and

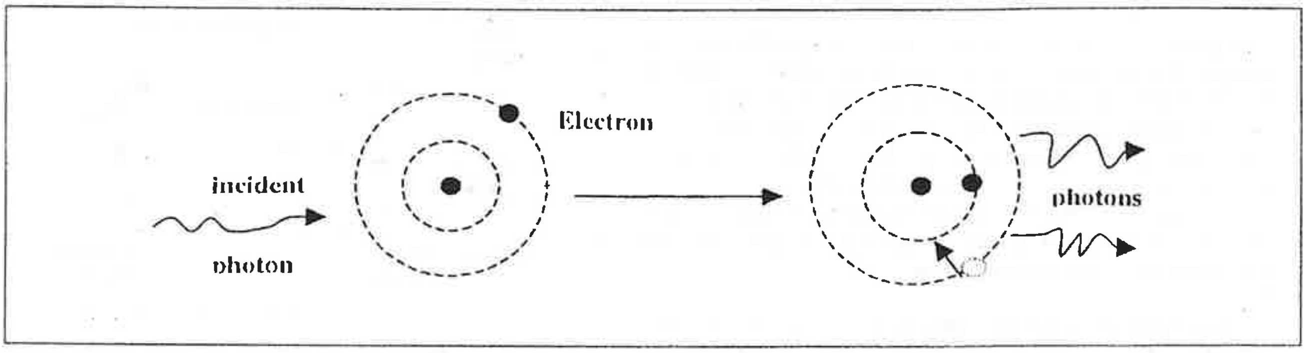

Figure 4. **Induced/stimulated emission.**

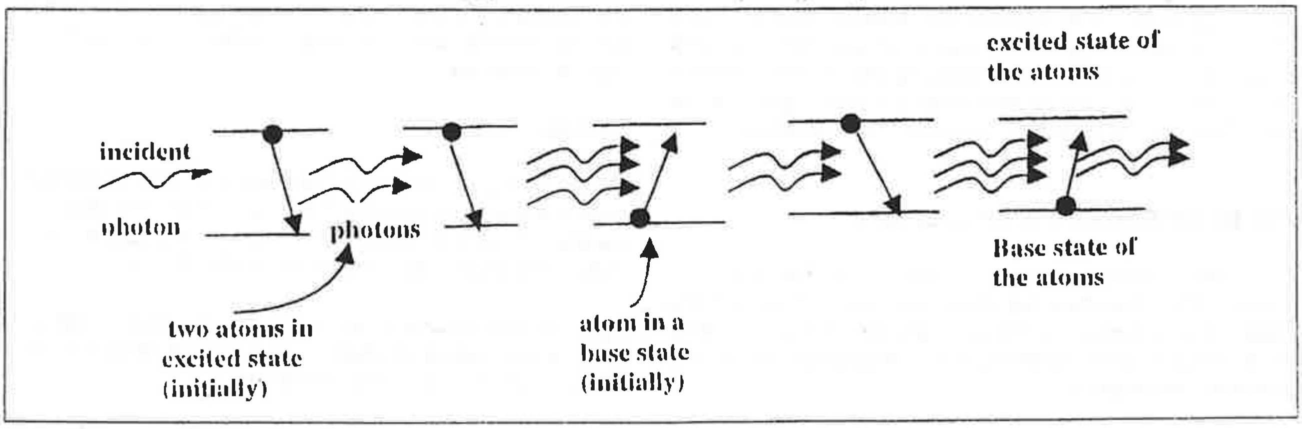

Figure 5. **Principle of the laser's amplification effect.**

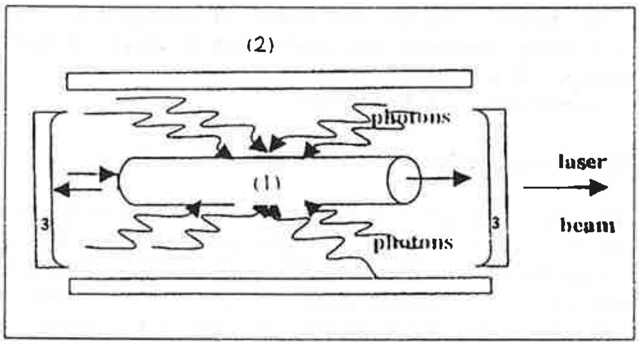

Figure 6. **Laser's basic structure,** 1. active medium, 2. "pumping system, 3. Resonant cavity.

colliding with a photon; as a consequence , this atom can release two photons and return to the energy level corresponding to its normal state, allowing the electron to migrate not to a higher orbit but to a lower one, as shown in figure 4.

This phenomenon is known as "induced emission" or "stimulated emission", and it is the basic principle for the operation of a Laser. It was discovered by Albert Einstein in 1917.

In essence, "stimulated emission" consist in the creation of suitable conditions for an atom in an excited state to return to its normal state. Those suitable conditions are really the collision of that atom with an

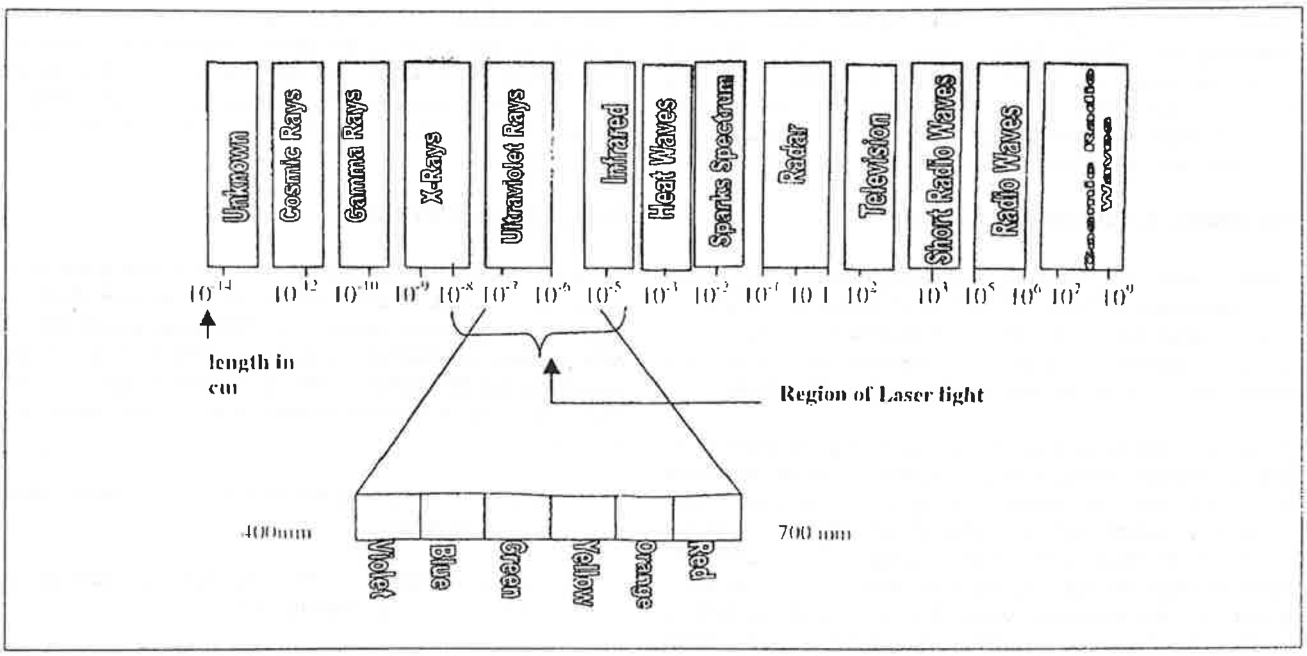

Figure 7. **Electromagnetic spectrum.**

incoming photon; this process will produce the emission of two photons with the same characteristics and propagation direction determined by the incident photon. Therefore, according to this phenomenon, light can be amplified via "stimulated emission" of radiation.

THE BASIC STRUCTURE OF A LASER

Consider a system with a group of atoms, some of them in their base/normal state and some in an excited state. If this system is hit by a photon, we could verify in its interior, both phenomena: induced emission and photons' absorption.

Stimulated emission will produce the emission of energy packets from some of the atoms, and the phenomenon of photons' absorption will create a tendency to make them "disappear". In other words; in one case the photon incident effect will be amplified while in other case, there is a tendency to nullify the effect. The final result will depend in the number of atoms in an excited state and atoms in the base/normal state. In order to have an amplification of the effect, is necessary that the number of atoms in an excited state be greater than the atoms in a base state. This is illustrated in figure 5.

Laser's Amplification effect

This effect is sketched in figure 5 above and a brief description is as follows: The upper horizontal lines represent the excited state of the atoms in the system being analyzed, and the bottom lines represent the base/normal state. When an incident photon hit an atom in the excited state, two photons are released/emitted by the atom and its energy level decays to its base state; afterwards, those two photons will hit another excited atom. This will produce the same amplification phenomenon. Those three "energy packets" will now be projected against an atom in its base state, releasing now only two photons and leaving this last atom in an excited state by absorbing energy. This process of photons' emission-absorption will continue on and on.

Conditions for amplification effect

In order for the induced emission amplification to prevail, it is necessary to have a number of atoms in an excited state greater than the number of atoms in a base state, which requires a "pumping" system that provides selectively, the necessary energy to some atoms.

Therefore, the objective of this "pumping" system is to provide a high energy flow to a certain number of atoms to induce the emission- absorption processes. This system is called "active medium" and it can be found in any of the three matter states: solid, liquid or gaseous, however even though the induced emission amplification effect can be achieved, when the "pumping" system is applied to the "active medium"; and since the time duration of each photon in this "active medium" is very small (photons travel at the speed of light), the stimulated emission process is not capable of extracting all the energy the "pumping" system provides to the "active medium".

Resonant Cavity

To solve this problem it is necessary to use an element/device known as "resonant cavity", which consists in a couple of parallel mirrors located in the sides of the "active medium", as shown in figure 6.

Each of the photons reflected by the mirror, bounce back to the "active medium", allowing this way a greater "expansion" for photons' emission.

However, only one of the two mirrors will reflect all incident photons, and the other mirror, allows a small number of photons to "escape". This number of photons that escape from the "resonant cavity", constitute the laser beam. This emitted beam of energy has both coherence characteristics, spatial and temporal. In other words, this Laser's light is monochromatic and concentrated in a point/beam.

Clasifying the laser

Therefore, the Laser is a source of radiation integrated by an 'active medium", a "pumping" system, and a "resonant cavity"; the characteristics of this radiation, placed it in the visible region, infrared or ultraviolet of the electromagnetic spectrum, although, there is research going on to operate a laser in the X-rays wave-length region.

From the Modern Physics point of view, the main difference among the visible light, X-rays, infrared and ultraviolet light, radio waves, etc., is in the wavelength of the radiation. The electromagnetic spectrum includes a great variety of electromagnetic waves, (from cosmic rays whose wave-length is very small, to radio waves with an infinite wave-length). Human beings are able to perceive only a small fraction of the spectrum, as shown in figure 7.

FINAL CONSIDERATIONS

To summarize this article, it is emphasised here that, Laser is a light source produced and amplified by following a process known as **induced emission** or **stimulated emission**, which is different from the **spontaneous emission**, of the conventional light sources. The most important characteristics of a laser beam are the following:

a) Great intensity and the possibility of concentrating it in one object.

b) Spatial coherence, allowing for the light to be emitted from a specific point.

c) Temporal coherence, which makes this light almost monochromatic. In other words, the beam of light has only one color or one wave length only.

d) Directional; which allows the light beam to have a negligible divergence , in its width, (it is a concentrated beam of light) through great distances.

These characteristics make the laser very useful for use in medicine, nuclear fusion, telecommunication, and the general industry.

NUTRITIONAL AND MINERAL COMPOSITION OF WHITE BREAD IN NATIONAL CAPITAL DISTRICT (NCD), PAPUA NEW GUINEA (PNG)

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ABSTRACT

The nutritive and mineral composition of ten samples of white bread sold in N.C.D., PNG, was investigated. The samples are rich in sodium, potassium and phosphorus but low in iron and calcium. The moisture, fat, ash and protein show a fair distribution thus making the bread samples comparable to those from overseas countries.

KEY WORDS: *baking, vitamins, proximate analysis, ash, fat, protein, enzyme.*

INTRODUCTION

Bread is basically foamed gluten (Kent, 1983) and it is made by baking a dough which has wheaten, flour water, yeast and salt as its main ingredients. Nutritive value is increased by the addition of fat, milk, sugar, soya flour, vitamins, fruits and nuts. Since bread is usually eaten along with milk, butter, cheese etc, that makes bread valuable for dietary purpose.

Bread making is an art which has been practised from earliest known times. Commercial production of bread in PNG and other third world countries is carried out by the Chorley Wood process (Bennion, 1967). This process is based on the principle of mechanical dough ripening and was developed by the British Baking Industry. Bread is thought to have come to PNG by the early missionaries and since then it has become popular in many parts of PNG. It is however unfortunate that there is no known reference on the mineral composition and nutritive value of breads sold in PNG. The present work was therefore undertaken to provide data on the chemical compositin of white bread which might be used by Nutrition Specialist in PNG to assess and improve the quality of bread sold in PNG. The bread samples investigated are referred to as "Papua New Guinean breads" for the purpose of comparison with composition of breads from other countries.

MATERIALS AND METHOD

Ten samples of white bread, baked with flour and supplied by various bakeries in NCD were used in the investigation. The bread sample were obtained in polyethylene bags fresh from various retail outlets in NCD between August, 1995 and September, 1996.

The ingredient labels were surveyed and coded (Table 1) and half of each loaf was removed from its polyethylene cover, weighed, covered and dried on paper at room temperature at constant weight for determination of equilibrium moisture content. The dried samples of bread were then ground in a mortar to pass through 0.6 mm sieve and stored in airtight screw cap bottles in desiccator until required for chemical analysis.

The total solids, ash, iron, calcium, chloride, phosphorus, and protein contents were determined by the method of Association of Official Analytical Chemists (AOAC, 1990). The fat content was determined as described by (Pearson, 1976). Sodium and potassium were determined by Flame Photo-metry. The carbohydrate was estimated using Frazer and Holmes (1967) method.

All assays and determinants were repeated four times on the ten samples and the average of each determinant is given in Tables 2 and 3. The relative standard deviation (%) in the nutrient composition of each sample was in the range 0.5 - 1.60.

RESULTS AND DISCUSSION

The nutritional composition of white bread in PNG is quite consistently distributed throughout the ten samples. Table 4 shows proximate nutritional constituents of bread from other regions of the world (Abede *et al.* 1992).

The equilibrium moisture contents according to Table 1 lie in the range of 15-39% while the total moisture content is from 30-50%. The bread moisture content

Table 1: **RETAIL WHITE BREAD WITH TYPICAL INCREDIENTS IN NCD, PAPUA NEW GUINEA**

Sample	Retail name	Typical ingredients
1	Premium White	Enriched wheat flour, shortening, yeast, sugar, salt, milk, water added
2	JJ's Island	Flour, salt, shortening, sugar, yeast, emulsifier, improver, water added
3	Bilas White	Bread making flour, yeast, salt, vegetable oil, emulsifier, soya flour, enzyme (α-amylase), preservative, vitamins (thiamin), water added.
4	Butter Cup Tasty	Bread making flour, gluten, yeast, salt, vegetable oil, emulsifier, preservative, enzyme (α-amylase), water added.
5	Island Fresh	Enriched wheat flour, sugar, shortening, dry milk, active dry yeast, salt.
6	Sunfield Super Toast	Bakers flour, shortening, salt, bakers yeast, emulsifier, enzyme (α-amylase), preservative, vitamin (thiamin), water added.
7	Bilas Toasty	Break baking flour, yeast, salt, vegetable oil, animal fat, gluten soya flour, emulsifier, enzyme (α-amylase), preservative, vitamin (thiamin), water added.
8	G. Bake Bun	Wheat flour, shortening, salt, sugar, yeast, poweder milk, eggs, flabouring.
9	Fresh Kai	Bread making flour, yeast, salt, veg. oil, animal fat, gluten, soya flour, emulsifier, enzyme (α-amylase), preservative, vitamin (thiamin), water added.
10	Buyers Choice	Bakers flour, shortening, salt, bakers yeast, emulsifer, sugar, vitamin, minerals, milk and water added.

Table 2: **PROXIMATE COMPOSITION* OF RETAIL WHITE BREAD IN NCD, PAPUA NEW GUINEA**

	total	moisture		constituents			carbohydrates
sample	solids	air dry	indirect method	ash	fat	protein	
1	62.9	219.0^x (302.2)^y	24.1a (24.3)^b	1.7	1.2	10.5	54.9
2	56.5	202.8^x (404.6)^y	32.5^a (33.5)^b	1.7	1.8	10.4	42.1
3	52.6	195.6^x (256.6)^y	37.1^a (37.4)^b	1.4	1.4	09.4	39.3
4	61.0	204.6^x (300.2)^y	38.9^a (39.0)^b	1.8	0.9	10.6	36.0
5	64.9	200.7^x (271.9)^y	35.0^a (35.3)^b	1.8	0.8	09.2	47.3
6	69.5	210.7^x (246.8)^y	33.6^a (33.9)^b	1.6	0.9	10.7	45.5
7	53.8	177.2^x (288.3)^y	30.2^a (30.5)^b	1.7	1.7	09.6	40.4
8	59.1	266.8^x (346.8)^y	32.7^d (33.0)^b	1.7	1.8	08.7	32.3
9	64.4	226.8^x (332.3)^y	32.3^d (32.7)^b	1.6	1.1	09.9	41.2
10	64.2	217.4^x (271.3)^y	33.7^a (34.1)^b	1.7	1.2	10.3	44.6

* - average of 4 determinations
a - air dry sample before oven drying
b - is the total moisture content (moisture lost in air dry + moisture in air dried sample, as determined by oven drying)
y - weight of half loaf
x - weight of half loaf after air drying (equilibrium moisture content is calculated as percentage)

Table 3: **MINERAL CONTENTS OF WHITE BREAD SOLD IN NCD, PAPUA NEW GUINEA.** (Mean of 4 determinants).

Sample	Mineral (mg/100 g)					
	Fe	Ca	P	Cl	K	Na
1	0.2	14.7	1050	47	230	1520
2	0.2	14.2	510	49	225	1470
3	0.2	14.3	910	45	230	1480
4	0.3	19.4	890	36	225	1450
5	0.5	12.5	575	42	225	1470
6	1.6	18.7	700	49	240	1810
7	1.4	15.3	1000	61	230	1490
8	2.3	21.3	720	54	205	1350
9	2.1	18.3	970	54	215	1655
10	1.7	21.6	1090	54	230	1730

of other countries (Table 4) are between 13-39%. This is very similar to the values obtained by the Air dry method. Egypt has the lowest equilibrium moisture of 13% while sample 6 of PNG bread has a lowest of 15%. The high relative humidity in these parts of the regions causes bread to stale rapidly.

The fat content level ranges between 0.8-1.8% which is comparable with those of Italy, Japan, Poland and Britain. USA has the highest fat content of 3.8% followed by Nigeria with 3.7%. This is associated with the level of fat as ingredient, probably to extend shelf life and tenderize crust (Klans *et al.* 1991). Samples 3 and 4 have vegetable oil added while 7 and 9 both have vegetable oil and animal fat added.

The protein content in PNG bread is between 8.7-10.7%. Egypt is the only country that falls within these range. Otherwise, the values are comparable to France, USA and Italy. Flour provides most of the protein content of bread around 11-13%. Bread sample 3 and 9 added soya flour which is responsible for most of its protein content since soya beans contain

Table 4: **CHEMICAL COMPOSITION OF WHITE BREADS FROM VARIOUS COUNTRIES**[T]

Country	Proximate Composition (%)					Mineral Composition (mg/100 g)					
	Moisture	Protein	Fat	Ash	Carbo dydrate	Ca	P	Fe	Na	K	Cl
France	30.6	9.1	3.0	1.9	-	43.0	85.0	0.7	580	90	-
USA	35.0	9.0	3.8	2.0	-	96.0	102.0	0.7	495	121	-
Italy	31.8	9.1	0.8	1.9	-	17.0	77.0	0.7	585	74	-
Japan	33.6	8.0	1.0	-	-	-	-	-	-	-	-
Poland	-	8.3	1.6	1.6	-	-	-	-	-	-	-
Sudan	25.3[y]	12.9	-	1.6	-	-	-	-	-	-	-
Pakistan	-	11.4	1.2	1.4	-	33.0	175.5	5.5	-	-	-
Egypt	13.9[y]	9.6	-	2.0	-	22.6	176.4	4.2	-	-	-
	23.7	13.8	-	3.6	-	70.6	375.4	9.6	-	-	-
UK	38.5	8.4	1.7	1.9	-	100.0	-	1.8	540	100	-
Nigeria[f]	31.42	8.7	3.7	1.5	41.7	20.8	1668	3.0	1896	197	59

T Abede *et al.* 1992
Y equilibrium moisture content
\- not quoted
f Average of 12 samples (Abede *et al.* 1992)

40.8% protein (Abede *et al.* 1992). Gluten is fundamentally protein and water (Kent, 1983) and when present in bread also gives a high protein content as added to samples 4, 7 and 9.

The total carbohydrate level is around 32-55% and is comparable with those from Nigeria around 35-59%. A low carbohydrate content is responsible for low food energies, however, carbohydrate content in PNG bread gives food energies similar to those from Nigeria, Japan, Poland and UK (Abede *et al.* 1992). Sugar is added to samples 1, 2, 5, 8 and 10 (Table 1) and contributes significantly to high content level. Sugar acts as food for growing yeast during fermentation process and is used as a sweetener in bread. The browning of bread when baked is due to caramelisation (sugar and heat) (Kent, 1983).

The total solids were found to be between 52.6-69.5% and the ash content is around 1.4-1.8%. The breads from Sudan, Poland, Pakistan and Nigeria fall within this range. This implies that the mineral composition is comparable with these countries. USA and Egypt have higher mineral content than other countries.

The level of iron of PNG bread samples is around 0.2-2.3 mg/100 g and is comparable to France, USA, Italy and Britain. Sudan, Pakistan and Egypt have a high level of iron content. This is probably due to enrichment as most iron is added to bread for nutritional purpose. Traces of iron are found in enzymes and vitamins which are added to all the samples except for 1, 2 and 5.

The results (Table 3) indicate that the most abundant bulk minerals in PNG breads are sodium, potassium, phosphorus and calcium. Nigeria has the most abundant sodium, potassium and phosphorus values. Other countries show consistent values comparable with PNG bread. Calcium level of PNG bread is around 12-19 mg/100 g. All other countries show high results except Italy with 17 mg/100 g and Nigeria with 20.8 mg/100 g. Bread in Britain, USA and Canada is enriched with addition of calcium carbonate or edible bone meal (Kent, 1983 & Abede *et al.* 1992). It shows that PNG bread samples 1, 5, 8 and 10 (Table 1), contain enriched flour and milk and add to total calcium level in PNG bread samples.

The chlorine content in PNG bread was found to be around 36-61 mg/100 g. That is comparable with those from Nigeria. Most chlorine came from addition of salt and chlorine from treated water system. Salt has no limit and can be added in any quantity to help control fermentation, toughens dough and extends required dough development (Kent, 1983). Most often the amount of flour used for baking determines the amount of salt input. Salt is considered as a flavour enhancer and can be added depending on the craftsmen as long as taste remains pleasant.

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TRADITIONAL FOODS FROM STARCHY STAPLES IN SAMOA (SOUTH PACIFIC)

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ABSTRACT

*Traditional foods need to be documented to develop a food processing database. A survey was conducted in Samoa to identify the various traditional food uses of taro (*Colocasia, Xanthosoma, Alocasia*), yam, cassava, and breadfruit. These were described using appropriate flow charts. There is a role for these foods in the Samoan food industry and they can contribute to the snack food sector and small-scale food processing.*

Keywords: *earth oven (*umu*), food processing,* masi

INTRODUCTION

The independent state of Samoa lies between latitude 30° and 15° South and 168° and 173° West close to the international dateline (DOS 1991). It consists of nine islands and it is located 4200 km South-East of Hawaii, 2900 km North-East of New Zealand and 4300 km East of Sydney, Australia. Out of a total land area of 2900 km^2, about 44% is either non-arable or unsuitable for cultivation due to volcanic activity (Fong 1991). Only 40% of the arable land is cultivated (Ekongocha 1990) with about half of this committed to starchy staples such as taro (*Colocasia, Xanthosoma* and *Alocasia*), cassava, yam, banana, and breadfruit. Agriculture is important in the Samoan economy and it contributes about 30% of the gross domestic product (ESCAP 1990).

The starchy staples are dominant in the country's agriculture and their production figures are quite impressive (FAO 1994). Taro *Colocasia* and banana are major export commodities (DOS 1993) but enough proportion of the harvest is available for local consumption. However, a surplus of these staples has been reported and pre- and post-harvest losses can be up to 65% (FAO 1982). Generally, the surplus can be processed to yield stable and convenient products and a direction in the processing strategy is to review the existing traditional uses that are deep-rooted in the Samoan culture. This is with a view to identifying the traditional foods that could be upgraded and improved to complement the conventional uses of the staples.

METHODOLOGY

A survey was conducted in Upolu and Savaii, the two main islands of Samoa. Farmers and housewives were randomly selected and interviewed. The interviewees were asked to describe as many traditional foods from the staples as they could remember. No questionnaire was prepared.

RESULTS AND DISCUSSION

The traditional foods that were obtained are described below. It is, however, recognised that there may be many more foods that were not described and the variation of a particular food. The following gives an idea of the diversity that is in existence.

Taro *Colocasia*

Taro (*Colocasia esculenta*) is the most preferred staple food with an avaeage consumption of 0.4 kg per person per day (Cable and Asghar 1984). It accounts for 39% of the diet in Upolu and 43% in Savaii (Clarke 1992). The production of taro *Colocasia* has been badly affected by the taro leaf blight disease since 1994. According to a market report (CBS 1993; 1994; 1995), about 18 tonnes of taro was available at the main (Fugalei) market in May 1993 but only 56 kg and 41 kg were available during the same month in 1994 and 1995 respectively.

Niue and *Manua* are the major cultivars of taro *Colocasia* in the country (Afutiti 1984) but *Niue* is the most preferred accounting for about 75% of the total production (Bradbury and Holloway 1988). Fig. 1 shows the traditional foods prepared from taro *Colocasia*. *Umu* is an earth oven in which stones supply the heat required for cooking. The earth oven is a widely used technique amongst the South

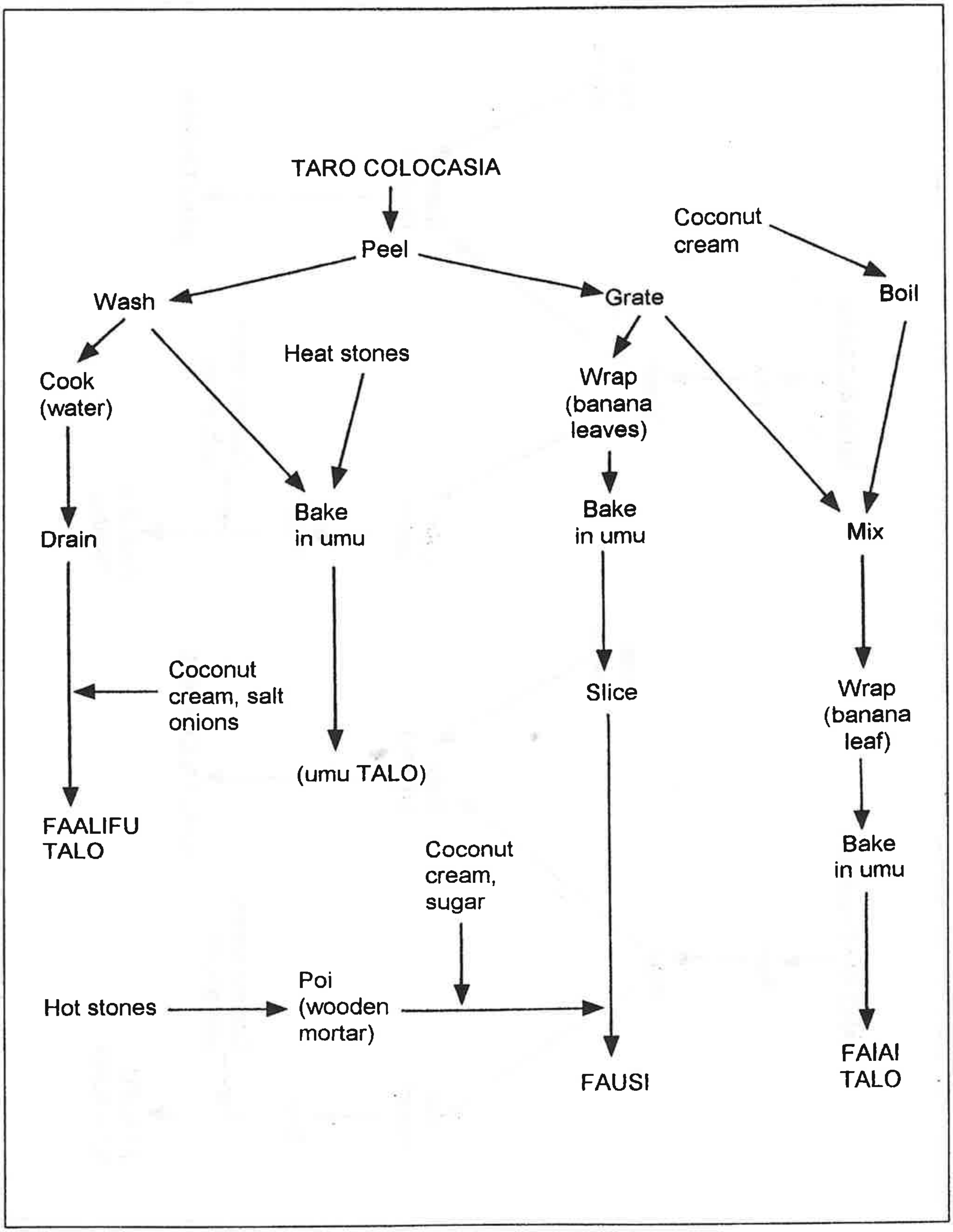

Figure 1. **Traditional foods prepared from tarp, *Colocasia*.**

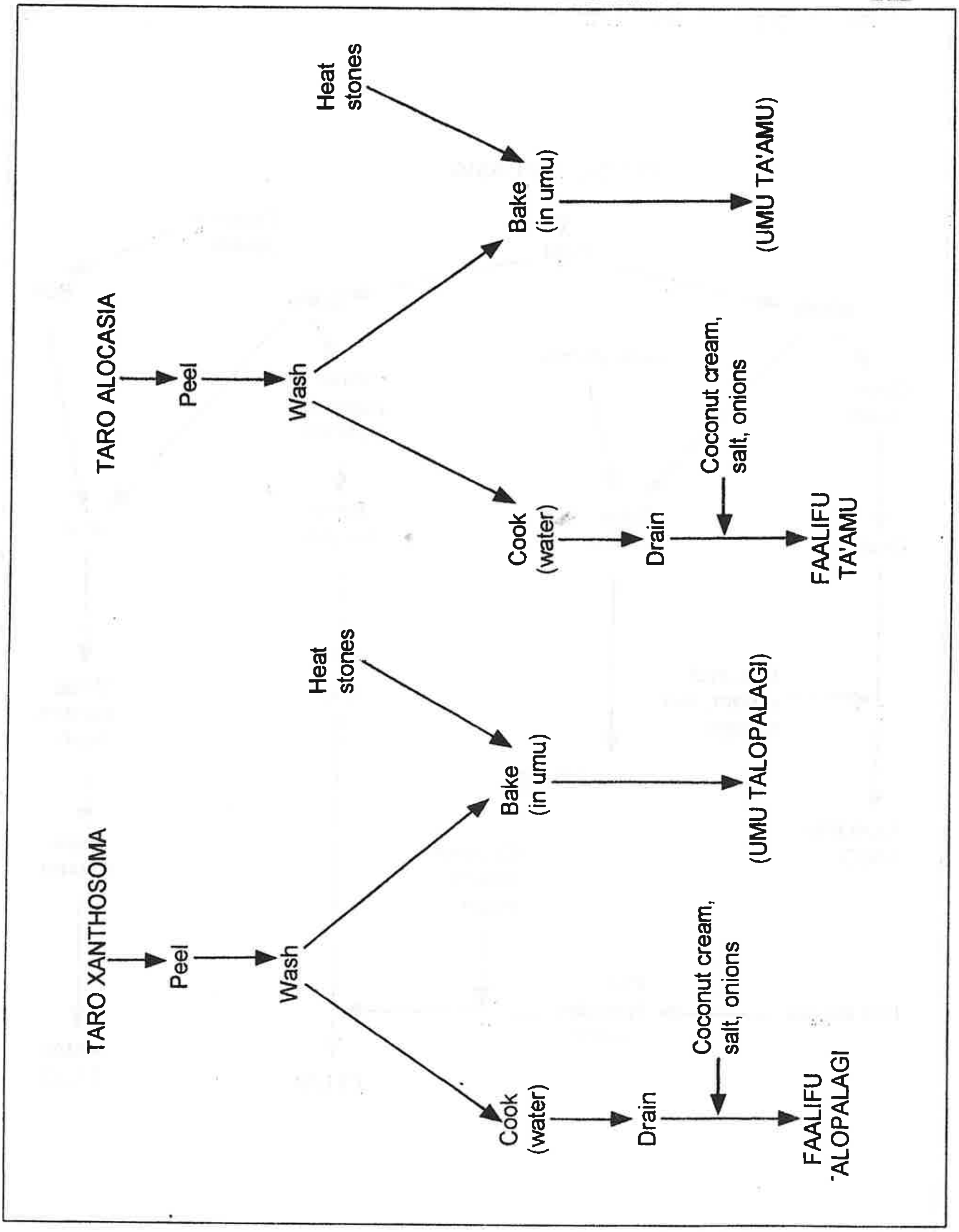

Figure 2. **Traditional foods prepared from taro *Xanthosoma* and *Alocasia*.**

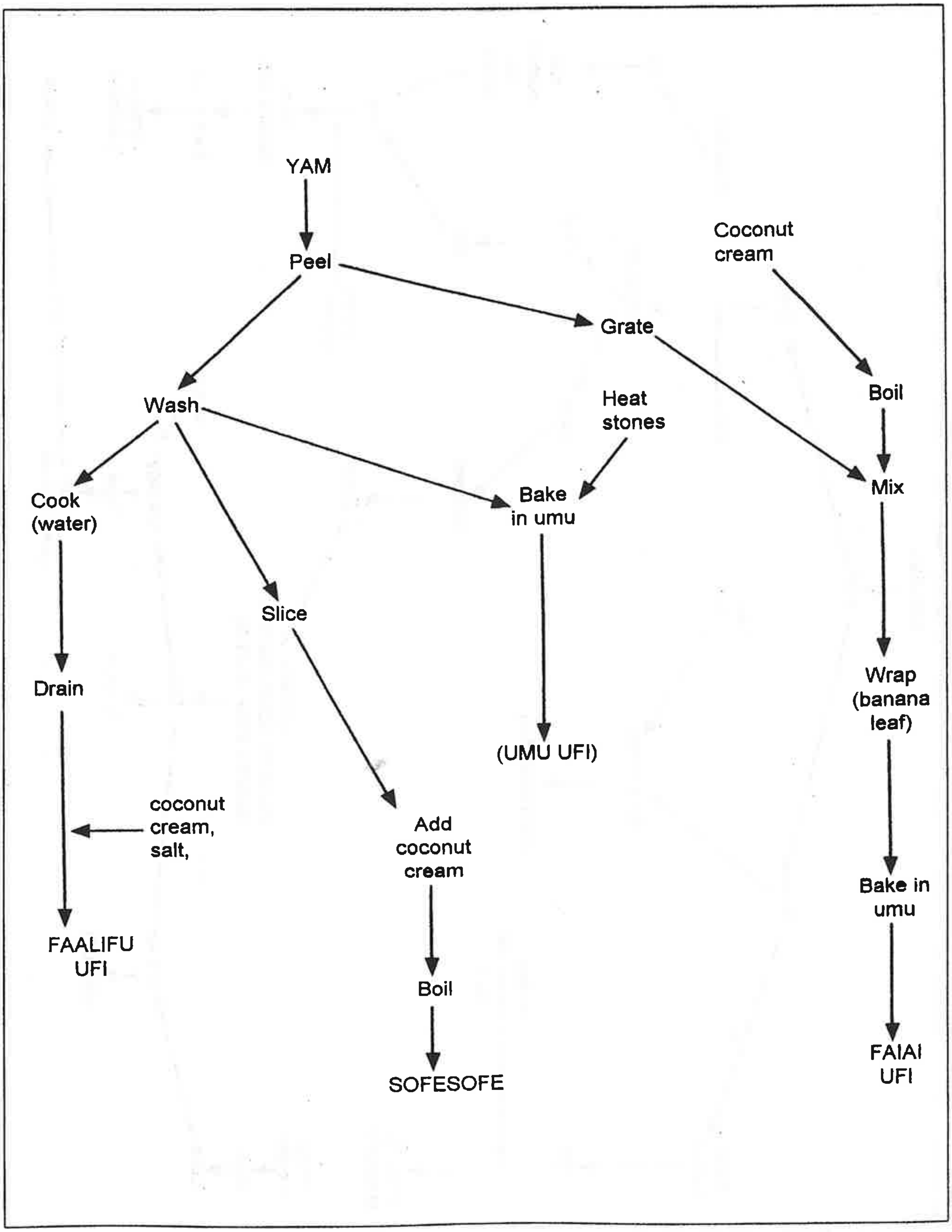

Figure 3. **Traditional foods prepared from yam.**

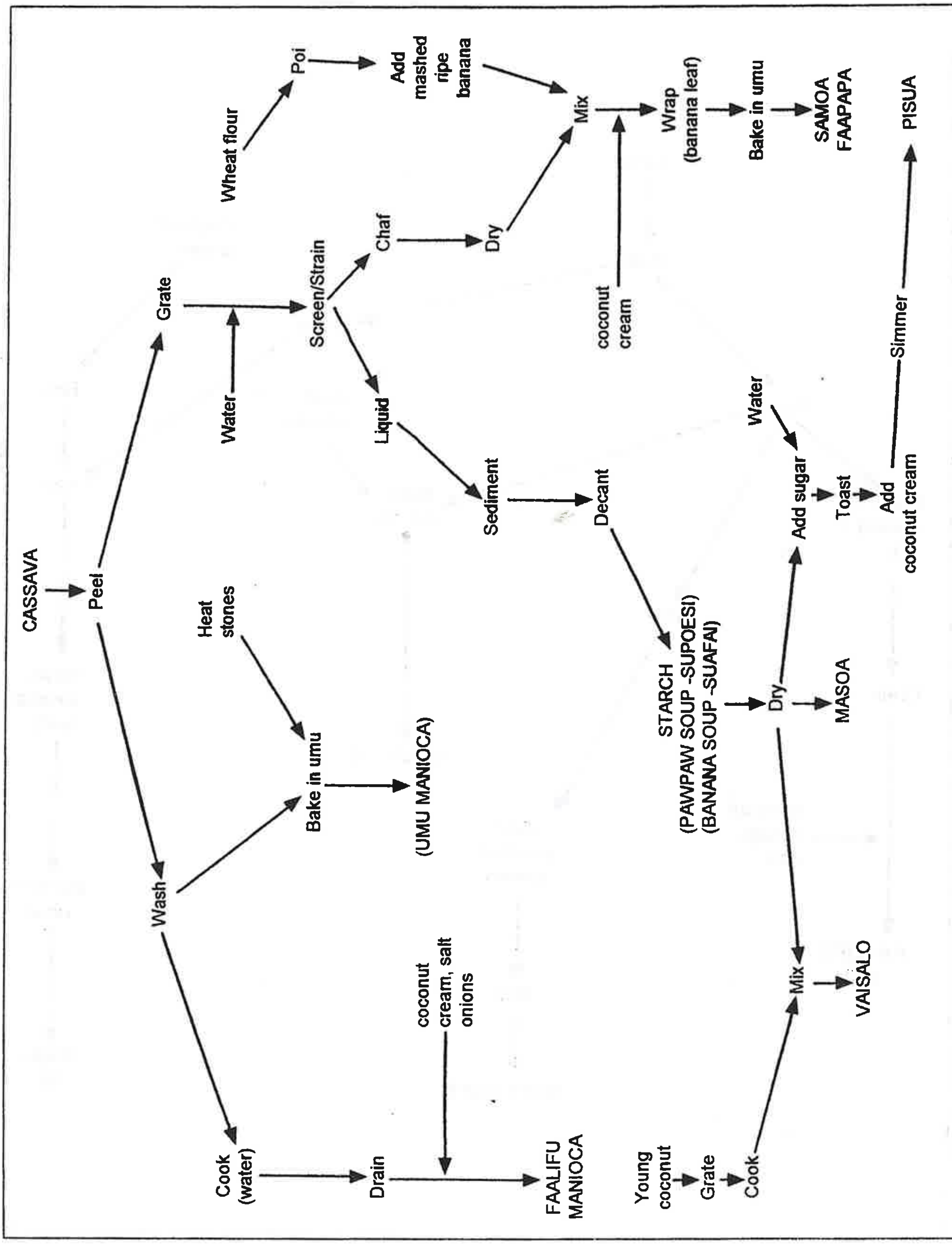

Figure 4. **Traditional foods prepared from cassava.**

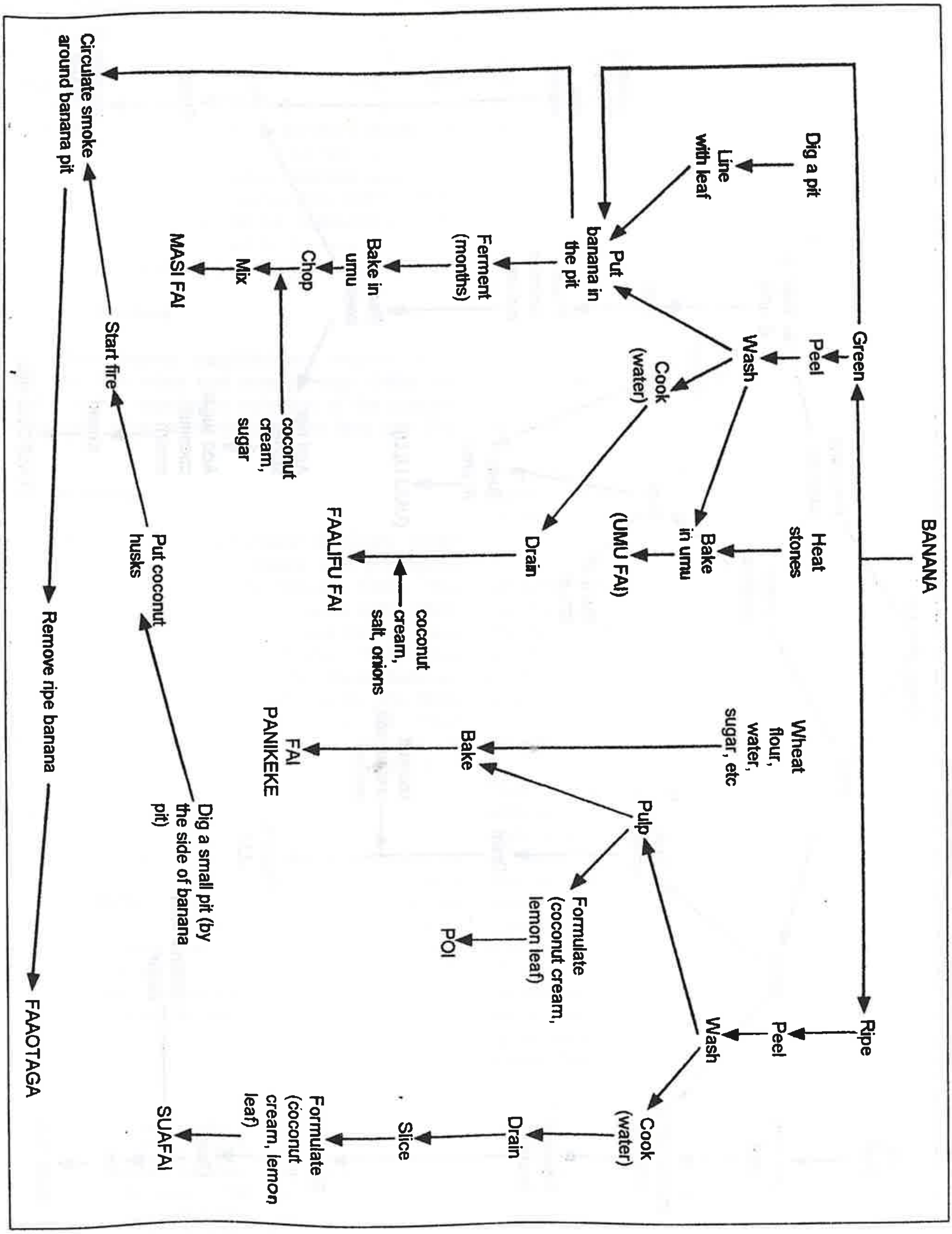

Figure 5. **Traditional foods prepared from banana.**

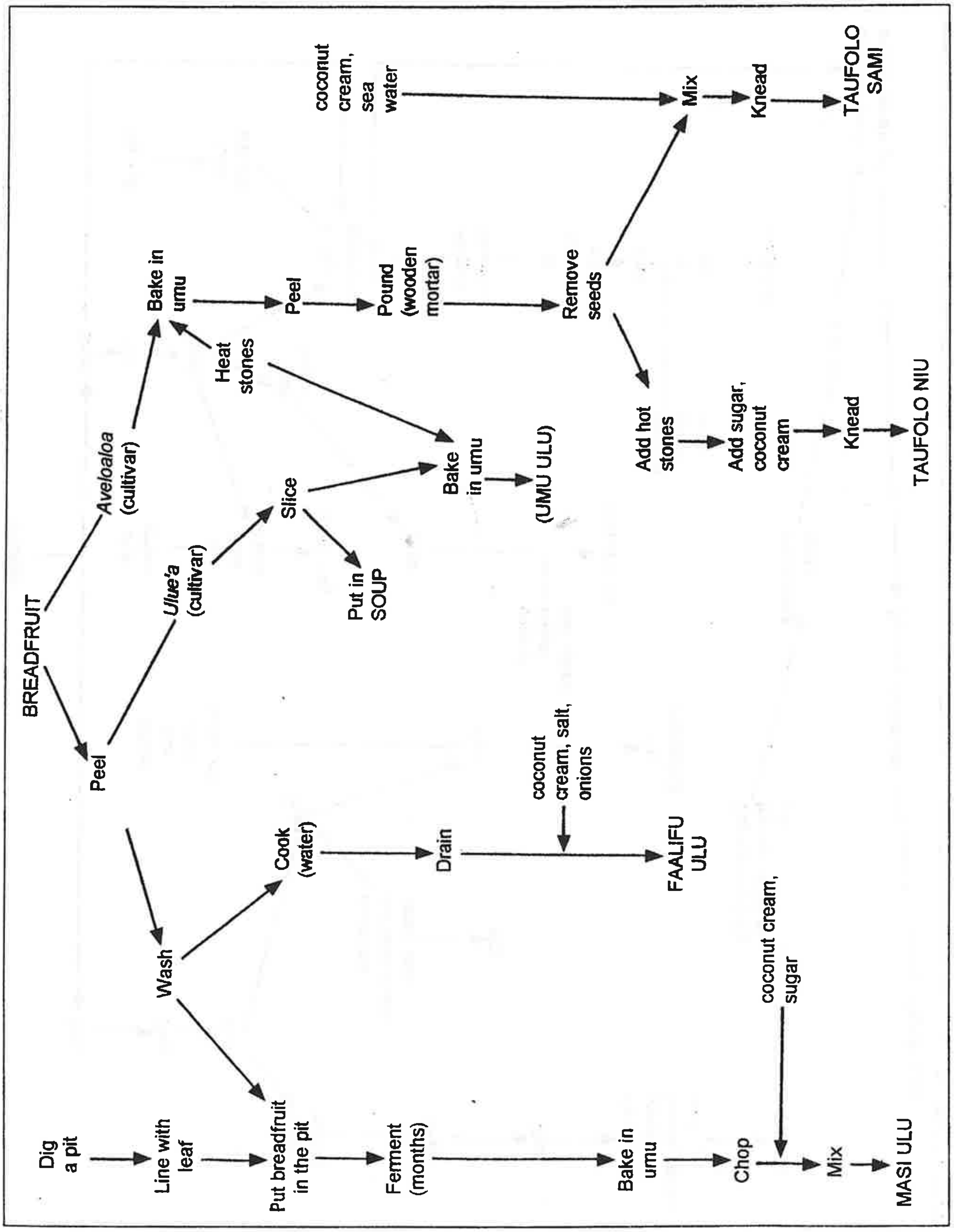

Figure 6. **Traditional foods prepared from breadfruit.**

Pacific islanders and it is called *mumu* in Papua New Guinea, *ahimaa* in Tahiti, *lovo* in Fiji, and *hangi* in New Zealand Sopade *et al.* 1994). There is a variation between islands and within an island in the way it is done and its temperature distribution. From a study of the Papua New Guinean *mumu* (Sopade *et al.* 1994), a typical Samoan *umu* could give a temperature that is higher than 200°C around the food. Baking would be predominant and steaming may be restricted to the available water from the food and the packaging leaves.

Taro *Xanthosoma*

Taro (*Xanthosoma sagittifolium*), locally called *talopalagi*, is a minor root crop although Cable and Asghar (1984) reported a collection of five cultivars in Samoa. It has a relatively limited food use (Fig. 2).

Taro *Alocasia*

Giant taro (*Alocasia microrrhiza*) is locally called *ta'amu* and it is a major staple and prestigious food in Samoa (Bradbury and Holloway 1988). The production of taro *Alocasia* has increased (CBS 1995) possibly in response to the scarcity of taro *Colocasia*. Bradbury and Holloway (1988) have discussed the composition of eight popular Samoan cultivars. *Toga* and *Niukini* cultivars are the most widely cultivated but the latter is the most predominant cultivar. Traditionally, taro *Alocasia* is either boiled in water or baked in *umu* (Fig. 2).

Yam

The main species of yam in Samoa is *Dioscorea alata*, which is locally called *ufi tau* (Wilson and Hamilton 1988). Others are *D. nummularia, ufi palai* and *D. esIculenta, ufi lei*. *D. nummularia* is of a harder texture than *D. alata* (Cable and Wilson 1983) and it is preferred by young Samoans. FAO (1994) put yam production in the country at 1,000 t and the four popular traditional foods are described in Fig. 3.

Cassava

Cassava, *Manihot esculenta*, is an important source of revenue (Tofinga 1991) and because of the favourable Samoan weather, there is no pronounced seasonality (Ekongocha 1990) in it availability. A major nutritional limitation of cassava is its cyanogens, which are lethal for humans upon an oral dose of 0.5-3.5 mg HCN per kg body weight (Onwueme and Charles 1994). Incidentally, cassava cultivars from South Pacific (Bradbury and Holloway 1988) are low in cyanogens and cassava-related nutritional problems are relatively unknown. From Fig. 4, cassava tubers are either cooked in water or baked in *umu*, both treatments should be enough to detoxify the cassava (Onwueme and Charles 1994) prior to consumption. Cassava starch is used for making various foods (*vai salo, pisua, supoesi,* and *suafai*) while the chaff from cassava starch manufacture is valuable for *samoa faapapa*.

Banana

This is an important starchy staple with about 10,000 ha under cultivation yielding 10,000 t (FAO 1994). The species in Samoa (Asghar and Wendt 1980) include *Musa* textilis Nee, *M. paradisiaca, M. nana*, and a hybrid of *M. acuminata* Colla x *M. balbisiana* Colla. Banana is locally called *fai* and the specific names for the various cultivars are available elsewhere (Daniells 1990). The various traditional products from banana are given in Fig. 5.

A notable traditional food is *masi fai*, which is a product of pit fermentation, and lactic-acid bacteria (Aaslbersberg 1988) are the dominant organisms. The fermented pulp has to be harvested at optimum quality to prevent the development of objectionable ("rotten") odours, which adversely affect the acceptability of *masi*.

Breadfruit

There are two main species of breadfruit, *Artocarpus altilis* and *A. mariannensis* (Ragone 1988) but *A. altilis* is the most widely distributed. The fruit can be seeded or seedless and its shape ranges from oval to oblong (SPC 1983). There are many varieties but *puou* has been recommended for large-scale production (Ragone 1988) possibly because it is low-bearing and easily pruned. The total number of breadfruit trees in Samoa was put between 270,000 and 290,000 (van Dissen 1978). However, the country had experienced cyclones which reportedly blew over 50-90% of the breadfruit trees (Clarke 1992).

Breadfruit is an energy food that is rich in fibre and contains a fair amount of vitamin C (SPC 1983). Breadfruit is used for a variety of products (Fig. 6) and Ragone (1988) noted that when compared to cooked unpolished white rice and enriched wheat flour, breadfruit is a better source of calcium, riboflavin, niacin, phosphorus, and niacin.

Generally, it can be observed that there are many traditional products from the starchy staples discussed in this paper. Ironically, they are less emphasised in the Samoan food industry and are being replaced by high-fat, -sugar and -salt (snack) foods with their attendant nutritional problems. This has altered the feeding habits of the Samoan people and the health concern has been discussed elsewhere (Quested *et al.* 1992). While not the only option, certain traditional foods can be upgraded to form the basis of small-scale food processing in the country but appropriate processing parameters must be established up front.

CONCLUSION

Taro, cassava, yam, banana and breadfruit are notable carbohydrate foods in Samoa. To increase their utilisation, they are converted into different products following traditional procedures. The products are diverse and their processing can be carefully studied with a view to applying existing techno-scientific knowledge for quality and efficiency. There is a potential for traditional foods in the Samoan food industry and their relationship to people's culture might help their acceptability amongst consumers. Their documentation should awaken a processing interest.

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D.A.L. ENTOMOLOGY BULLETINS, PLANT PATHOLOGY NOTES, HORTICULTURE NOTES AND LIVE-STOCK DEVELOPMENT NOTES

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15. The Sorghum Midge
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17. The Sweet Potato Weevil
18. Occasional Pest of Sweet Potato
19. Fruit Flies
20. Insect Pest of Winged Bean 1. *Leucoptera* - Leaf Miner
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9. Vegetable Variety Recommendation for Highlands of Papua New Guinea
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12. Mangosteen
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15. Harvesting, Storage and Marketing of Bulb Onion
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30. Chicken Manure Increases Aibika Yield
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LIVESTOCK DEVELOPMENT NOTES

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2. Biogas Production at Highlands Agriculture College
3. Performance of Sheep and Goats in the Eastern Highlands Province of Papua New Guinea
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5. Mycotoxicosis: I - A cause of some concern for Papua New Guinea
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7. Mycotoxicosis: III - Sampling, reporting and safety measures
8. Practical Financial and record keeping procedures in managing a chicken project
9. Management and Operation of a Chicken Distribution Centre

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ml - millilitre
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mm - millimetre
m - metre
a.s.l. - above sea level
yr - year
wk - week
h - hour
min - minute
s - second
K - kina
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n.r. - not recorded
var - variance
s.d. - standard deviation
s.e.m. - standard error of means
s.e.d. - standard error of difference
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