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PROVISIONAL REPORT No. 4

RABBIT HUSBANDRY

Morogoro, Tanzania

December 1978

International Foundation or Science • IFS

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In this context speed is more important than perfection. Therefore the original manuscripts are neither edited nor retyped, but are immediately duplicated in simple form in a very small edition, not exceeding 100 copies.

Quite independently, attempts are also being made after each meeting to have suitable parts of the material published in more carefully edited form by an international publisher. However, experience shows that such negociations, if they succeed, and the following publication can take months or years - then with due attention to editorial perfection.

IN AFRICA

MOROGORO, TANZANIA - DECEMBER 16 - 21, 1978

ORGANIZED JOINTLY BY

THE TANZANIA NATIONAL SCIENTIFIC RESEARCH COUNCIL

THE UNIVERSITY OF DAR ES SALAAM

AND

THE INTERNATIONAL FOUNDATION FOR SCIENCE

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OPENING CEREMONY

WORKSHOP ON RABBIT HUSBANDRY IN AFRICA, MOROGORO, TANZANIA
DECEMBER 16 - 21, 1978

A welcome address to the participants by Professor M.L. KYOMO, Dean of the Faculty of Agriculture, Forestry and Veterinary Science of the University of Dar Es Salaam

The Hon. Minister of Agriculture

The Hon. Representative of the International Foundation for Science of Sweden

The Hon. Director-General of the Tanzania National Scientific Research Council

Distinguished Workshop Participants,

Ladies and Gentlemen,

It gives me great pleasure to welcome you all on behalf of my Vice-Chancellor to this Campus of the University of Dar-es-Salaam. My Faculty has been greatly honoured by the sponsors of the workshop, namely, the International Foundation for Science (IFS) of Sweden and the Tanzanian National Scientific Research Council in being chosen as the host of the Workshop on Rabbit Husbandry in Africa. The importance my country has attached to this workshop is manifested by the fact that the Minister of Agriculture in my Government has agreed to come and open the workshop. We are quite aware of the fact that there are several countries in Africa which are ahead of us in promoting rabbit production. You have already seen what some of our farmers are trying to do in this field and we expect that you will have some comments and suggestions on our rabbit managament systems. We shall look forward to learning from these suggestions.

Before calling upon the Minister of Agriculture to address to you, I would like to tell you something about this Faculty. It was started in July, 1969 as part of the University of East Africa and in July 1970 it became part of the University of Dar es Salaam. It is currently offering three undergraduate degree courses, namely in Agriculture, Forestry and Veterinary Science. In addition, higher degrees by either coursework and thesis or by research only are being offered in all disciplines of Agriculture, Forestry and Veterinary Science. The Faculty has received students from the United Kingdom, New Zealand, Gambia, Ethiopia, Sudan, Nigeria, Zambia, Swaziland, Rwanda, Kenya, Uganda as well as from within the country. We do not wish to compare our courses with those being offered in other Universities but at undergraduate level we emphasize very much the integration of theoretical and practical training. We have for this reason been given permission by the Senate of my University to start our Academic Year in January instead of July, which is the normal commencement period for the rest of the University. This will enable us to have students from the beginning to the end of the growing season for most of the agricultural crops. When we start in January 1979 we shall have for the first time students from Ghana in our forestry and Veterinary Science Courses. We hope that while you are here you will take an opportunity to meet some of our staff and students and that when you get back to your countries you will encourage some of your people to come and study in my University. Although, the Faculty is 200 kilometers from the Main Campus in Dar es Salaam the good road joining Morogoro and Dar es Salaam enable us to cover this distance in about two hours. We do not therefore have a feeling of isolation at all. Furthermore, the beauty of Uluguru Mountains compensate for the beauty of the beaches at the coast. In addition, the Faculty is located near Morogoro Town which at present has a population of nearly 65.000 and can provide all the amenities we require.

With these few words I would like to call upon the Minister of Agriculture the Honourable Dr J.S. MALECELA M.P., to open the workshop.

THE OPENING OF THE WORKSHOP ON RABBIT HUSBANDRY IN AFRICA

by

THE MINISTER OF AGRICULTURE, THE HON. DR. J.S. MALECELA, M.P.,
MOROGORO, TANZANIA

DECEMBER 18 - 21, 1978

Mr Vice-Chancellor,

The Hon. Representative of the International Foundation for Science,

The Hon. Director-General of the National Scientific Research Council,

Distinguished Workshop participants,

Ladies and Gentlemen.

It is indeed an honour and privilege to have been invited to address you at this opening of the workshop on rabbit husbandry in Africa. I am very pleased to note that my country was chosen as a venue for the workshop and I take this opportunity to welcome all of you to Tanzania. The subject you will be discussing here might seem unimportant to some people, but in the continent where about two thirds of the human population are hungry and malnourished the subject should stimulate a lot of interest.

In 1974 the World Food Council noted that in most of the developing countries food output has been rising more slowly than effective demand. Again, at the Ninth and Tenth FAO Regional Conferences for Africa which took place in Freetown and Arusha, respectively, member countries noted the worsening food situation throughout the Continent and attempted to find solutions to alleviate the situation. Although several parts of Africa have experienced in recent years severe droughts which have led to starvation and death of thousands of people, the problem in normal years has been that of eating of unbalanced diet. In several African countries people subsist on starchy foods such as cassava, yams, rice, maize and millets which have low protein content. The deficiency of protein in the diets of infants and pre-school children leads to poor physical and mental growth and development and in extreme cases causes death. The FAO has estimated that about 50% of all young children in developing countries are inadequately nourished, and several of these will die prematurely. Furthermore, the health of pregnant and lactating mothers can be severely impaired if there is inadequate protein in the diet. The situation can be corrected by providing to these groups of the population adequate protein from pulses and animal products such as meat, eggs, milk and fish. However, this is easier said than done. For example, from sheer numbers of 12 million head of cattle, 7 million sheep and goats, 40 000 pigs, 18 million chickens and a large body of water where fish can be obtained, my country would have been expected to have adequate protein for its human population. There are several reasons to point out why this is not the case.

Firstly, our livestock are not evenly distributed throughout the country and therefore there are meat surplus and meat deficient areas. In the latter areas because of

expensive distribution and storage systems the meat is so costly that some sections of the community can not afford it. Secondly, even where animal protein is available such as in the urban areas, there are, due to low GNP, poor sections of the community which cannot afford to buy these sources of protein regularly. It is therefore worth looking for other sources of protein particularly those which can be produced cheaply.

There have been good agricultural schemes which have been introduced in developing countries but due to poor supply of inputs, some of these schemes have not produced the desired results. It is therefore gratifying to note that in addition to the general management of rabbits you will be discussing also the feeding aspects. In the tropics there are abundant crop and animal by-products which go to waste and which could be used in feeding to livestock. My Ministry will be anxious to receive cheap feed formulations for rabbits from this workshop.

Rabbit production was introduced in my country in the late 1950s. We started raising them at the Farmers Training Centres where farmers were taught how to take care of them. I am pleased to report that from these centres rabbit production has spread to the villages and schools. Our problem at present is to teach rabbit owners management systems which can lead to maximum returns in terms of meat and pelts on labout and capital investment. The other problem is that of providing farmers with good breeding animals. My ministry is therefore looking into ways of importing breeding animals from outside the country. Animal Research Scientists in my Ministry and in the University of Dar es Salaam have already initiated programmes to compare performances of

different breeds as well as to produce strains and breeds of rabbits which will do well in our different environments. It is expected that these scientists will work hand in hand with the extension workers and spread to the farmers good breeding stocks as well as improved management techniques. It is gratifying to note from the programme for the workshop that reports on rabbit husbandry in various African Countries as well as from other parts of the tropics will be presented here. We expect to learn a lot from them.

Honourable guests, I wish you success in your deliberations and hope that your stay during the workshop will be both worthwhile and enjoyable.

With these few remarks I have pleasure in declaring the workshop open.

TANZANIA NATIONAL SCIENTIFIC RESEARCH COUNCIL

ADDRESS GIVEN BY DR J M LIWENGA VICE-CHAIRMAN OF TANZANIA NATIONAL SCIENTIFIC RESEARCH COUNCIL AT THE OPENING CEREMONY OF THE WORKSHOP ON RABBIT HUSBANDRY IN AFRICA, MOROGORO 19-21 DECEMBER 1978:

On behalf of the Chairman INSRC, the Council, and in my capacity as Vice-Chairman of Tanzania National Scientific Research Council which is a member of the International Foundation for Science it gives me much pleasure to welcome distinguished participants to this Workshop. I note with pleasure that delegates come from mine African Countries besides a number of observers from Overseas. It is also gratifying to note the interest taken by the Ministry of Agriculture (Livestock Division) which has encouraged its officers to attend this Workshop. The Tanzania National Scientific Research Council wishes to thank you all and especially all overseas delegates for being able to respond to our invitation. This is the second International Foundation for Science supported activity in Tanzania which has been partly organised by Tanzania National Scientific Research Countil. The first was held at the University of Dar es Salaam Main Campus and consisted of lectures and demonstrations of research work being undertaken by International Foundation for Science research grantees.

The Tanzania National Scientific Research Council attaches much importance to these activities as they not only provide a forum for scientists and scholars to read their papers but also they provide an opportunity for the public to question and comment on the relevance of their research. The credit for the success of this workshop goes to our two co-sponsors, namely International Foundation for Science and Faculty of Agriculture, University of Dar es Salaam, Morogoro, who had the foresight to suggest this Workshop. I should like to stress here that the Tanzania National

Scientific Research Council Act empowers us to collaborate with Scientific Organizations inside and outside Tanzania. For this reason Government has plans to strengthen the Tanzania National Scientific Research Council so as to enable it to be more effective.

Allow me now to give a brief history of our association with International Foundation for Science. Tanzania has been associated with International Foundation for Science since its inception in 1972. The Tanzania National Scientific Research Council has been honoured by being elected to its Board of Trustees. Currently there are twelve research projects supported by International Foundation for Science in Tanzania including the one on Rabbits Husbandry.

This project is of particular interest to us because it is an example of work that could be translated from theoretical studies to practical reality. I have been informed by the Director-General of Tanzania Natioanl Scientific Research Council that participants took the opportunity to visit Kilimanjaro Region where they met and discussed problems of rabbit keeping with local people. The authorities in the region are planning to provide the farmer with an animal that does not require too much resource for its management because of land availability. The answer to this is the pig and the rabbit. Farmers are taking much interest in both animals. The Tanzania National Scientific Research Council therefore feels very much privileged to be associated with these recent developments in farming in Kilimanjaro Region. We shall recommend to the Council the need of continuing to associate ourselves with this work and see it to fruition.

I should like to take this opportunity to encourage scientific communities to think of such collaborative programmes. Dr. Bo Gohl is going to explain the catalytic role which organizations like IFS could play in

ding research in developing countries. Mr Chairman, adies and Gentlemen, let me also join the previous peakers in wishing your Workshop every success and ope that those of you who come from abroad will find ime in future to come back to Tanzania and collaborate ith us in some other endeavours. Thanks.

ADDRESS BY THE REPRESENTATIVE OF IFS

Dr. Bo Göhl
Project Secretary
International Foundation for Science

The Representative of the Ministry of Agriculture,
The Representatives of the Tanzania National Scientific Council,
The Dean of the Faculty of Agriculture, Forestry and Veterinary Science of the University of Dar es Salaam,
Ladies and Gentlemen,

Representing the International Foundation for Science at this workshop on rabbit husbandry in Africa, it is a pleasure for me to wish you welcome and to convey greetings and good wishes of the IFS.

This is the first scientific meeting on rabbit husbandry covering the African continent. Today we have present among us delegates from Tanzania, Kenya, Mozambique, the Sudan, Togo, Zambia, Malawi, Ghana and Mauritius. There are also participants from England, Germany and Sweden. It is very pleasing to note the great interest and high expectations this workshop on rabbit husbandry in Africa has aroused. The interest in rabbits as meat producers is increasing rapidly in a number of countries all over the world. The reason for this is that the rabbit has several advantages over other animals: it reproduces rapidly, the keeping of rabbits does not require access to much land, rabbits can be maintained on home grown feeds and it has a convenient size suitable for a family dinner, just to mention a few.

There are, of course, also problems associated with this animal, but taking into consideration that the rabbit has received comparatively little research attention there is great scope for improvements. I think it is fair to say that the rabbit is both a neglected and under-exploited animal. During the next three days it will be discussed whether the rabbit is an animal that has a hidden potential that can be exploited by research and in such a case what kind of work will be needed to make full use of this animal.

/...

Hopefully, the discussions will assist in finding the proper place of rabbits in African agriculture, whether it will be in the form of backyard farming or in large intensive units. Heated discussions on this subject have already started among the delegates. Also a possible outcome from this meeting will be an outline of a package of guidelines for the practical farmer on how to keep rabbits and how to solve problems associated with rabbit keeping.

Support to research on an under-exploited animal like the rabbit is very much in line with the philosophy of the International Foundation for Science. This workshop is in fact the fourth scientific meeting sponsored by IFS during the last four months on subjects that have great potentials but have not attracted the attention of researchers. Of these three earlier meetings one was held in Kumasi, Ghana, on mycorrhiza, one in Buea, Cameroon, on Yam and one in Penang, Malaysia, on aquaculture. The workshops are new adventures for IFS. We hope meetings of this kind will promote personal contacts amongst research workers, particularly IFS research grantees. We also hope that the workshop on rabbit husbandry in Africa will promote research interest on rabbits and on the practical use of results of research. A workshop as this one may also stimulate transfer of knowledge from one region to another or from one continent to another continent, and encourage future applicants to foresee new or better uses of the resources of the IFS.

The International Foundation for Science is a young, non-gouvernmental organization founded in 1972, based on the support of scientific academies and research councils, of which about 15 are from nations in the developed world and 28 amongst the less developed countries. Of these 43 nations, ten contribute to the Foundation's budget, of which one, namely Nigeria, belong to the less developed world. The budget last year was about one million dollars. This can support only modest and very selective programmes of research. So far the IFS has awarded more than 300 research grants in the seven major scientific

Subjects covered by IFS: Animal Production, Aquaculture, Vegetable Production, Mycorrhiza Studies, Food Science, Natural Products Chemistry and Rural Construction.

A number of people have worked hard to organize this workshop, first suggested by Mr. Muze Mgheni who is also an IFS grantee. When organizing this workshop, the organizers have been encouraged by the interest that has been shown by the Ministry of Agriculture. From IFS I also wish to convey thanks for good cooperation both to the Tanzania National Scientific Research Council and the University authorities.

We will now, after a coffee break, all have the occasion to hear reports on most aspects of rabbit husbandry in a number of African countries. Let us hope that our discussions will be productive so that rabbit husbandry will find its proper place in African agriculture.

SESSION I

RABBIT HUSBANDRY IN TANZANIA

Muze Mgheni

Department of Animal Science
Faculty of Agriculture, Forestry and Veterinary Science
University of Dar es Salaam

Introduction

Just as it is difficult to generally talk about Beef, Dairy, Goat, Sheep, Pig or Poultry Husbandry in Tanzania it is even more difficult to talk on Rabbit Husbandry. In a country where the human population is estimated at 14 million, and cattle is estimated to be 10,271,009, goats 5,228,000, sheep 2,472,000, poultry 18,000,000 and pigs 400,000 and grazing land 7 million hectares, it might at first sight appear unjustifiable to talk of other meat sources like rabbits but yet I definitely think it can play a vital role due to reasons that I will elaborate later on. To start with, very little is known about rabbits in this country, we for example have very little knowledge on the numbers and distribution of rabbits in the country. There is, however, a growing desire among farmers, scientists and politicians on the rabbit as a meat animal. It is also known that the keeping of rabbits is increasingly becoming important among school children and that a lot of school children have developed interest in keeping rabbits. As far as it is known, rabbits are kept in most regions of the country for quite a variety of reasons. Apart from institutions like ours, Central Veterinary Laboratory (Temeke), Tsetse research at Tanga, Muhimbili Medical Centre, where rabbits are kept for a variety of research work, most rabbits are kept as a source of meat and money. The housing for rabbits in most cases differ with the size of the rabbitry. Some farmers would maintain two to three does in the kitchen were they are allowed to bore holes and nest their youngs in the hole. Similarly some keep small units outside their houses and let them bore holes and

nest the youngs. In most cases there are kept in small units of one to ten rabbits and wooden or mud and wood boxes are constructed to keep the rabbits. In most cases such boxes and the small houses are constructed from materials that can be found idle around the homesteds. The feeding of rabbits vary from one place to another depending on what is available in different regions. The most commonly used feed in most areas is the wild Lettuce, Leunae cornuta. This is a weed occuring widely and used as a vegetable as well as forage for chicken and poultry. This weed grows in almost all areas in the country. It is fed green and supplemented with different types of brans (maize, sorghum, millets), cooked food remains (porridge, rice, beans), brewers mash, roots (yams, potatoes), bananas pealings, vegetable remains (cabbages, carrots, spinach), and grasses and grass hays. There is still scanty data on their performance but extension material on how to keep rabbits still remain a problem.

Justification for rabbit as a meat producer:

The problem that we need to answer is why rabbits have not for a long time been seriously kept in Tanzania for meat? The answer to this question is not an easy one. It can only be mentioned that probably there were other cheaper sources of meat, or probably there has existed some tabooes among tribes or probably lack of encouragement and knowledge has existed amongst scientists and extension workers, or probably the tradition of keeping rabbits simply did not exist.

Similarly one can pose other questions as to wether there is any justification for keeping rabbits now? Are the people likely to accept the rabbit meat and will they keep more rabbits in future? What are the current limitations on increasing rabbit husbandry in Tanzania?

We should first try to appreciate the fact that animal protein consumption in Tanzania is still below the set limit of 20 grams. Table 1 compares the animal protein consumption in selected contries. It will be seen that while other countries are consuming more than 30 grams per person per day, Tanzania is consuming about 9 grams per person per day. This should be taken as an average and definately it is not evenly distributed. Kwarshiokor is still eminent in parts of Tanzania and this still emphasizes on the need for increased animal protein. It is also important to mention here that in order the world to achieve the desired levels of 2,450 calories, 91 grams of total protein, 21 grams of animal protein per person per day by year 2,000 the overall output of animal products in developing countries must increase by 383% Schmidt and Van Vleck 1974. This is not a small increase unless alternative meat sources are encouraged. Similarly the world Bank/FAO 1974-1980 livestock projections in Tanzania concluded that by 1980 consumer prices for beef will increase simply because supplies will not be able to satisfy increasing demand. If the price increase are held down, the report pointed out that some form of demand restriction i.e. rationing or meatless days, will have to be introduced. The report also mentioned that the increase in beef prices will have some useful effects on that alternative sources of other meats such as small stock will be encouraged. This is a very realistic prediction and probably explains why rabbit meat is now being appreciated as the year 1980 approaches. People are already experiencing some meatless days in most areas in Tanzania where price control is practiced. The problems of keeping cattle in the tropics is very well known. I have always mentioned the disadvantages that cattle, sheep and goats have on the genetic parameters that is long gestation length, small number of kids born per birth, long generation intervals, and late maturity. Rabbits as a meat producer has a lot of qualities. It can be fed on a variety

Table 1. Availability of calories and protein per person per day in selected countries

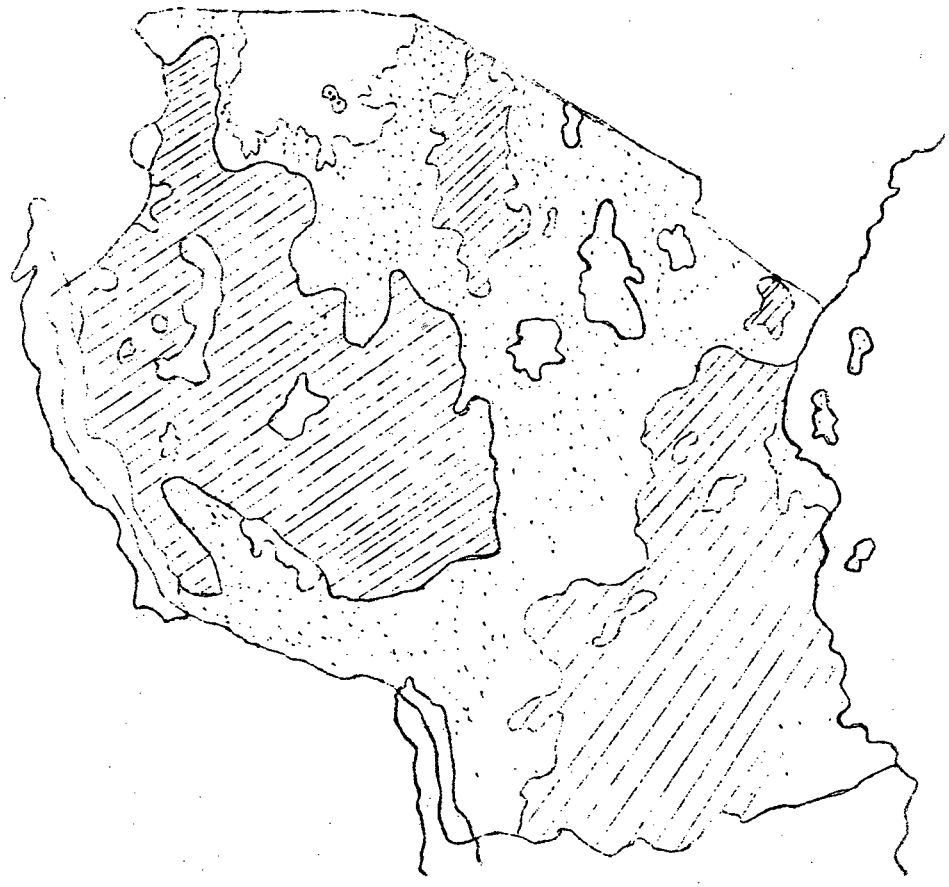
Country	Calories	Total protein, g	Animal protein, g
Union of South Africa	2820	80.2	31.5
Libya	2660	63.7	14.7
Mozambique	2420	47.9	3.8
Madagascar	2330	52.3	9.4
Ghana	2160	48.6	10.5
Kenya	2120	64.4	12.1
Tanzania	2080	58.1	9.1
Ethiopia	2040	54.4	10.0
Sudan	1940	63.9	25.9
Turkey	3110	97.5	15.9
Taiwan	2520	68.2	23.9
Japan	2460	74.7	28.2
Switzerland	3170	88.0	52.8
United Kingdom	3150	87.5	53.8
Denmark	3150	88.7	60.2
Norway	2950	81.2	50.4
United States	3200	95.6	68.6
Canada	3180	95.4	64.1
Mexico	2550	65.7	15.2
Guatemala	2220	56.8	16.7
New Zealand	3290	107.3	74.3
Australia	3120	90.5	60.6
Uruguay	3170	101.6	67.1
Argentina	2920	68.0	58.7
Brazil	2690	66.3	18.3
Venezuela	2490	65.9	26.4
Ecuador	2020	51.5	17.9
Malaysia	2400	54.3	16.3
Pakistan	2230	51.5	11.2
Ceylon	2170	48.3	6.3
India	1810	45.4	5.4

Source: Schmidt and Van Vleck (1974).

of green food, hay, potatoes, roots including some herbs which are considered as weeds in our farms. As a meat producer, the domestic rabbit can claim to produce meat of high quality on a range of feeds wider than that of any other domesticated animal and as efficient as any. It has the advantages that it can be bred at an age of 6 months, and the gestation period is 30 - 33 days, suckling period 5 - 6 weeks (but dams can be mated immediately after giving birth), it gives four to five whelpings per year, and even up to 8 whelpings per year under foster mothering. It throws six to twelve kids per whelping and from 1 doe 30 - 35 kids can be reared and 25 - 30 brought to slaughtering in a year (Sandford 1969).

Where as rabbits can be kept in almost all areas in the country, cattle, sheep and goats are limited to lowland areas and it is rather difficult to keep them on mountains. It is also worth mentioning that tsetse has been quite a limiting factor on the distribution of cattle, sheep and goats in this country. Figure 1 shows the distribution of tsetse and livestock in this country. Though we talk of more than 10 million head of cattle in the country, 88% of this herd is confined to only 7 out of the 20 regions we have and 46% of this herd is confined to only 2 regions (Shinyanga and Arusha). Rabbits can therefore be of great use in these tse-tse areas where other livestock meats are not available. Rabbits also stand a better chance when compared to pork because the moslems who form almost 50% of the population in Tanzania accept rabbit meat in their dishes. Poultry though is well developed industry in Tanzania now and has a short generation interval we still cannot produce our own strains and thus importation of parent stocks seem innevitable. Also poultry needs feed of biological value similar (if not better) to that of human beings. It has therefore been

Fig. 1. Tsetse fly and cattle distribution in Tanzania



Source: Berry, L., (1975), Tanzania in Maps.

difficult to meet the nutrient requirements and we have sometimes had disappointing performances as a consequence of this. Also feed prices have always gone up making the final product prohibitively expensive for the normal wage earners in Tanzania. It appears apparent from my few remarks that there is actually the need and justification for talking about rabbits. The question as to wether the meat is an acceptable one does not really arise. There is already a growing demand for this type of meat and also the Tanzania peoples tastes are very flexible. The farmers have shown quite some keen interests on rabbits and what I have found to be most limiting in rabbit husbandry now is the need for extension material. We need to teach rabbit husbandry through all medias available. Rabbit husbandry need to be incoocperated as a course in all levels of Agricultural learning. Pumphlets to farmers on how to keep rabbits are urgently required. Besides all the education required, we need to establish rabbit multiplication units in the regions and these will serve as sources of rabbits to farmers.

Observations:

Data preliminary collected in this Faculty show that rabbits can successfully be kept under the Morogoro conditions. Table 2 summarises the performance of the rabbits and Figure 2 shows the growth pattern of the rabbits. Considering the small mature weight of the rabbits we started with, this is satisfactory performance. It is evident that there is still some improvement that can still be brought about through selection and this is what the project is aimed at. It also appears that with the type of feeds we have used, that is, rabbit meal diluted with maize bran to give a ration of about 12% CP and about 1800 kcals per kg of metabolizable energy and ocassionally supplemented

Table 2. Performance of rabbits in Faculty of Agriculture, Morogoro

Parameter	Means	C.V. (%)
Mature weight (grams)	2980	22
Weaning weight (grams) at 42 days	620	24
Weight at 56 days (grams)	1068	18
Gain per day till slaughter at 56 days (grams)	19	-
Dressing (%)	57	8
Percent meat in carcass	74	4
Percent bone fat in carcass	18.8	16
Percent fat in carcass	7.2	25
Meat: Bone ratio	4:1	-
Pre-weaning mortality	5	-
Adult mortality (%)	0.9	-
Gestation length	30.9	7
Litter size	7.1	28

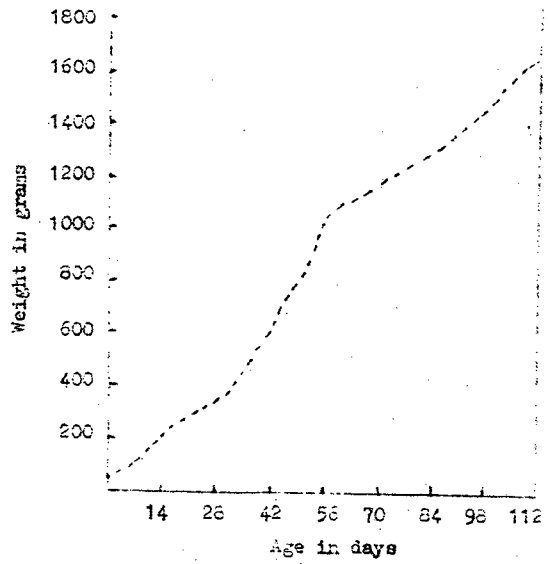


Fig. 2. Growth curve of rabbits from birth to 112 days.

Table 3. The analysis of variance for body weight (in kg) at different ages

Age in days	42 days		56 days		112 days	
Source of variation	DF	Mean squares	DF	Mean squares	DF	Mean squares
Between litter sizes	7	.289[3]	7	0.4999[3]	7	.897[1]
Within Litters	106	.0136	106	0.0248	106	.212

DF = Degrees of Freedom

1. $P < 0.05$ 2. $P < 0.01$ 3. $P < 0.001$

with lucerne, a better performance can be attained if feed of higher energy and protein levels is used. The latter however is not the goal of the experiment since most environments that rabbits can be kept will not afford highly nutritive feeds. The cost of selecting under a poor to moderate levels of feeding is a slow genetic progress. Also as shown in table 3, it appears that there is a prolonged maternal effects in that even at 112 days, there is significant difference in weight between litter sizes. This is probably a bit exaggerated if we take into consideration the few numbers of litters considered. Another worthwhile observation to note, is that there seems to be no particular demarcation for slaughtering rabbits because even after 8 weeks of age there seem still to have a high growth rate.

Conclusion:

Throughout this paper emphasis have been on the justification of rabbit husbandry in Tanzania. There is definately a potential for such an industry and encouragement need to be enforced. Extension education and government support on rabbits should be increased. Rabbit rearing and eating should for example be encouraged in schools, hospitals, prison and other public institutions. Rabbit rearing and multiplication units should be established in regions to form a source of rabbits to the farmers and institutions as well as being focal areas for extension materials.

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Rabbit Husbandry in the Sudan

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1. Introduction

Rabbits can contribute very significantly to world food supply. It has a relatively high efficiency of food utilization compared to large farm livestock and it can utilize foods that are not suitable for human consumption. Therefore, it increases the resources of man in obtaining large quantities of high quality protein.

The development and expansion of such an industry depends upon consumer demand for rabbit meat. A demand might develop due to shortage of alternatives, competitive prices or elasticity. These factors might have led to the present situation, where large scale operations have already started around the world (Tudge, 1972)

The problem of raising any livestock under a specific system is essentially one of obtaining maximum turn over with minimum costs.

In other words, the sale of products should at least match the costs in the short term and make a profit in the long one. To achieve that, we require an animal of high biological merit, fed and managed economically, to be capable of maximum production under intensive systems of husbandry.

In spite of the early extensive studies of the biology and reproduction of the rabbit (Hammond, 1925), limited use was made of those studies in genetic and husbandry improvements. The achievements which were obtained currently were due to efforts of individual breeders and those were mainly in the methods of production. Therefore, there is a paucity of scientific information under the present husbandry systems. Since management of the rabbit has changed completely, new problems have emerged which require new solutions. At a time when rabbit keeping and utilization are expanding, such studies seems to be timely.

2. The efficiency of the rabbit as a potential meat producer:

The theoretical potential of a species is essential in defining the expectation and thereby help in formulating targets. Usually some hypothetical levels are assumed. In case of a breeding

doe; effective production starts when the doe reaches sexual maturity. A doe can be remated postpartum while it is suckling a litter. In other words, the production cycle is continuous. Allowing 31 days for the gestation period and remating 4 days after kindling; about 10 litters can be expected. Hafez (1964), studying implantation in the rabbit, showed that it was biologically possible to produce 15 young in a litter. Let us simply assume that these young can be raised to marketing weight of 2.5 kg and yield 55% carcass on slaughter. Thus, the potential of meat production in this hypothetical example is:

$$10 \times 15 \times 2.5 \times 55\% = 206 \text{ kg/doe.}$$

The following table compares the theoretical limits with the results realized in practice (Walsingham, 1972).

Table 1. Theoretical and realised production potentials:

Reference	No. of litters: per year	Total No. of: progeny reared/year:	Carcass production (kg)
Theoretical limit:	10	150	206
Blount (1968)	6	54	63
Moss (1970)	7	54	73
Commercial rabbit Association (1970)	6	36	42
British oil and Cake Mills (1972)	8	54	55

It is obvious that there is a large difference between the biological potential of the doe and what is obtained in practice. The causes of the discrepancies are numerous and some of these are biologically unavoidable. It is unlikely that substantial advances will be achieved until techniques of management and disease control are well known under these conditions before establishing the biological ceiling.

In Sudan, less than about 15 - 20 kg are obtained per doe annually.

3. Rabbit meat consumption:

Sabatier (1971) considered France as the chief producer and consumer of rabbit meat. About 200 ($x10^3$) tons are consumed annually. Italy ranks second to France in rabbit meat consumption (Table 2). However, rabbit meat consumption is relatively low in Sudan. This is because of the availability of cheaper sources of meats (mutton and beef). Rabbit meat is a luxury food taken at week ends and on special occasions. The per capita consumption is less than 0.2 kg.

Table 2. Rabbit meat consumption in some European countries:

Country	Carcass production (tons x 10^3)	Per capital consumptions (kg)
France	200	6.0
Italy	100	1.5
West Germany	25	1.1
Britain	15	0.3
Belgium	1	1.1
Holland	3	0.8
Sudan	1	0.2

4. Breeds:

Rabbit keeping is an old practise in Sudan. There are plenty of varieties and/or strains in the country. All these strains belong to a dominant breed which can be designated as the Baladi (or local type). It ranges in colour from white to various mixtures of black and red. They are all characterised by a small bodysize. Another wild type of a similar variety exists in the various parts of the country. However, it is rather smaller in bodysize.

There are also limited importations of foreign breeds especially the New Zealand white.

5. Rabbit keeping and husbandry:

In Sudan, rabbits are kept mainly at the backyards of house.

Rabbit farming has not yet developed along the recent intensive systems of the European or other African countries like Ghana. However, it contributes substantially to the household budget (of those who keep them) through the sale of surplus rabbits to the market

6. Housing:

Breeding animals are kept in rather small houses situated at the backyards of houses. These houses are not in the majority of cases designed or built specifically for rabbits. They are mainly disused poultry or other-purpose houses. There are plenty of rabbits which are just kept in the house without any special enclosure. They run about in the house.

Where houses are available in the backyards, they are mainly made up of wire netting on the sides. The roof is made up of local materials (thatch) and in some cases corrugated metal sheets.

Floors are mostly made up of sand.

The utilization of local materials for housing should be encouraged, but due consideration should be given to proper hygiene to avoid losses from disease. This requires proper research followed up by proper extension service to transmit useful information to rabbit keepers. This is hitherto lacking in the Ministry of Agriculture.

7. Food:

Food is a major portion of the total cost of running an animal unit. But, information in the nutrition of rabbits is rather scarce in comparison with other meat animals.

The large development of the digestive system, particularly the caecum, initiated some comparative studies on the digestion of fibrous feeds between rabbits and ruminants (herbivore). Digestibility trials (Besedira, 1971) on different foods showed that rabbits can utilize a fair quantity of fibre in their diets (10 - 15%), but not to the same extent as ruminants. It has also indicated, like ruminants, that the rabbit, increases its food intake with the rise in the fibre content of the diet. This high utilization of fibrous diets is facilitated by the habbit of coprophagy (pseudorumination) as was shown by Kulwick, Struglia and Pearson, 1953.

In Sudan, rabbits feed mainly on Barseem (Medicago sativa) and kitchen remains which are made up of left-over pieces of bread and unutilizable vegetable parts. Chemical analysis showed that green Barseem has the following composition: crude protein (C.P) 4.1, crude fibre (C.F) 7.2%, calcium (Ca) 0.4% and phosphorus (P) 0.6% and carotene 80 mg/kg.

Since the daily requirements of an adult rabbit is in the region of 272 calories and 10 grammes of digestable proteins, we require a ration which contain about 10% fibre and 15% crude protein.

It can generally be seen that green Barseem, when given alone will not be sufficient to sustain high levels of production. This also applies to kitchen remains which might even have lower nutritive value. Therefore, it will be a necessary step to collect the various traditional feeds on which rabbits are fed in Sudan, analyse them and assess their digestabilities and try to complement the deficiencies where necessary. It is quite evident that there is a lot to be desired in this area.

8. Breeding:

As has been mentioned earlier, the major breed used for rabbits production is the Baladi (or local) type. Its production potential is rather low. This is depicted by a small mature bodysize, small littersize (average is 5.5 young/litter) and low levels of nutrition.

Food efficiency (food/gain) is rather large indicating that large quantities of food are required to be converted into meat.

Since the relationship between bodysize and littersize is well known, it will be essential that we have to increase both littersize and bodysize if we desire to increase production. This can be effected through the importation of one or two breeds for purposes of crossbreeding. For example, the New Zealand White breed or the Californian breed.

A three-way crossbreeding system is to be preferred to a two-way or a pure-breeding system. This is because we can incorporate various traits from the contributing breeds and complement the deficiencies in others. For example, the Baladi (local) breed (B) can give us characters that relate to adaptations to local conditions like disease resistance and utilization of low quality diets. When this is crossed with the Californian (C) breed; known for its large bodysize but slow growth; we can obtain a doe with a relatively reasonable bodysize that can contribute good maternal abilities mediated through a large bodysize. The third strain, for example, a New Zealand White breed (N), will be introduced to contribute its high growth potential to the progeny (broiler rabbit).

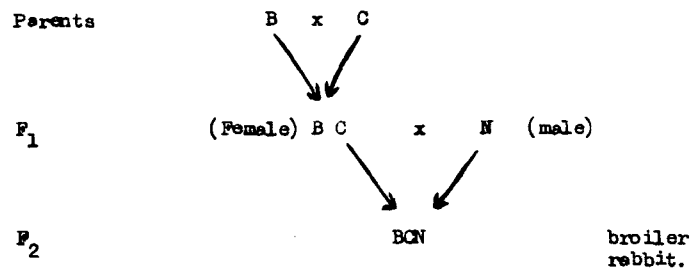

Table 3 depicts clearly litter traits, body size and growth rate data of the three different breeds of rabbits.

Table 3: Litter and body weight traits of three breeds of rabbits (gram)

Trait \ Breed	Baladi M	Baladi Av.	Baladi F	Californian M	Californian Av.	Californian F	New Zealand M	New Zealand Av.	New Zealand F
Number born		4.7			7.10			7.49	
Number born alive		3.5			6.67			6.94	
Number weaned		4.0			5.33			5.53	
Average birth weight (g)		(40)			(63)			58	
Average weaning weight (g)				697		668	583		616
" "		(310)			(683)			(600)	
Average mature weight	1 272		1 344	3 766		3 815	3 191		3 433
" "		(1 308)			(3 791)			(3 312)	

M = Male
F = Female

9. Marketing:

Rabbits are sold live in the Sudan through two channels (a) personal transactions whereby rabbits are sold in the neighbourhood or (b) in the market where they are sold along with other classes of birds like chickens, pigeons, ducks, geese and turkeys. They are mainly sold in pairs. Grading and selection are done by consumer's inspection and the price is subject to negotiation. There is no sale according to weight and there is no sale of dressed rabbits.

Marketing is done at a very late age when rabbits are more or less mature, when they reach a reasonable size.

10. The future:

There are two areas in which rabbits can contribute immensely in bridging the protein gap in the Sudan: (a) In large towns in the country, it could help in increasing the meat varieties available to the consumer at a reasonable price. Thus, the problems here require solutions to production problems. (b) There is a large zone in the Southern Sudan which is infested by Tsetse fly (Tsetse fly belt) where large animals were not able to survive in the area and consequently there is a very real shortage of animal protein. Therefore, rabbits have a great potential if introduced in that area. Therefore, it will be useful if a small trial is started there.

To improve these objectives, a rabbit research unit; which will attached to one of the research centres is very important. This can collect information on rabbit breeding, utilization of local feeding materials, housing, etc. It can also contribute towards rabbit marketing which requires substantial improvements.

As a conclusion, there is a great deal which rabbits can contribute to meat supply of consumers in Sudan.

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RABBIT BREEDING PRODUCTION IN MOZAMBIQUE

by

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Maputo, 1978

1. RABBIT PRODUCTION IN THE COLONIAL ERA

1.1 During the colonial times there was little economic interest in rabbit breeding as cattle was the basis of all animal production due to the great abundance of cheap labour and limitless possibilities of territorial exploitation. Only poultry, amongst small animal species, was utilized in a relatively commercialized way for the urban market, which guaranteed the consumption of large quantities of poultry meat. This made it possible to develop various poultry enterprises throughout the country which are now, once again, in use and have now almost reached their former level of production. A very important increase is foreseen in 1980 which will equal the 1973 production.

1.2 On the other hand rabbit production was confined to pets, and had insignificant economic value compared to other animal production enterprises. A statistical survey made in 1970 gave the total rabbit population in Mozambique as 168 000, but it is not clear if this figure refers only to breeding animals, or to all rabbits in captivity. It is probable, from the method of census that this is the total figure. Consequently, we are able to calculate that the number of breeding stock was less than 20 000 at that time so that rabbit production could hardly have been called a commercial operation.

1.3 This lack of commercial production was reflected in the low level of technology. It is notable that we have found no records of studies on genetics; nutrition; effect of climate on production; economic aspects; or on health and disease in rabbits, all production being of a purely individual and empirical nature.

Obviously, with the end of colonialism and the departure of the colonists, the breeding stock disappeared and rabbit production quickly collapsed.

2. OBJECTIVES OF RABBIT PRODUCTION IN THE NATIONAL PLAN FOR RECONSTRUCTION

2.1 The Third Frelimo Congress decided that conditions would be provided to initiate a national campaign of rabbit distribution in 1978, mainly in the rural areas and through agricultural cooperatives, with the objective of increasing the amount of protein of animal origin for human consumption, using techniques and methods which would stimulate collective reproduction in line with the social and economic development of the rural areas.

2.2 The director of livestock services was therefore asked to submit a National programme of rabbit production for Mozambique. This programme was approved in March 1977 by the Ministry of Agriculture, and the livestock services were made responsible to carry out the programme in the field.

2.3 The plan is divided into three fundamental parts:

The study defined the general conditions, deadlines and phasin and anticipated the limiting factors such as the ordering of technical material, the type of culture and the productive limitations, subject to ambiental factors such as temperature, humidity, feed, tropical diseases, management etc. The plan concluded that the tech nical limitations could be overcome only by predetermining basic conditions which should be carried out before starting the operatio in the production units.

The programme is based on the following fundamental principle which, in our opinion, determines the character of the whole operation.

Assisted rabbit production campaign

This insists that before the campaign starts, suitable sites for the operation (which in this first phase are the production collectives such as agricultural cooperatives, schools, hospitals, military units etc.) should be selected. Following this that a cent-

ral and provincial organization for technical assistance and supplies should be established.

Consequently it was decided to construct a National Centre with the following objectives:

a. To utilize a standard type of housing suitable to the greater part of the country.

b. To adapt the standard system of housing to utilize locally available materials in each province, region or district, (to conform to the principle of "self sufficiency").

c. To produce the necessary animals in order to stock the provinces, progressively.

d. To select a genetic line of rabbits with a higher resistance to tropical conditions.

e. Since rabbits are herbivourous rodents, to utilize this fact to the maximum in order to prevent competition with human food stuffs, especially by selecting local legumes in order to provide a plan of nutrition that would guarantee an economic production performance.

f. To study and elaborate a feeding plan as in e) for all provinces, using local supplies hitherto not utilized by the population, including new species of easily cultivated grasses.

g. To construct a school for 32 students to train persons for the campaigns.

h. To establish one or more centres in each province (e.g. Gaza 3; Cabo Delgado, Niassa, Zambézia 2 or more).

i. The provincial centres have to assume the duty of the national centre, namely:

1) to put into practice the system of housing of rabbits using locally available materials.
2) to multiply the breeding stock to supply the production units.

3) to train people to help with the units. These people are only selected after a thorough search of motivation in all cooperative members, and who afterwards will return to work in the production unit as a member of that cooperative.

The provincial centre, therefore, functions as a school but with special characteristics, e.g. it is designed to reproduce all the conditions that the participant will encounter in his village, without any special technical advantages.

Furthermore, socio-political training will be given to him during the course, with the objective of increasing his level of social responsabilities of his emancipation.

Lastly the provincial centre has an obligation to produce sufficient animals to replace those in the production units every 18 months.

Techniques

The technology adopted will depend on the various possibilities and necessities. Thus we have three types of technology:

a. A technique employed in the centres which utilizes cages of imported netting and a centralized water supply. This is a sophisticated technology with a high investment, with the object of obtaining a high production. This will be the technology transferred to the state production units for intensive poultry production.

b. An intermediate technology which uses wooden cages and locally produced netting, feeders and drinkers and a feeding programme less sophisticated than in a).

This technology will be used for the urban collective units. The object of the technology is to guarantee good production with low capital investment and avoid importations.

c. A basic technology such as we have presented in our manual, which is the only one which will allow successful production in rural communities. In this technology the feeding will be exclusively in cages made of local materials, production will be limited and investment will only consist of the labour for constructions

and maintenance, or so called "self sufficiency".

3. TARGETS ACHIEVED

To date a part of the initial programme has been completed. The rabbit houses have been constructed at the national and provincial centres, with 430 breeding stock in the former. Fiftysix supervisors have been trained from the provinces to which they have now returned.

The provincial centres are functioning (in some provinces more than one) and peasants are being trained for the production units, 60 of which have now been selected in the country.

Apart from these courses others have been initiated to train members of other entities (Min. Education, Min. Interior, workers' organization etc.) which have agricultural sections. During January 1979 an evening course will be held for voluntary supervisors, who will be responsible for assisting the urban production units.

A boarding school was constructed for 32 students and more than 2 000 breeding stock have been distributed, with a potential production of 50 000 rabbits, which already surpasses the colonial era.

4. PROBLEMS OF FEEDING, BREEDING, AND HEALTH

4.1 Once it was established that we could breed rabbits using correct techniques and organization, there still remained the problem of feeding them with food not competitive to human nutrition, and at the same time guaranteeing a minimum production to justify the inclusion of a rabbit production unit in the agricultural cooperatives. To solve this we investigated natural legumes present in many parts of Mozambique, but so far we have not tried them out in practice.

We have two alternatives: a) the utilization of sown legumes, where possible under irrigation, such as Medicago sativa which is considered the best where conditions permit its cultivation.
b) The use of natural legumes which are not used for human consumption. Such plants must be hardy and grow without irrigation during the dry season, so that it is only necessary to collect the seeds at the right time and sow them with a minimum of preparation. We have investigated four species, Indigofera errecta (25% Protein D.M.), Psilotricum boivinianum (20.4%), Marremia tuberosa (23.9%), and Leucaena leucocephala (28%).

This last has the toxin mimosine and should not be used at more than 25% of the ration. Utilization of these legumes could resolve the feed problem in the dry season. Unfortunately although there is an abundance of feed in the wet season, this coincides with the period of highest temperature, which decreases the production of rabbits, so we have an abundance of food but low production in the hot wet season followed by a food shortage at the most suitable time for production in the dry season. With these deep rooted species, the leaves can remain green in time of drought permitting high level nutrition at the most appropriate season for production.

4.2 We are working mainly at a practical level to select a genetic line of animal highly resistance to heat and intestinal coccidiosis - a disease especially favoured by the type of feed available. For heat resistance we are concentrating on the respiratory system, continually eliminating all individuals with coryza or difficult respiration during the hot season.

Our original stock was from animals acquired in the local market, mainly crosses of Californian and Chinchille breeds, crossed with imported animals to prevent inbreeding. At present we have Californian, New Zealand Whites, and improved crosses.

4.3 Regarding health, the major problem is with respiratory conditions. Amongst the imported animals, was diagnosed a Pasteurella multicida of great virulence, with a mortality of about 10 % of the initial animals. We are now selecting severely and continually to improve the situation. As a treatment we are using sulfaquinoxaline at 60% and furazolidone at 40%, in a dosage of 40 g/100 l of drinking water, for 14 days.

In the provinces we had only one case of apparent intestinal coccidiosis, and this through negligence due to lack of any type of prophylaxis and in spite of continual change of feeding. After 3 days of treatment the problem was overcome.

In conclusion, the basic health problem in rabbits in tropical climates is the proper functioning of the respiratory system. Our experience has shown that it is best to eliminate all rabbits that show signs of coryza. In this case it is always advisable to study the feeding regime and control the ventilation system.

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RABBIT HUSBANDRY IN THE TOGO

by

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Several factors have led the father of the Togolese Nation, General Eyadema, to give priority to the development of animal husbandry in the Togo. These are: the increased national shortage of animal proteins; the high prices of meat products imported from neighbouring countries (Niger, Upper Volta, Mali, etc.); families in rural villages not being able to eat meat more than ten times a year; the fairly common sight of children with nutritional defficiency symptoms.

Recently the number of rabbit breeders in Togo has increased and there are now more than two hundred. Rabbit production operations can be divided into three different types:

(1) Non specialised family type operations,

(2) Farms specialising in rabbit production,

(3) Semi intensive commercial rabbit operations.

(1) Family type operations

In this kind of rabbit production system, the number of animals is generally less than ten. Enclosures of 2 x 4 m covered by corrugated iron, or wire-netted cages of 1 x 1 x 0.65, are used. The rabbits are weaned when they are six weeks old and left in freedom in enclosures until they are sold.

The main feed given to the rabbits is crushed corn and grass. There are no or little sanitary measures.

(2) Farms specialising in rabbit production

In this kind of farming system, the number of animals is usually between 50 and 200 and there is generally one male for 10 females. The rabbits are housed in two-storey wire-netted cages, placed in buildings which floor is made of cement and roof of corrugated iron or straw. Droppings are collected about once a week and spread on the fields as manure. Very often rabbit breeding is a subsidiary to poultry, sheep and goat production. The farmers usually have a fair knowledge of rabbit husbandry. They know how to avoid inbreeding, the weaning follows the recommended pattern and they can optimize the number of litters per year.

/...

(a) Feeding

The rabbits generally receive, at 7.00 hours in the morning, a diet based on wheat bran, crushed corn, rice bran, spent brewer's grain, peanut oil-cake and fish meal. In the afternoon, between 16.00 and 17.00 hours, they receive wild herbage and dandelion leaves. Rabbits seem to like dandelion leaves very much, which are rich in proteins and whose Togolose name is Aninonsigbé. The weight of feed distributed every day to each rabbit is about 250 grammes. The feed is prepared on the farm with what is available to the farmer.

Since the beginning of 1976, it has been impossible to feed rabbits well as a drought destroyed everything; the lack of grass provoked the increase in price of compounded feeds. The shortage of feeds caused the closing down of many rabbit operation Some nutritional disorders thought to be caused by poor nutrition were observed, such as loss of weight, sterility, abortion and stunting.

(b) Sanitary conditions

Besides the usual rabbit diseases, there are many problems linked to the insufficient feeding, and to the environment. Rabbits are regularly given a prophylactic for the two forms of rabbit coccidiosis. The product used is Nivaquine which is added to the drinking water on a daily basis. The rabbits are treated for parasites every three months.

(3) Semi intensive rabbit operations

There are three important intensive rabbit operations in the Togo: BENA DEVELOPMENT, BETANIA and the CENTRE D'ELEVAGE ET DE FORMATION DE BATOME. The people in charge are specialists who have been trained in Europe and the operations are of high technical standard. Their equipment is relatively modern compared to the other two forms of rabbit operations in the Togo. The rabbit hutches are similar to the ones used in Europe and can house between 500 and 1 000 rabbits. The same sanitary and feeding problems existing in smaller farms are also encountered in these larger operations.

Rabbit husbandry in the Togo is developing. The main difficulties are:

- Lack of wire-netting used for the construction of breeding cages;
- Inadequate nutrition resulting in a poor mating response in females;
- Lack of selected breeding rabbits;
- Inbreeding;
- Sterility lasting 3 to 4 months (caused by inadequate feeding).

/...

Rabbit hutches

The wire-netted cages used by Togolese farmers have adequate dimensions generally but their floors are not suited to rabbits. The ordinary wire-netting (which tends to be thin and not smooth) causes paw problems, sores and abcesses. The equipment inside the cages (feeding troughs, drinking bowls, nests) is built from local materials: bamboo, rattan and clay.

Feeding

The main problem which caused the ruin of many Togolese rabbit operations is that the compounded feeds are made of low quality ingredients and stored under unsuitable conditions. Also, they do no exist in sufficient quantity for large-scale production. This is currently the main limiting factor to the development of rabbit production in the Togo, and also to the development of poultry, pigs, sheep and goat production. Animal husbandry in the Togo will really start only when proper animal feed producing facilities have been set up. Until then the present situation causes desperation among Togolese farmers.

Rabbit health

The health of rabbits is influenced by the environment (climate, housing, management) and by feeding.

Besides sores, abcesses and paw problems, transient respiratory diseases occur. Scab is endemic in badly run rabbit operations.

Coccidiosis, diarrhoea caused by feeding too much fresh grass, parasites and nutritional disorders are found in Togolese rabbit operations. These have been cured by appropriate treatment.

There is no myxomatosis in the Togo. Great care is taken when breeding stock is imported (quarantine under the surveillance of the Department of Animal Health and Animal Production). Any stock showing disease symptoms or suspected of suffering from any disease is destroyed immediately.

One of the most worrying diseases in the author's experience is a nervous disease known as Cénurose. The symptoms of this disease are that the rabbit starts to scream, whirls round during two to three minutes and then becomes paralyzed while the whole body is shaking. The rabbit remains paralyzed until its death 48 hours later.

Several treatments have been tried without success, including coccidiostats. Several post-morten examinations were executed by the author and by the Department of Animal Health, but the results were always inconclusive. Since a competent laboratory for investigations concerning rabbit diseases is not available in the Togo, assistance from Europe will have to be sought.

RECOMMENDATIONS FOR THE DEVELOPMENT OF RABBIT KEEPING AND BREEDING IN THE TOGO

To be realized with the help of the International Foundation for Science (FIS):

- The creation of a modern Centre for Rabbit Husbandry. The aims of the Centre should be:
  - (a) Extension services, including demonstrations;
  - (b) Production of good breeding rabbits to popularize rabbit husbandry in the country;
  - (c) Erection of an animal feeds mill;
  - (d) Supply and assembly of materials for rabbit keeping.

RABBIT PRODUCTION IN ZAMBIA

by

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SUMMARY

Very little can be said about commercial rabbit farming in Zambia. No scientific research or experimental work has yet been carried out. The little that is known about rabbits is as a result of work done elsewhere. In the University and Research Institutes, rabbits have only been used for experimental purposes in other fields of biological research.

There is need therefore for research to be carried out in housing, health, feeding and breeding under Zambian conditions. Also, the extension workers still have to be taught the fundamentals of rabbit husbandry and intensify the campaign among the masses to popularize rabbit meat consumption.

SCOPE

Although the introduction of large commercial rabbit farming has been slow, there is every indication that rabbit meat production will at one time be part of the major livestock industry. Over the years, poultry broiler industry has expanded well above all other livestock, mainly because (according to Urwick, Lugg and Could, 1971) of the general shortfalls of other meat products, and the relative price advantage poultry meat has in relation to the alternative meats. The retail prices of pre-packed meat in large supper-market, Lusaka, were as follows: Beef depending on the cut, went from 35 ngwee per pound for mince to 65 ngwee per pound for rump-steak; mutton and lamb from between 45 to 65 ngwee per pounds; chickens were 35 ngwee per pound for boilers and 39 ngwee per pound for broilers (young chickens).

The present prices in supermarkets (Kwachas) are: beef steak K3.00 per kilogram, chickens K2.00 per kilogram, rabbits K5.00 per kilogram. The relative market demand for each type of meat seems to be reflected in the levels of these prices. All retail meat prices are controlled. No attempt has been made in working out the economics of producing rabbits but the picture looks attractive at the moment.

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The rapid growth of the broiler industry in comparison with other livestock can also be said to be due to other reasons like:

a) The short length of the production cycle which is only about one tenth of the period required for beef production;

b) The availability of expertise in breeding, housing and health;

c) The big emphasis placed on poultry by the Government at the time of independence in 1964, which was necessitated by the increasing demand for animal protein following the gradual rising of living standards. This, together with the lack of well organized and reliable source of rabbit breeding stock and the apparent unpopularity of rabbit meat among some Zambians, has resulted in rabbit farming taking a back seat.

Fortunately, the climatic conditions in Zambia seem to answer some of the requirements of rabbit breeding. Although Zambia is situated in the tropics, the climatic conditions are favourably affected by the great Central African Plateau. As described by Webster and Wilson (1966), we have three distinct seasons:

a) The wet season from December to April with minimum and maximum mean temperature ranging from 16°C to 27°C and the relative humidity not exceeding 80%;

b) The cool dry season from May to August with wide temperature range of up to 20°C with the minimum and maximum daily means being between 6°C to 26°C;

c) The hot season from September to November with the daily mean temperature ranging from 15°C to 32°C with relative humidity just above 40%.

We know that breeding rabbits for instance (according to J.I. Portmouth), do well in temperature ranging from 10° to 16°C and fattening stock at 15.6-18.2°C with humidity in the range of 75%.

Under our conditions therefore, the first attempt with rabbits was in about 1965 with the introduction of a nucleus breeding stock of Californian rabbits (N.L. Davies 1967). There was a growing interest for rabbits, especially among schools and other farming clubs and even among individual farmers who kept them along side poultry and pigs. However, due to lack of breeding stock this interest died down. Today there are quite a few farmers using imported breeding stock having units which are capable of producing 1 000 meat rabbits per year. A majority of the people keep them as a hobby or for educational purposes. Management in many of these units leaves a lot to be desired.

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FIELD PRACTICE

Housing

Housing for rabbits in Zambia in most cases is simple. A majority of building materials consist of local bush poles and burnt or unburnt bricks for the construction of open sided shelters which house hutches. Roofing materials can either be of grass thatch or iron roofing sheets. The use of wire cages has been practised in some larger units. Temperature regulation in these houses is done by either leaving the sides of the sheds completely open during warmer months or closed with hessian sacks at night and during cold months. Hutches may be constructed with bush timber and wire mesh used in chicken houses.

Feeding

Being bulk feeders, rabbits fit in the present situation very well as it is almost impossible to always find concentrated balanced food. Where they have been kept in small numbers as a hobby or for home consumption rabbits have been raised successfully on scrap foods such as the waste products from the kitchen and garden. A wide variety of this type of food has been given; for example, scraps of bread, fruit peelings, carrots, groundnuts, green lettuce, soft banana leaves, etc. Those who have tried rabbits on commercial scale have in addition made arrangements with the National Milling Companies to have rabbit pellets compounded for them. A wide range of feeding equipment too is used, such as clay pots and empty oil tins which have been cut in half and adapted for the purpose.

Diseases

It is difficult to say which diseases have caused mortality without veterinary research on the subject. A pathologist (Dr. L. Benko) at the Veterinary Research Station in his review of the rabbit diseases published in the local farming magazine in 1977, gave an impression that quite a number of diseases had been diagnosed in Zambian rabbits. These included pasteurellosis, salmonellosis and coccidiosis.

FUTURE PROSPECTS

The advantages of rabbit keeping in villages are obvious. Being less dependent upon concentrated feeds than poultry, rabbits would provide quicker and cheaper means of increasing the supply of the much needed animal protein in human nutrition. In peri-urban areas, rabbits would provide a quick turnover than any other farm animals because of its higher meat output in relation to its body size, weight and space requirements over an average lifespan of three years.

Session I - Discussion 1

Speaker: Mr M. MGHENI: Rabbit husbandry in Tanzania

C. Giattas, (University of Dar es Salaam), understood that in Malawi rabbit meat was taboo to Moslems, contrary to that reported by Mr MGHENI for Moslems in Tanzania.

A. HAQ, (University of dar es Salaam), reported that in the Moslem country of Pakistan rabbit meat consumption was not restricted by religious taboos.

M. MGHENI, reiterated that Moslems in Tanzania consumed rabbit meat without any apparent infringement of religious teachings.

N. MAMATTAH, (Ghana), submitted that poorer Moslems in Ghana used rabbit meat as a cheap alternative to mutton in religious celebrations.

R. RAMCHURN,(University of Mauritius), commented on the danger of rabbit meat being likened to that of cats and a consumer resistance developing as a result.

M. MGHENI, replied that such associations were in fact commonly found but stated that such problems in increasing consumption arose due to an ignorance of the potential of rabbit meat and its extreme palatability.

J.W. RUGH, (voisins Mondiaux, Togo) commented that when eggs were in short supply, there were sometimes taboos against certain family members eating them, e.g. pregnant women and children. Once eggs were plentiful the taboos tended to disappear.

A. HAQ, asked for comparative costs of rabbits as compared to other species, re: cost of producing 2 kg of liveweight in 112 days.

M. MGENI, answered that proper costings were not yet available in Tanzania, he further pointed out that comparative costings were of limited meaning when different feeds were being used e.g. waste grasses for rabbits c.f. specially compounded feeds for poultry. However, using concentrate feeds on the University Farm, Morogoro, he stated that the feed costs amounted to 3 shillings 85 cents to 3 months of age.

P. WARNER, (Tsetse Fly Research Project, Tanzania) commented that introducing kindling boxes at 3-5 days before kindling gave best results.

J.I. MCNITT, (Bunda College, Malawi), agreed with the previous statement, adding that earlier introduction of the kindling boxes led to them being used for defaecation resulting in coccidiosis problems.

J.E. OWEN, (Tropical Products Institute, Britain), stressed the need to slaughter at a fixed liveweight rather than a fixed age. For New Zealand Whites the approximate weight was 2.5 kg after which feed conversion efficiency declined rapidly.

J.L.MREMA (Tanzania), questioned whether rabbits might become a pest, as in Australia, if widespread production was undertaken.

M. MGHENI, said that the survival of non controlled population of rabbits showed their adaptability to a wide range of feeds and added that pest problems will not arise as the rabbits will be raised in confinement.

L.N. ODONKOR, (Ghana), said there was no risk of rabbits becoming a pest provided free range systems were not used.

J.P. ARUMA, (Kenya), noted that in Kenya there were some taboos about pregnant women eating rabbit meat and stressed the need for rabbit extension work to women who largely determined eating patterns.

N. MAMATTAH, returning to the potential pest problem with rabbits, stressed that with the type of broiler rabbit being considered by the workshop there was no problem as such domestic rabbits would not survive long if outside their artificial environment.

Session I - Discussion 2

Speaker: Dr F.M. EL AMIN: Rabbit husbandry in the Sudan

L.N. ODONKOR, (Ghana), asked if the colony systems included both bucks and does.

F.M. EL AMIN, replied that the colonies contained only females and young and that the does were handmated outside the colonies, he reported no problems of fighting or mismothering due to the development of a strong dominance order among the rabbits.

J.OWEN, (Tropical Products Institute, Britain), asked how widespread rabbit keeping was in the Sudan.

F.M. EL AMIN, replied that rabbits were extensively kept under many small scale systems and that rabbits were brought regularly to markets for sale.

R. RANCHUM, (University of Mauritius) enquired if marketing of rabbits was easy in the Sudan.

F.M. EL AMIN,answered that there were no taboos partly because wild rabbits were long hunted and eaten and that rabbit was regarded as a luxury meat on some occasions, in other words there was no marketing problem.

K. MAEDA, (Livestock Development Division, Ministry of Agriculture, Tanzania) asked aobut the most important disease problems in rabbits in Sudan and Tanzania.

F.M. EL AMIN, replied that enteritis constituted the main problem in the Sudan and reported that antibiotics were used in the water supply when the need arose.

M. MGHENI, (University of dar es Salaam), stated that disease problems in Tanznaia would be dealt with in a later paper by Dr SEMUGURUKA.

H.Y. KAYUMBO (Director-General, Tanzania National Scientific Research Council),commenting on the biological characteristics of the rabbit,presented a table extracted from Ecological Energetics by J. Phillipson (1966, Publ. Edward Amold), as follows:

Food utilisation and rate of growth per unit weight by cattle and rabbits

Animals	1 steer	300 rabbits
Total body weight	1300 lb	1300 lb
Food consumption/day	16 2/3 lb	66 2/3 lb
Heat loss/day	20.000 kcal	80.000 kcal
Gain in weight/day	2 lb	8 lb
Gain from 1 ton of food	240 lb	240 lb

J.M. LIWENGA,(Vice-Chairman, Tanzania Scientific Research Council), asked what were the natural predators of broiler type rabbits.

F.M. EL AMIN, replied that there were no predators of hutch kept rabbits except perhaps dogs.

N.MAMATTAH, commented that when there is nothing to eat people will eat anything; snakes, lizards, etc. and thus the introduction of rabbit meat constituted no problem when meat supplies were short. On the question of pests he stated that in Africa where there were so many carnivors and opportunist hunters that pest problems were not likely to occur.

F.M. EL AMIN noted that whilst working in the Sudan the Chinese ate donkeys although these species are not normally eaten by the Sudanese.

J.P. LUNGU (Zambia) asked about the rabbit breeding plans in the Sudan and the value of local breeds.

F.M. EL AMIN noted the adaptability of local breeds but stressed that these were local domesticated and not purely wild rabbits.

J.P. ADUMA (Kenya), asked about the seasonal breeding of rabbits.

F.M. EL AMIN commented that there was no noticeable seasonal effect in his experience although he had not studied it in detail.

M. MGHENI thought that the 3-way crossing system suggested by Dr EL AMIN was only practicable on commercial units.

F.M. EL AMIN agreed with the previous comment and stated that he hoped to receive government subsidies in the Sudan to make the 3-way cross feasible on a commercial scale.

Mr MSHANA (Tanzania) asked about the origins of the local Sudanese rabbit.

F.M. EL AMIN replied that the term "local" referred to an evolved domesticated type and not a purely wild type. In the Sudan the local domesticated type had evolved from various imported rabbits.

J.E. OWEN stressed that a truly wild type in captivity would suffer from such a degree of stress as to make it prone to many disease problems.

N. MAMATTAH stated that the intention in Ghana was to "blow up" the local types with imported exotic stock and to blend the crosses of the latter into the local environment. Further, the intention was to set up parent stock headquarters and to use these to provide stock to prevent inbreeding in village units.

Session I - Discussion 3

Speaker: Mr D GASPARI: Rabbit husbandry in Mozambique

C. GIATTAS (University of Dar es Salaam), asked if the temperatures in Maputo were so high as to justify a selection programme for resistance to heat.

D. GASPARI answered that the temperature in Maputo ranged from 30-40°C. Since high temperature were one of the pre-disposing conditions to coryza infection selection for heat tolerance was justified.

C. GIATTAS asked how one recognized animals suffering from coryza.

N. MAMATTAH (Ghana) replied that the clinical symptoms of coryza were: the affected animal snuffled and there was a nasal discharge coupled with other symptoms very similar to symptoms of pneumonia.

C. GIATTAS said that when the animals showing clinical symptoms of coryza were eliminated, the selection was actually not for heat resistance but rather for resistance to coryza.

D. GASPARI said that it was during intense heat (36°C when it was best to observe the occurrence of respiratory troubles. At this temperature susceptible animals were culled, thus a nucleus stock not showing symptoms of coryza was established to which further selection could be applied. Respiratory problems were associated with productivity in that the higher the infection the lower the productivity of the animals.

J.E. OWEN (Tropical Products Institute, Britain) said that it seemed that selection for heat tolerance was because the susceptibility of the animals to coryza infection increased with increasing temperature, and asked if it was dry heat or moist heat that increased rabbit susceptibility to coryza.

D GASPARI replied that it was the moist heat that increased rabbit susceptibility to coryza. The animals were most susceptible during the wet season. This was the best time to carry out the selection because selection for resistance to diseases had to be done at the time when the animals were most likely to be susceptible.

W.D. SEMUGURUKA (University of Dar es Salaam) asked if it were just one species or strain of bacteria that caused coryza in rabbits.

D. GASPARI answered that there was more than one type of bacteria causing coryza in rabbits.

W.D. SEMUGURUKA stated that selecting for resistance to a disease was difficult due to the numerous pre-disposing factors for a disease infection. These factors might change from one generation to the next.

D. GASPARI replied that the selection operation had to be carried out under controlled environmental conditions.

N. MAMATTAH pointed out that in Europe, poor ventilation and high humidity increased the incidence of coryza because under such conditions ammonia from the urine could predispose to respiratory problems.

J.P.ADUMA (Kenya) stated that in poorly ventilated environments the respiratory system of the rabbit was irritated and the protective mucous membrane was damaged, thus encouraging infectious bacteria to flare up.

M. MGHENI (University of Dar es Salaam) commented that it was best to both change the environment, in order to reduce disease incidences, as well as to breed for disease resistance.

J.E. OWEN said that rabbits could withstand high concentrations of ammonia, more than human beings could easily tolerate when working in rabbit units. The accumulation of ammonia in rabbit houses was not usually the direct cause of coryza, but was symptomatic of poor ventilation.

R RAMCHURN (University of Mauritius) said that in his opinion the drug used in the treatment of coryza in Mozambique was correct but that the dosage indicated was rather too high.

D GASPARI replied that the dispensing of the drug was controlled. The dosage might be too high for pregnant animals but was satisfactory for young growing animals.

C. GIATTAS pointed out that the dosage used would very much depend on the amount of water the animal were expected to take. This factor varied from situation to situation and the quoted dosage might be correct depending on the amount of water taken in by the animals.

Session 1 - Discussion 4

Speaker: Mr L.D. KANGNI: Rabbit husbandry in Togo

J.I. MCNITT, (Bunda College, Malawi),pointed out that it was mentioned in the paper that rabbits were treated against parasites every three months and asked what were the parasites and what was the treatment.

L.D. KANGNI, answered that the parasites were mainly intestinal; ascariasis was the condition most frequently observed. However, problems were rare except where husbandry practices were neglected.

W.D. SEMUGURUKA, (University of Dar es Salaam), asked if the disease was so rare why the three monthly treatment.

L.D. KANGNI, pointed out that the treatment was mainly prohylactic as a precaution against possible outbreaks.

M.E. SHAYO, (Ministry of Agriculture, Tanzania), asked what was the drug of choice, was it a broad spectrum or narrow spectrum antibiotic and what were the active ingredients.

L.D. KANGNI,answered that the veterinary officer was consulted whenever a problem was observed and he was the one who knew the drug of choice and the active ingredients.

N. MAMATTAH, (Ghana), stated that Cénurose was a disease observed in Ghana and was suspected to be caused by a protozoon Encephalotozoon cunuculi, and was more common when there was a heat wave. He reported that sprinkling the animal with cold water might alleviate the problem in some cases and that the disease might be spread by urine of dogs and humans. He suggested to kill the affected animals before the disease was too severe and eat them after discarding the heads.

T.S. KAVISEH, (University of dar es Salaam), stated that Cénurose was an intermediate stage of a tapeworm found in dogs resulting from the ingestion by the rabbit of grass contaminated by dog faeces.

R. RAMCHURN, (University of Mauritius),asked how the speaker saw an experimental centre developing according to the recommendations in his paper.

L.D. KANGNI, replied that a centre for rabbit research was highly desirable in all countries. The centre should be started with modern techniques and be a place where teachers from all over the country could come and follow a three months course in rabbit husbandry. These people would then start small rabbit husbandry units in their schools with hutches supplied from the centre. These school units would be used to teach the children good practical rabbit husbandry coupled with theoretical lessons in class. Such units would then be pilot projects. With such an arrangement there would be rabbits everywhere in Togo in one year!

N.T. BANGU, (University of Dar es Salaam), said that in the Togolese experience they seemed to be facing problems whilst using high quality feeds like grains, fish meal etc., while earlier reports from Sudan and Mozambique had indicated the converse. He asked why this should be so.

L.N. ODONKOR, (Ghana), pointed out that in commercial production units formulated feeds were required to maintain profitable production in contrast to small scale production where cheap feeds could be used.

L.D. KANGNI, said that forages were useful on family scale production units but in large scale enterprises there were problems about how to offer forages, i.e. dry or fresh. Fresh forages had resulted in intestial troubles but these were reduced on dried forage.

E.M. KIANGI, (University of Dar es Salaam), asked what caused the disease Cénurose and what was the percentage of animals affected.

L.D. KANGNI, answered that the actual casue was unknown but the symptoms were: screaming and whirling around for 2-3 min. followed by paralysis and later death.

Session I - Discussion 5

Speakers:	Mr J.P. LUNGU:	Rabbit husbandry in Zambia
	Mr J.E. OWEN:	Rabbit production in tropical countries
	Mr N. MAMATTAH:	Sociological aspects of introducing rabbits into farm practice

P. WARNER, (Tsetse-Fly Research Project, Tanzania), asked for advice on the problem of pre-weaning mortality which was an important factor in his rabbit unit.

J.E. OWEN, (Tropical Products Institute, Britain), answered that there were two points of high mortality in the rabbit production cycle, namely, at weaning and the first days after birth. At weaning, mortality was most often caused by poor nutrition, coccidiosis and respiratory conditions. After birth the causes of mortality were trampling, mis-mothering and even predators such as rats. He indicated that for pre-weaning mortality standards of 10% were good and that levels of 20-25% were common with levels of up to 30-40% being often encountered.

P. WARNER, commented that litter mortality was a major constraint in rabbit production and that the kindling box system may not be the most appropriate one.

J.E. OWEN, agreed with the previous statement and pointed out that although there had been significant progress in genetic and nutritional aspects there had been no similar improvements in husbandry techniques. He suggested that the mortality rate following birth might be reduced by joining the litter and does only once per day for feeding and for the rest of the day keeping them separate.

N. MAMATTAH, (Ghana), commenting on weaning mortality indicated that in Ghana experience suggested that the main cause was poor nutrition and he recommended the use of a little chick feed, chicken scraps etc. for newly weaned rabbits.

L.N. ODONKOR, (Ghana), pointed out that newly weaned rabbits had relatively immature teeth which meant poorer utilisation of roughage feeds and impiled the use of more concentrate feeds at this stage.

N. MAEDA, (Director Livestock Development Division, Tanzania), asked why, if rabbit meat prices were so high in Zambia production was not more widespread.

J.P. LUNGU, replied that as production was so limited in Zambia the majority of the output went to hotels and expatriates and as a result the producers could demand and get relatively high prices.

N. MAEDA, stressed the need to consider carcass yield rather than liveweight in measuring performance.

J.E. OWEN, pointed out that many projects did not record dressing percentage and further that it was a very variable parameter due to the effect of gut-fill. He stressed the need to base dressing percentages on an empty gut basis.

M. MGENI, (University of Dar es Salaam), quoted dressing percentages ranging between 53 and 61% at the University Farm Morogoro, with an average of 57%.

R. RAMCHURN, (University of Mauritius), quoted a dressing percentage of 55% from his work.

J.E. OWEN, added that the dressing percentage might be as low as 40% when the diet was based on a high level of roughages.

SESSION II

CHAIRMAN: PROFESSOR M.L. KYOMO, TANZANIA

RABBIT PRODUCTION IN TROPICAL COUNTRIES

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Abstract

Rabbits are making an increasing contribution to meat production in many developing countries in the tropics. These animals are capable of supplying meat in reasonable quantities when kept under small-scale low input systems.

This paper draws attention to some of the advantages of the rabbit as a meat producer in tropical countries, and also to the problems which must inevitably arise.

Although successful rabbit production is being achieved in many cases, notably in Ghana, there is considerable room for improvement without resorting to the use of expensive equipment and materials. Work needs to be carried out on many aspects of rabbit meat production in the tropics. The most important consideration is nutrition and feeding in relation to the efficient utilisation of locally available materials. The Tropical Products Institute in collaboration with Reading University has initiated a research programme on this subject. Some data arising from this project is discussed. Much of the information presented was collected during overseas visits by the author.

Introduction

There is evidence that rabbits are beginning to make a useful contribution to the meat supply in many tropical developing countries. The greatest potential for the use of meat rabbits is in those countries which experience national meat shortages. However, even in countries where official statistics indicate adequate consumption levels, the uneven distribution of supply often means that the poorer people are not able to purchase sufficient meat for their needs. Under such conditions the value of the meat rabbit is becoming increasingly recognised in both rural and urban communities.

The advantages of the rabbit as a meat producer in the tropical developing countries have been pointed out by Owen, Morgan and Barlow (1976) and by Owen (1976).

In developing countries, the vast majority of meat rabbits are produced under non-intensive small-scale, or backyard systems. It is in such systems that the rabbit can make its most valuable contribution towards supplying meat for the poorer urban and rural peoples. Where a strong market demand for rabbit meat and reliable feed supplies of good quality can be developed, commercial production at intensive or semi-intensive levels may well be feasible in the tropics. Indeed the intensive commercial rabbit industries of countries such as France and the UK have been developed from small scale backyard industries.

Breeds

In the developed countries the New Zealand White has displaced most other breeds for meat production. Indeed in countries such as the UK it is used to the exclusion of almost all other breeds for this purpose, although on the

Continent of Europe, breeds such as the Fauve de Bourgogne, Californian, Beveren, Termonde White and Belgian Silver are also used (Belgian Government Research Station for small Stock Breeds, 1972).

The reason for the popularity of the New Zealand White is that it has been found, by many breeders, to be superior in terms of breeding and meat production when kept under intensive commercial systems. The New Zealand Whites now used in the UK, have been specially bred for such systems.

The situation in developing countries is different in that a wide variety of breeds are used for meat production. Different breeds appear to be favoured in different countries. In most cases the use of a particular breed or breeds is purely fortuitous, depending on the breeds that were originally available. These breeds were originally introduced to different countries for a variety of reasons (Owen et al 1976). Nowhere has a particular breed of rabbit been selected and developed specifically for tropical backyard conditions. Notwithstanding this, many of the well-known breeds (ie the New Zealand White) appear to have adapted very well to the varied tropical conditions.

There is obviously a need for work to determine the most suitable breeds for use under various tropical conditions. It should be pointed out that the requirements of local farmers are often subjective and not always related to the performance of the animal. For instance size and colour can play an important part in the popularity of a given breed or strain. A larger breed may be preferred even though it may have poorer growth and reproductive performances than other smaller breeds also available. In Nepal white is unpopular because of its association with pet rabbits. Even within one area, such as Pokhara, there can be a diversity of demand with regard to colour in rabbits (Craven, 1977). There is a need in these cases to have available a choice of coloured breeds.

Nutrition and feeding.

The general nutritional needs of the rabbit, as far as they are at present understood, have been reviewed in the literature by Portsmouth (1977) and Davidson (1977).

Nutritional data relating to the rabbit as an intensively reared commercial or laboratory animal are now accumulating at a reasonable rate. However, with regard to low input systems, particularly in relation to the tropics, few data are available. The most important nutritional aspect as far as small-scale, low input systems are concerned is the rabbit's ability to utilise fibrous material in the form of herbage (fresh or dried) and agricultural waste products.

It has been pointed out that the rabbit, which is a non-ruminant herbivore, is much less able to digest dietary fibre than ruminants such as goats, sheep and cattle (Davidson, 1977). Cattle are reported to be twice as efficient as rabbits in this respect (Slade & Hintz, 1969). However the faster rate of passage through the alimentary system of non-ruminant herbivores allows a higher rate of feed intake. An adequate amount of nutrients can be obtained from relatively poor quality high fibre diets in this way, whereas rumen fill with fibrous material can prevent this happening in the ruminant (Bayley, 1978). It has in fact been stated that hind gut digestion, which takes place in the rabbit, is a superior adaptation for dealing with high fibre herbage, provided that intake is not restricted by the actual quantity of herbage available (Jarvis 1976) Another advantage enjoyed by the non-ruminant herbivore is the ability to utilize soluble carbohydrates in plant material more efficiently by absorbing them as sugars rather than converting them to volatile fatty acids. The rabbit also offsets some of the relative inefficiency of hindgut digestion by practising coprophagy. With regard to dietary fibre requirements a level of 12-14% fibre in the diet is recommended for breeding rabbits, but non-breeding stock will take

up to 25% fibre (MAFF, 1976). Walsingham and Large (1977) have shown that weaned New Zealand Whites can produce growth rates of 38-39g a day up to 2kg liveweight on diets consisting solely of dried herbage. However, this was achieved with high quality lucerne and ryegrass hay and such good quality herbage is not always available to the tropical backyard farmer. Liveweights of 1.23kg at 16 weeks were obtained using 100% alfalfa (Trifolium alexandrium) diets on Flemish Giant x Baladi Red rabbits in Egypt (Aboul-Seoud, Abdel-Salam, Radwan, Raafat and Abou-Raya, 1970). The mean growth rates of the weaned rabbits up to 1.23kg liveweight was 9.6g a day.

In practice diets for rabbits can be based largely on herbage, although the feeding value of different herbage species can be expected to vary considerably. In the Philippines it was found that para grass (Bachiria nutica) when fed to breeding does produced better performances than either napier grass (Pennisetum purpureum) or guinea grass (Panicum maximum). In most countries, however, it is difficult to maintain rabbits solely on fresh grasses and other herbage throughout the year. Apart from the fact that the quality of the herbage varies with the growing season, in some countries such as central Nepal (Craven, 1977) and Egypt (Aboul-Seoud, et al 1970) there is a serious shortage in the dry season. In other countries such as Togo, there is a persistent state of drought.

The conservation of herbage such as lucerne hay in Egypt or dried groundnut leaves in West Africa (Odonkor, 1977) is one answer, although this is not always possible. In Nepal, for example, the relative humidity is usually too high for 'hay making' after the monsoon growing season. Where hay making is possible and where legumes (ie alfalfa, clover, lespedeza, cowpea, vetch, kudzu and groundnut) are available, it is better to make legume hay since this contains about twice as much protein as grass hay and is palatable to rabbits (Weisbroth, Flatt and Kraus, 1977).

The use of forage legumes cut at an early stage, and leguminous species such as leucaena is worthy of investigation. In Pokhara, Nepal, Gynura cusimba is unique in that it grows fairly abundantly in the dry season in very poor soil. Its leaves have a crude protein content of 27% (DM) and it is eaten readily by rabbits, although refused by other livestock, including goats, presumably due to poor palatability. Similar examples of locally available herbage of particular use in rabbit feeding must exist in many tropical countries. Again in Pokhara six week weaning weights in rabbits of 800-1,000g were obtained on a diet consisting solely of radish tops (Craven, 1977).

In many areas it has been possible to produce home mixed concentrate rations using such materials as rice bran, spent brewers' grains, ground maize, groundnut cake and coconut cake. The availability of agricultural by-products offers particular scope for the production of such foods on a local basis. A major problem in the feeding of such concentrate rations is that they are nearly always fed in meal form which often gives rise to considerable wastage. Modifications in the design of feeding troughs can help to minimise this (Odonkor, 1977). Preliminary work on a collaborative project between the Tropical Products Institute (TPI) and Reading University had indicated that problems can be encountered when feeding meals to rabbits. From table 1 it can be seen that on a low energy diet, weaned New Zealand White Rabbits were hardly able to produce any weight gain at all from diets fed in meal and mash form (Owen, Bryant, Machin, Owen and Butcher, unpublished data). Diets of identical composition fed in pelleted form produced growth rates of 21g/day. In the case of high energy diets (table 2) the rabbits appeared to be able to cope with the meal and mash presentation much better, but again growth performance was poorer than in those fed on pelleted diets. Although wastage was particularly high in the case of the meal presentation, the feed containers were continually topped up so that the rabbits had excess feed available throughout the trial. This has important implications since pelleting facilities are not widely available in the developing countries, especially to backyard farmers.

The question of palatability is also important, as demonstrated by Cheeke (1974) in his studies on Dutch Rabbits. Rabbits, however, will consume diets high in

alfalfa that rats, pigs and chickens reject. It has been suggested that this is largely related to taste responses, as rabbits have a higher tolerance for bitter compounds than the other animals (Cheeke, 1977). Evidence to support this is given by Hermus (1975) who fed quinine sulphate to rabbits at levels of up to 1%. Cheeke (1977) provided further evidence in a study which involved feeding rabbits on high and low saponin-alfalfa meals.

It is evident that there are very many problems associated with the feeding of rabbits under small-scale conditions in the tropics, but there are also many possibilities, and in several countries the problems are being tackled with some success. However, nutrition and feeding is an area which needs considerable attention.

Housing and Equipment

It is not always possible for the backyard farmer in a developing country to obtain wire, especially galvanised wire of the correct gauge and mesh size which is commonly used in commercial systems. Thus, most backyard units consist of outdoor cages which have only crude shelters, if any. In such systems wire is in any case unsuitable for anything but the fronts and floors of housing due to the lack of protection from weather and disturbance. Wood is the most commonly used material in places where wire is either too expensive or unavailable, and has been used satisfactorily in several African countries. It has been reported that concrete cages with wire floors are used in a large commercial Angora rabbit project in Kulu, Himachal Pradesh, India (Acharya, 1977). Most often a combination of wood, or woody material and wire is used. Wire is especially useful for the fronts (for observation purposes) and floors. A wire floor is easier to keep clean and assists in maintaining a high level of hygiene.

In many African countries chicken wire (usually supported with wooden struts) is used with apparent success. However, experience in UK rabbitries has shown that the use of any wire but the recommended type has resulted in problems with sore hocks. The commonly used type is galvanised wire of 1.6-2.0mm thickness and 19mm x 19mm or 25mm and 13mm mesh size. This is clearly an area which needs further investigation.

With regard to feeding and drinking equipment, a great variety of innovations employing locally available materials such as old bottles and tins etc can be found throughout the tropics. The problem of wastage when meals are fed has been tackled with varying degrees of success.

Although there do not appear to be any great problems in the use of locally designed and made equipment, many farmers would benefit considerably from exchanges of information, both within and between countries. This has not yet happened on any significant scale.

Disease

Rabbits are prone to a variety of diseases and these have been reviewed by Ostler (1961) and more recently by Cowie Whiting (1977).

Rabbits kept under backyard conditions are usually relatively healthy, providing attention is paid to cleanliness, the sensible construction and siting of housing and good feeding practice, without undue recourse to expensive drugs and treatment.

Tropical conditions can of course give rise to special problems. If adequate protection is not provided against cold winds and rain, which occur seasonally in many parts of the tropics, pneumonia can cause serious losses.

External parasites such as the chicken flea, Echidophaga gallinacea, and particularly Sarcoptes scabei which causes sarcoptic mange, can be troublesome. The ears of the rabbit are particularly vulnerable to parasites, which can in some cases be controlled by such simple methods as the application of palm oil.

One of the major disease problems in many countries, including those in tropical latitutdes, is Coccidiosis, which particularly affects young weaned rabbits and those kept on solid floors. Damp climatic conditions also enhance susceptability to Coccidiosis. In Nepal it was found that the problem occurred mainly in the very damp weather following the monsoon in September. The treatment of all stock during this month, and young stock for one week at weaning, with embazin, proved to be effective and inexpensive. A management regime of frequent cleaning and changing of housing, with the avoidance of undue stress, also helps considerably.

There is much scope for work in this field, and experience in some countries has shown that inexpensive and effective disease control is possible under tropical backyard conditions.

Climate

The most obvious feature of tropical climates which might be expected to affect rabbit production, is the occurrence of high ambient temperatures. The fur-bearing rabbit is largely reliant on respiratory evaporation for the regulation of its body temperature, which implies only a limited capacity for adaptation to higher ambient temperatures (Lee Robinson and Hines, 1944; Kamar, Shafie and Abdel Malek, 1975). Also the physiological effects of such temperatures on rabbits are closely related to relative humidity, being more acute when the humidity is high. Temperature effects appear to be more serious if the high ambient temperature is constant. At ambient temperatures above 30°C rabbits suffer increasing discomfort and stress (Lee et al, 1944, Shafie, Malek, El Issawi and Kamer, 1970). No data is available to date which indicates differences in the

ability to withstand heat stress by different breeds. However, Srivastava and Mukherjee (1976) reported that there was no difference between Albino and non-Albino rabbits in this respect.

Sittman, Rollins, Sittman and Casady (1964) indicated that maximum daily temperatures above 26-27°C severely depressed reproductive activity in penned New Zealand White rabbits. Work by Tacher (1970) in a dry Sudanese climate and also by Kirkpatrick and Somade in Nigeria, provided similar findings. Laboratory studies on the domestic rabbit have produced some insight into the problems associated with reproduction at high ambient temperatures. The studies of Olouta, Bogart and McKenzie (1951), Hiroe and Tomitsuka (1965), Chou, Yi-Ch'uan and Chen-Ch'ao (1974) and Rathore (1970) have demonstrated that ferility in male rabbits can be impaired, although not irreversibly, at these temperatures. Also in female rabbits embryo mortality was found to increase (Shah, Rich and Alliston, 1970, Alliston, Howarth and Olberg, 1955).

Published information based on field studies in tropical countries is virtually non-existent, although general observations by rabbit farmers appear to support the above findings. It is of course very difficult to disentangle the effects of adverse temperatures from those of other factors such as poor nutrition in non-controlled field conditions.

In Ghana observations have shown that young rabbits up to two weeks of age were particularly affected by high ambient temperatures (Odonkor, 1977). Field Studies by Cleland (1978) in St Vincent led to the conclusion that the occurrence of high ambient temperatures was a major factor in reducing the productivity of rabbits.

There are also nutritional implications (Kirkpatrick & Somade, 1974). For instance feed intake is reported to decrease with increasing temperature (Prudhon, 1976). This introduces the possibility of varying dietary formulations in hot and cool seasons. In certain circumstances water intake decreases also (Johnson and Ragsdale, 1957).

In certain countries such as Ghana, Nepal and Mauritius, it has been found that cold wet weather is a much more serious hazard to rabbits than high ambient temperatures, especially if the onset is sudden. This has already been referred to. Although the effects of high ambient temperatures should be always borne in mind by farmers in the tropics, it should be pointed out that in practice they can be minimised by properly designed housing which may be constructed from locally available material.

In temperate countries seasonal breeding behaviour of rabbits can be attributable to variations in day length. In the fairly constant day lengths of tropical latitudes, little seasonality of breeding, other than that associated with extremes of temperature and humidity, has been experienced.

Performance levels

Performance levels being currently achieved in UK intensive commercial rabbit units are (45-50) young reared per doe per year (approx 6 litters), with meat rabbits achieving a slaughter weight of 2kg in 2 to 2½ months. In general, rabbits kept under backyard conditions will not perform so well, particularly if they are not fed on balanced high energy and high protein diets. However, the main advantage of such systems is that meat can be produced cheaply with very low inputs other than labour.

Results being currently achieved in developing countries are illustrated in Table 3. With the exception of Oman & The West Indies, where the figures were obtained by correspondence (Bell, 1977, Cleland 1978), the data were collected by the author during visits to the countries concerned in late 1977. Again with the exception of Nepal, the West Indies and Oman, all of the data were recovered from controlled projects of various kinds rather than from local farmers, who generally did not keep any records.

From the author's experience greater attention needs to be paid to record-keeping in such projects. Accurate records, even very simple ones, are essential if any systematic progress is to be made and various production problems dealt with

effectively, particularly those concerned with breeding and feeding. The data quoted were not collected under scientifically controlled conditions, but do serve as a useful indication of the general production levels being achieved.

The production figure of about 20 young reared per doe per year (4 litters), was remarkably common throughout the countries visited. Slaughter weights of the order of 2kg were mostly obtained at 4 months of age or more.

There is clearly room for improvement, although the performance levels quoted for UK commercial rabbits would not be generally achieved without recourse to intensive high input systems. But even with low input backyard systems, considerab progress could be made by such means as the identification and development of breed and strains best suited to tropical backyard conditions, the raising of general management standards, and particularly, by the use of improved feed formulations based on locally available materials.

Discussion.

A number of problems have of course been encountered, the nature and severity of which vary according to the area and country concerned. These have resulted in some failures, chiefly amongst inexperienced farmers who had not received adequate instruction. However, there is evidence of considerable success in some areas. The success rate has been relatively high in countries where Government support has been strong. For example, The National Rabbit Project (NRP), which has played a vital part in the development of rabbit meat production in Ghana, arose as a direct result of Government support. The NRP, apart from providing breeding stock to villagers, has been very active in the dissemination of practical information. Such support has also been important in Mexico where a Government organisation dealing with small species, such as poultry and rabbits (Direccion General de Avicultura y Especies Menores) has set up a chain of about 40 extension centres throughout the country. At these centres farmers are provided with breeding animals, and given short courses in rabbit management which include instruction in

the preparation of meat. At the largest centre in Irapuato, they are also taught to process rabbits' skins and manufacture fur skin products.

Although the domestic rabbit is derived from the cool temperate European species Oryctolagus cuniculus, it has adapted well to hot tropical conditions provided it has been given sensibly constructed and sited housing. In fact periods of wet windy weather have appeared to cause far more problems than high ambient temperatures in the tropics. Although preferences have developed for different breeds in different countries, in many cases it is not at all clear if these preferences are based on sound production information or how representative the particular strain is of the breed in question. The situation with regard to breed choice is in many cases adventitious and work needs to be carried out in this area.

The area which needs the greatest attention, however, is concerned with the nutrition and feeding of rabbits and the efficient utilisation of locally available feeding materials. To this end a collaborative project has been set up between TPI and Reading University. The project is investigating the utilisation of low energy high fibre diets by rabbits kept at high ambient temperatures.

Finally, it is of the utmost importance that there is an exchange of ideas and information between various rabbit producers and projects both within and between countries. The provision of new information on such topics as nutrition and health by research, practical experience and field studies, is of little value unless it can be readily disseminated. National rabbit associations, and the recently formed World Rabbit Science Association could do much to achieve this. However, such associations cannot survive and function without support. It is up to Government organisations, farmers and all other interested bodies to provide such support.

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TABLE 1: THE EFFECT OF FEED PRESENTATION ON THE GROWTH PERFORMANCE OF NEW ZEALAND WHITE RABBITS KEPT AT 25°C AND FED ON DIETS CONTAINING 8MJ/kg METABOLISABLE ENERGY LEVELS (WITH STANDARD DEVIATIONS WHERE n = 4)

Form of Presentation	Pellets	Mash	Meal
Initial Liveweight (gm)	1478.00 ± 47.97	1328.50 ± 181.22	1373.00 ± 87.75
Final Liveweight (gm)	2049.75 ± 89.13	1420.5 ± 484.50	1374.75 ± 220.09
Growth Period (Days)	30.5 ± 0.58	37.75 ± 5.06	42.00 ± 00
Daily Weight Gain (gm)	20.73 ± 3.73	3.45* ± 12.06	3.24 ± 5.91**
Carcase Weight (gm)	1044.25 ± 60.30	-	-
Dressing Out % (Empty Gut)	58.20 ±	-	-

Two Rabbits of each sex per group. Rabbits slaughtered at approx 2 kg liveweight.

* On mash presentation one rabbit lost weight and died after 32 days.

** On meal presentation one rabbit lost weight. In both cases rabbits remained on treatment for 42 days and no slaughter data were recorded.

TABLE 2. THE EFFECT OF FEED PRESENTATION ON THE GROWTH PERFORMANCE OF NEW ZEALAND WHITE RABBITS KEPT AT 25°C AND FED ON DIETS CONTAINING 12 MJ/kg METABOLISABLE ENERGY LEVELS (WITH STANDARD DEVIATIONS WHERE n = 4).

FORM OF PRESENTATION	PELLETS	MASH	MEAL
Initial Liveweight (gm)	1468.00 ± 218.56	1427.25 ± 121.87	1393.25 ± 69.39
Final Liveweight (gm)	2072.00 ± 33.33	2111.25 ± 29.49	2192.75 ± 78.76
Growth Period (Days)	19.00 ± 7.57	25.25 ± 4.86	29.50 ± 1.00
Daily Weight Gain (gm)	33.10 ± 4.69	28.00 ± 1.60	26.51 ± 3.65
Carcase Weight (gm)	1111.75 ± 20.65	1171.75 ± 27.00	1220.75 ± 72.07
Dressing Out % (Empty Gut)	58.90 ± 1.89	61.00 ± 0.94	62.45 ± 2.03

Two rabbits of each sex per group. Rabbits slaughtered at approx 2kg liveweight.

TABLE 3 RABBIT PRODUCTION PERFORMANCE DATA FOR VARIOUS DEVELOPING COUNTRIES

Country	Place	No of Litters/Year	No of Live Young/Litter	Total Weaned Doe/Year	Slaughter or Market Weight (kg)	Age at Slaughter or Marketing (Months)
Ghana	Legon	4	5	20	1.6-1.8	4.5-5.5
	Tsito	4	6	24	1.3	?
Tanzania	Moshi	3	5	15	3	6
	Marangu	2-3	4	10	1.8-2	4
	Kilacha	4	6	24	1.2	2.5
	Mtwara	3-4	6-7	23	•	4-5
Nepal	Kathmandu	4	7	28	2	3
	Pokhara	4-5	5-6	22	•	•
Oman	Al Kabourah	5	4	20	•	4-9
Mexico	Chihuahua	3-4	6	21	1.2	2
W Indies	St Vincent	3	3	9	1.5	5.5-6

• In these cases no data were available. In many areas of developing countries livestock or carcases are not weighed before sale.

SOCIOLOGICAL ASPECTS OF INTRODUCING RABBITS INTO FARM PRACTICES

BY

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The experiences that are discussed in this paper are mainly those that have been with the Ghanaian for whom, from time immemorial, rabbit breeding has been a way of dealing with perennial meat shortage. The Ghanaian rural dweller knows the value of meat proteins as proven dietetic requirements and the dangerous consequences of low protein in-take to his bodily development.

Such situation naturally leads to a search for quick producing animals for food. The Ghanaian rural dweller therefore was quick to develop an interest in the breeding of rabbits for food and has historically exhibited no aversion to rabbit-meat.

In Ghana the rabbit is bred in colonies in natural style as a family food animal and used as protein meat of great delicacy. It is popular with the rural folk because it can be fed on grass over which it does not vie with man. The rabbit is a quiet animal, takes little space and increases rapidly. Because of its increasing popularity, back-yard meat rabbit industries are developing in many parts of the country. This is the direct result of the efforts of the National Rabbit Project of the Government of Ghana.

Religion has for long influenced the dietary habits of people. Thus the Moslem does not eat pork and the cow is taboo to the strict Buddhist.

The Ghanaian society has no religious inhibition against the consumption of rabbit-meat which on the contrary is accepted as venison of great palatability and delicacy. Indeed it is so accepted throughout western, central and southern Africa where for thousands of years, rabbit production for meat in colonies in the home-warrens has been an age-old practice. Rabbit-meat for food in Africa can therefore be said to have become a major protein break-through.

Our experiences in Africa also indicate that the ready acceptability of the rabbit into farming practice is due to the fact that rabbit raising is not inhibited by the usual factors that limit the production of large animals. Cattle, sheep and goats need large tracts of land for pasture. They offer strong competition to man for such human food as maize and other cereals. These two factors alone impose severe limitations to the raising of large animals in several parts of Africa. To such an audience as you constitute this does not need further elaboration.

On the other hand, rabbit production requires very little space. The rabbit can eat a wide variety of fibrous plants over which it does not compete with man. The popular acceptance of rabbit raising in many parts of Africa stem from such considerations.

Another circumstance making for the popularity of rabbit raising in Africa is the fact that the rabbit is a safe animal to breed from the epidemiological point of view. The rabbit cannot be accused of spreading such dangerous diseases as anthrax, rinderpest, trypanosomiasis, bilharzia, guinea-worm; it does not carry such dangerous parasites as round or tape worms.

The introduction of rabbits into farming practices has been found to present no health hazards.

Furthermore, cocks crow, sheep and goats bleat, geese and hens cackle and the noisy guinea fowls are most unpopular in the suburbs for the din they raise. But the rabbit does not create a noisy environment. Back-yard rabbit-meat industries are fast developing in Africa on account of these two factors - safety as far as public health is concerned, and the fact that the rabbit is a quiet animal.

The comparatively low capital investment involved in rabbit raising has also contributed to its popularity in Africa especially among the small-scale farmers and back-yard operators. The risk of loss resulting from death has also been found to be low compared with experiences with other farm creatures. On the other hand, the returns are substantial and quick for the market farmer as rabbits multiply fast. All these considerations have made it easy to introduce rabbit breeding into farm practices in Africa.

Let me now return from the general to the particular and elaborate a bit our Ghanaian experience which is at once exciting and challenging. Animal protein supply in the Ghanaian diet has been deficient for years. During the past two decades, meat production has not kept pace with population growth and bush-meat, which supplied a substantial portion of Ghanaian meat requirements in the past is now hard to come by. The country is now faced with the problem of finding alternative sources of meat supply locally to feed the increasing population and help conserve Foreign Exchange.

Among the many measures so far taken by Government to deal with the problem was its decision, six years ago, to promote scientific rabbit production in Ghana. The result was the establishment of the National Rabbit "Pilot" Project in October 1972.

The Project is established on a 32-hectare farm at Kwabenya some 24 kilometers outside Accra. From an original stock of 80 the farm currently houses some 7,000 rabbits. Thousands of rabbits have gone from the Farm to the back-yards of Ghana and the calculations are that some five million rabbits are consumed annually by Ghanaians.

The farm grows its own sugar-cane, sorghum, guinea grass and cassava for rabbit food. It has a staff of about 70 persons of various categories. When it reaches capacity, the farm will have about 3,000 hutches and employ about 200 persons.

However, the success story of the Ghana National Rabbit "Pilot" Project has brought problems in its trail. These stem from the popularity of rabbit-meat and the heavy demand for breeding-stock by would-be breeders. The solution lies in the provision of adequate Foreign Exchange to move the Project from the pilot stage to its final phase. In its determination to encourage protein meat production in Ghana, the Government has done its best to support the pilot phase of the National Rabbit Project, but, as with most developing countries, Foreign Exchange constraints have limited the scope of direct Government commitment.

From the Ghana experience, therefore, the rabbit answers the need for supplementing the protein-meat supply of the African family. No adverse sociological aspects have been observed which militate against the introduction of rabbits into farm practices.

The related problems all seem to revolve on finance, especially Foreign Exchange, for:-

(a) regular procurement of high-grade varieties of stock for reproduction with hardy local breeds;

(b) provision of more enduring hutches;

(c) provision of rolls and rolls of thick diamond-metal floor-mesh for the hutches;

(d) provision of veterinary drugs and additives;

(e) provision of rabbit-feed/pellets and concentrates during the period of acclimatization of imported breeds; and

(f) purchase of portable irrigation machines for the rabbit feed farms.

Given maximum support, the Ghana National Rabbit Project can in turn assist in closing the protein gap by extending aid to farmers and back-yard breeders by way of cheap parent-stock, drugs and additives as well as the extension of information and advisory services.

This paper will not be complete, if mention is not made of another problem we have observed in connection with rabbit breeding in Ghana.

This is also not sociological but psychological and is perhaps international. The problem has to do with extreme affection for the rabbit as a pet by fanciers. For the love of breeding beautiful exhibition animals, some keen breeders cannot bear to slaughter their animals for food or see others kill them to be eaten. It is this expensive luxury attitude that presents a certain amount of problem in Ghana.

But the problem soon solves itself and is solved not by man but the rabbit itself. It is solved by the rabbits' extraordinary reproductive ability! The kind-hearted Ghanaian breeder with open hands make gifts of his over-bred rabbits to members of his extended family and friends, thus unconsciously releasing them for consumption as food once the animals leave his rabbitry.

That problem having taken care of itself, I should like to end by re-stating that no sociological problems militating against the introduction of rabbits in farm practices have been observed in Ghana. In all my years of broiler table-meat rabbit production, I have yet to meet ten people who have an aversion to rabbit-meat as there are thousands in the case of pork. On the contrary, the popular desire by many in Ghana is to experience the palatability of rabbit-meat. Once they have tasted it, like the legendry Oliver Twist, they continue to ask for more!

Thank You.

SOCIOLOGICAL ASPECTS OF INTRODUCING RABBITS INTO FARM PRACTICES

S U M M A R Y

(1) As far as I am concerned, I know of no sociologically adverse aspects for introducing Rabbits into Farm Practices.

(2) If there are problems, they should be related to those underlying factors, namely:-

(a) The need for funds for the expansion of more Rabbit Projects and thousands of back-yard rabbitries in support of the break-through now being experienced and proved in Ghana; and

(b) Aid to the back-yard and commercial breeders by way of cheap parent-stock, drugs and additives to make it possible for more and more people in the slender income group to produce, through the breeding of rabbits, quick and rich protein-meat for their families - thus forcing down the cost of other meats they need to eat for variety and good health.

METHODS OF SMALLHOLDER RABBIT PRODUCTION 1/

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SUMMARY

A number of problems which may impede rabbit production in developing countries are enumerated. The approach of the Bunda College Rabbit Research Project to the problems of housing and facilities, breeding, alternative feedstuffs and disease are described along with examples of possible solutions to each problem. It is concluded that smallholder rabbit production is possible in the Central Region of Malawi but further work must be carried out before widespread introductions are made.

INTRODUCTION

Under high levels of management, a single doe should produce 32 offspring resulting in an output as much as 58 kg edible meat per year (Templeton, 1968). This high productivity, coupled with a ability to produce on feeds which are not in direct dietary competition with humans, gives the rabbit tremendous potential as a source of high quality animal protein. The value of rabbits as meat source in developing countries has been recognized and several projects have been initiated in these areas to promote rabbit production or to investigate methods of rabbit production which are less sophisticated and less capital intensive than the systems used in developed countries (Owen, Morgan and Barlow, 1977).

1/ The work reported in this paper was carried out in collaboration with Dr. P.E. Makhambera under grant G118 from the International Foundation for Science for which the author expresses his sincere thanks.

As noted by Owen, Morgan and Barlow (1977), producers in developing countries raising rabbits using less sophisticated systems than elsewhere will suffer a reduction in productivity. This reduction is, however, acceptable as long as costs do not outstrip returns.

A smallhold farmer in a developing country who wishes to produce rabbits primarily for home consumption with the possibility of some saleable meat will wish to establish his rabbitry with minimum capital input. This means that cages, water and feed dishes and nestboxes should be constructed by the farmer using locally available materials as much as possible. In most cases this will preclude wire cages since suitable wire is expensive and may have to be imported. Where plywood is locally made, the farmer may use this material to construct very good nestboxes if he has suitable skills. Otherwise, alternative provisions will have to be made.

Discarded tins can be used for feed and water, but the problems of rust, spillage and sharp edges when using tins for rabbits have long been recognized. Automatic, piped, water systems are generally out of the question due to lack of running water and glazed crocks are not generally available locally. Self-fed hoppers often are not practical due to the type of ration used.

Once the farmer has his facility, he will require his initial stock of rabbits. These should be hardy, disease free, fast growing, prolific animals which will soon provide output to the neophyte farmer to encourage his continued production.

Assuming commercially prepared rabbit pellets are not available, the farmer will require information on what and how to feed his animals. These feeds should be low-cost and locally available. As far as possible the feeds used should not be those used for human consumption and should be relatively simple to grow. Formulation of complex concentrate mixtures should be avoided and components of the diet should preferably be available year around to avoid frequent changes in diet.

Disease such as coccidiosis, sarcoptic mange or pneumonia may be encountered and advice must be available on how to avoid, control and eradicate these diseases without use of expensive commercial modications.

Finally, the neophyte farmer will require frequent extension advice on his enterprise. Seemingly small errors in management may, over a long period, result in failure of the project. Many questions will arise on how the rabbits should be managed and, the farmer being human, will want to show off the results of his efforts.

The Bunda College Rabbit Research project was established in 1975 to investigate these requirements of the smallhold rabbit producer with the aim of promoting rabbit production among smallhold farmers in Malawi for production of meat for home consumption. This paper is an interim report on the project and describes some solutions which have been found suitable or at least workable. Undoubtedly some will be changed in the future or may be replace by better solutions. Others may be location specific due to dependence on local vegetation or human dietary preferences. Flexibility is one of the important aspects of the Project and being ever-willing to try something new has led to some important advance in the programme.

METHODS OF SMALLHOLDER RABBIT PRODUCTION

Housing

Housing for rabbits must be secure (to keep the rabbits in and predators out), provide protection from the weather, require minimal maintenance, be safe for the rabbits and easy to clean as well as being low cost, of relatively simple construction and of locally available materials.

The climate of Malawi is generally mild with temperatures between 5^{o} and 35^{o} C; the extremes being experienced for only a few days each July-August and October-November, respectively.

Rainfall in the Central Region where the College is located averages about 80cm per year. Most of this falls during the five-month period from November to March. Some areas of the country are hotter, colder, wetter or dryer than stated but these tend to be limited areas and still can be considered "moderate" climates.

Two types of housing felt suitable for smallhold farmers have been developed; the woven bamboo cage and the free-standing modification of the traditional poultry house used in Malawi. Photographs of these were included in the review by latter published (McNitt and Makhambera, 1976).

The bamboo cages are constructed by weaving freshly cut bamboo split into 6 to 8 millimetre withes. The walls are constructed by weaving an oval approximately 80x45cm on the major and minor axes, respectively. The cage is about 45cm deep. The floor was originally constructed of a mat of withes wired together lengthwise as shown by Owen, Morgan and Barlow (1977), but young rabbits tended to catch their legs between the strips so a criss-cross weave with holes about 1.5 cm square was substituted. The top of the cage was constructed of strips of bamboo wired together and attached to the cage so it would roll back approximately half the width of the cage to provide access (McNitt and Makhambera, 1976).

This cage is intended for the producer who intends to keep his rabbits in a building or is willing to construct a shelter surrounded by a fence; probably dried stems of Pennisetum purpureum (Napier grass). The cage is easy to construct using existing technology and requires only a small quantity of light wire. It is easy to clean and allows easy access but continual maintenance is required to replace chewed withes. The woven floor tends to be weak and sags if not well supported externally. If the cages are properly maintained, the rabbits will seldom escape but these cages provide little protection from predators since snakes and rats can enter through the floor and larger predators can easily break into the cage.

The modified poultry unit has been used for over a year in [illegible] from the main unit. Productivity of rabbits in the unit

was somewhat less than for the rest of the herd due to severe problems with sarcoptic mange and coccidiosis. These diseases are especially difficult to control in this unit due to the parasites lodging in the mud of the walls and floor. A new unit has been constructed which includes a woven bamboo ceiling to prevent the rabbits moving from cage to cage. The ground-to-floor distance has been increased to 106cm to provide more comfortable access for management of the rabbits and the individual cage size has been increased.

This unit is relatively inexpensive to construct and uses local materials ans skills. If rat guards are installed on the legs, rat and snake access is reduced and larger predators are more easily deterred by the greater height and stability and the increased security of having woven bamboo exposed only at the door. The unit provides adequate protection from rain expect in extremely heavy, driving rains and stays cool even on very hot days. The primary disadvantage of the unit is maintaining high standards of cleanliness and controlling parasites.

Nestboxes

Most kindling in the main breeding flock occurs in nestboxes contructed of plywood. These are ideal but the cost of materials may deter the smallholder. A pot made by a local potter using local clay and traditional techniques is under evaluation (see Owen, Morgan and Barlow,(1977) p. 16 for a photograph). Our criterion for evaluation is proportion of kits weaned from each litter. The comparison with the wood nestbox has been under way for six months but the results are confounded due to other factors; especially coccidiosis. Preliminary observations in the project herd and by a nearby producer indicate that the pot is reasonably satisfactory although death losses increase in the colder seasons; probably due to chilling of the kits.

Feed and Water Dishes

Owen, Morgan and Barlow (1977) included a photograph of the unglazed clay feed and water dishes used throughout the Project rabbitry. These were constructed of local clay by a potter using traditional techniques. Due to the heavy, flat base, the quantity

of clay required is high. This may lead to increased cost unless the purchaser is willing to supply the clay. These dishes have been used in the rabbitry for over two years and have proven satisfactory in all respects.

Breeding Stock for Farmers

The author is not aware of any reports of wild rabbits occurring in Malawi although two species of hare (Lepus saxatilus, the scrub hare, and Pronolagus crassicaudatus, the red rock hare, are found (Smithers, 1966). Representatives of Oryctolagus were probably brought by settlers and missionairies. Stocks present in the country and in the Project rabbitry are generally mixed although New Zealand White, Californian and Angora breeding is evident.

The Bunda College Rabbit Project is intended to act as a supplier of breeding stock for smallholder farmers wishing to establish rabbitries. No guidelines have been established for development of the stock to be sold although hardy, fast growing rabbits are selected for breeding stock. Efforts are also being made to elimante coccidiosis and sarcoptic mange from the flock so these will not interfere with the development of the smallhoders enterprise.

Feeds

Since locally produced commercial rabbit feeds are not easily available in Malawi, all feeds used in the Rabbit Project have had to be developed at the Project. The concentrate mixtures used for the breeding herd and other rabbits not on feeding trials are shown in Table 1. These concentrates are offered each afternoon and roughages of various types each morning.

Roughages used include vegetable waste, freshly cut Leucaena leucocephala, Amaranthus spp, and Tridax procumbens. Does on this regime in 1977/78 produced an average of 19.4 young per year and growth rates of weaners from 4 to 16 weeks of 15.0 gm per day were recorded in a trial in mid-1978.

Table 1. Rations routinely used in the Bunda College Rabbit Project

	Breeders ration 1/ %	Growers ration 2/ %
Maize meal	39.5	39.5
Maize bran	26.0	16.0
Groundnut oil meal	34.0	44.0
Salt	0.5	0.5

1/ Fed to breeding stock and growers over 16 weeks.
2/ Fed to lactating does and weaners up to 16 weeks.

While these rates of production are satisfactory, the diet itself, particularly the concentrate portion, does not meet the previously stated requirements for a ration since careful mixing is required, groundnut oil meal must be purchased and both maize and groundnuts are consumed by the people. Maize is the staple diet of a large proportion of the population of Malawi with the bran produced as a by-product. The maize bran is not normally eaten and is often sold (in exchange for salt) as livestock feed.

Because of the desirability of a concentrate not requiring mixing and the availability and low cost of maize bran, work has focused on using this as the sole concentrate with the roughage portion of the diet providing the remainder of the nutrient requirements. The proximate analyses of some of the feedstuffs which have been tried in the Project are shown in Table 2. Other feeds which have been used include commercial broiler-grower mash, Napier grass and Amaranthus spp.

Nutrient requirements of rabbits vary with function. Suggested compositions of rations for adult rabbits based on early nutritional studies in Ghana reported by Owen, Morgan and Barlow (1977) were minimal values of 18% crude protein and 3% crude fat and maximal values of 20% crude fibre and 10% ash.

Table 2. Representative proximate analyses of feedstuffs used as rabbit feeds.

Component	Maize bran	Leucaena 1/	Tridax 1/	Rumen contents	Dried blood
Dry Matter (%)	90.0	45.4	12.7	88.9	87.1
Crude protein 2/(%)	11.5	22.1	12.6	21.7	54.8
Ether Extract 2/(%)	7.6	2.9	3.0	4.0	0.6
Crude fibre 2/(%)	7.6	56.3	20.3	22.1	37.7
Ash 2/(%)	5.5	5.0	2.0	10.2	4.7
Nitrogen-free extract 2/(%)	67.8	13.7	62.1	42.0	2.2

1/ Values vary substantially depending on leaf: stem ratios of material analyzed.

2/ Expressed as a percentage of dry matter

Comparing the feedstuffs shown in Table 2 with these requirements, it is immediately apparent that maize bran is deficient in protein but otherwise suitable for rabbits. Leucaena leucocephala, a perennial shrub, and Tridax procumbens a common weed of lawns and distrubed lands, have been tried as companion roughages to maize bran. These were chosen since both continue to grow throughout the long dry period experienced each year in Central Malawi. Results of a preliminary feeding trial carried out in early 1977 to compare three roughages as supplements to maize bran are shown in Table 3. All rabbits were provided with the appropriate roughage each morning and maize bran each afternoon. Both were provided in excess of appetite. Salt and water were available at all times. The rabbits were 4 to 8 weeks of age at the start of the trial and were on the rations for 3 to 8 weeks.

Table 3. Effects of three roughages on growth rates of weaner rabbits

Roughage	Rabbits (No.)	Gain 1/ (gm/week)
Pennisetum purpureum	3	14.6 a
Tridax procumbens	2	35.8 a
Leucaena leucocephala	5	59.7 b

1/ Means followed by different letters are significantly different ($P < .05$).

Leucaena leucocephala appears to be a suitable supplement for use with maize bran while rabbits fed maize bran and Leucaena had signifcantly ($P < .05$) greater growth rates than those fed maize brand and Napier grass while the differences were not significant for rabbits fed maize bran and Tridax. No definite conclusions can be drawn with so few rabbits however. Qualitative experience indicates that Tridax and leucaena are useful roughages for rabbits when fed with the standard rabbitry rations. Napier grass is a low protein-high fibre grass which appears to have low palatability. No further work on this species is presently planned.

Rumen contents often are discarded at slaughter. While the feeding value will depend on the diet of the ox before slaughter, the analysis shown in Table 2 (from oxen which had been fed maize silage, chicken manure, cob meal and maize meal before slaughter) indicate that rumen contents could be useful for rabbit feeds although the dry matter and ask contents are somewhat in excess of the maximum values cited. In early 1978, rumen contents for rabbit feeding trials were collected and sun dried at the College Butchery. A trial was carried out to compare the relative palatabilities of rumen contents and growers ration. After four days acclimatization to the new feeds, the amount eaten in one hour was determined on each of three days when the respective feed was offered as the only concentrate. The average consumption per rabbit for 3 rabbits over three days each was 31.9 gm per hour per rabbit for rumen contents and 43.1 gm per hour per rabbit for growers ration. This difference was not significant. Use of rumen contents in a feeding trial is planned for the near future.

Blood meal is often used as a protein supplement in livestock feeds. The analysis values shown in Table 2 are for sun dried blood collected at the College Butchery. Its value as protein source is apparent although some problems with palatability were noted when fed at very high levels (31 to 50% of the concentrate portion of the ration). Only limited future work with blood is anticipated since blood is a highly prized human food and would rarely be available for use as livestock feed.

A trial was conducted in mid-1978 to compare the growth rates of weaner rabbits fed commercial broiler-starter mash with those fed growers ration. The trial lasted nine weeks starting with rabbits ranging in age from 4 to 9 weeks. During this period, both groups

received freshly cut Leucaena as roughage and water was available at all times. The results are shown in Table 4. The growth rates of rabbits receiving broiler-starter mash were slightly (but not significantly) better than rabbits receiving the growers ration. Perhaps the greatest advantage of the commercial feed is that it contains a coccidiostat thus providing some control of this parasite in the herd.

Table 4. Comparison of two concentrate rations as rabbit feeds after feeding for nine weeks

	Broiler starter mash	Growers concentrate
Rabbits (No.)	7	8
Mean initial weight (gm)	490	490
Mean final weight (gm)	1500	1420
Mean days on trial 1/	62	62
Mean gain (gm/day)	16.3	15.0
S.E. (±)	0.66	

1/ One rabbit in each treatment was on the trial for only eight weeks rather than nine.

Amaranthus spp. (pig weed) has been used as a routine feed in the Project rabbitry but no controlled feeding trials or analyses have been carried out. These are intended when numbers of rabbits permit.

Disease and Parasites

Due to crowded, inadequate facilities for the Project herd, isolation of newly purchased rabbits was not possible during the first two years. As a result, coccidiosis and sarcoptic mange were inadvetently introduced into the herd and both became serious problems.

Attempts to control coccidiosis have included early weaning, rigourous, frequent cleaning of cages and minimization of contact between rabbits. Chemicals used include 0.024% amproluim (Amprol 20%, MSD (Pty) Ltd.,), sulphacholoropyrazine sodium (Coxytrol, A.S. Ruffle, 0.03% a.i.) and sulphaquinoxaline sodium (Embazin, May and Baker). None of these have been entirely successful but moving the herd to a newly constructed rabbitry with all wire cages and regular treatment with Amprol have substantially reduced the incidence of clinical coccidiosis.

Sarcoptic mange generally does not kill the infected rabbits but lesions around the mouth, eyes, anus and reproductive organs may

severely reduce productivity. Early attempts at control included local treatment of lesions with 2.5% toxaphene (Coopertox 75% w/v toxaphene dilute 1:30 in mineral oil) or weekly dipping in 0.25% toxaphene (Coopertox diluted 1:300 in water. Due to toxicity problems with toxaphene rabbits are now treated with gamma benzene hexachloride ointment (Temedex, Burroughs Wellcome) which seems to give good control.

Rabbits are susceptible to attack by fly larvae (species unidentified) which develop under the skin. The hind feet are attacked first and, if not controlled, will spread over the entire body. Squeezing out the larvae or treating the lesions with Temedex provides control.

CONCLUSIONS

Based on the experience of the Bunda College Rabbit Research Project, smallholder rabbit production requiring low levels of capitalisation, utilizing locally available feeds and producing 16 to 20 edible carcasses per doe per year apperas feasible in the Central Region of Malawi. Factors requiring research include housing and facilities, feedstuffs and disease; particularly coccidiosis and sarcoptic mange.

Either the woven bamboo cage or the modified, traditional poultry unit are suitable for housing the rabbits. Which is used will depend on the situation. Plywood nestboxes, if available, are excellent. The value of clay nesting pots is uncertain at this point although offering an interesting alternative. Unglazed feed and water dishes made of local clay using traditional techniques are a distinct improvement over tins.

A ration with maize bran as the sole concentrate and freshly cut Leucaena leucocephala as the roughage is a suitable ration for growing rabbits although the effect of this ration over a long term with breeding stock is yet to be evaluated. Other feeds which may prove useful include Tridax procumbens, Amaranthus spp., dried bovine rumen contents and blood and commercial broiler starter mash. Napier grass is an unsuitable roughage due to low palatability.

Coccidiosis, particularly that caused by Eimeria steidae, is extremely difficult to control or eradicate under less-than-ideal management systems.The necessity for wire cages and chemical treatments for adequate control shows the importance of not introducing the disease in the smallhold situation. The best control for sarcoptic mange has been

obtained with regular application of benzene-hexachloride ointment to freshly scrubbed lesions. Other disease problems should be occasional, isolated cases provided the herd is properly isolated and quarantines are established for newly purchased or ill animals.

Based on the information currently available, field trials appear warranged provided the farmers are carefully selected and have intensive support in dealing with the problems which are certain to arise.

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RABBIT PRODUCTION IN DEVELOPING COUNTRIES

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RABBIT PRODUCTION IN DEVELOPING COUNTRIES

In developing countries the question of food supplies has the highest government priority, since on this depends many other problems especially those associates with health, education, the efficiency of labour and of well being in general.

In most cases hunger has a greater qualitative than quantitative perspective, especially as regards the insufficiency of protein in the human diet, of animal origin, which is the principal cause of a low growth rate in children with consequent on the physical stature and resistence to disease in adults.

The solution to this problem of poor growth in developing countries which do not have adequate means of production, requires a strategy for animal production aimed principally at the great majority of the rural or semi-rural population. In defining of such a strategy is not merely a technical or economic one, above all it is a political decision which depends on the active participation of the people in the production process.

In Mozambique, a developing country, which has had but 3 years of liberty from the Portuguese Capitalist Colonial Domination, the situation regarding food supplies, health and education is extremely serious, a direct result of the selfish politics and inhuman exploitation carried out to extrems by this foreign power.

When FRELIMO party, which is the vanguard of the Mozambican people assessed the situation, it defined the first priority of the Government as the development of the agricultural sector, to provide essential supplies, the most important of which was food.

The eleven million inhabitants of Mozambique have a very low intake of protein of animal origin especially in rural areas, where in many parts it is restricted to game animals.

The cattle, which supply the major part of the meat eaten in Mozambique are raised in only 30% of the country and their meat supplies mainly the urban areas. Studies reveal that 93% of the rural population and 78% of the urban population are deficient in animal protein.

Confronted with this problem the party and the government gave top priority to the rapid development of small species, amongst which the rabbits, for production mainly in communal villages, cooperatives, schools, hospitals, military establishments, etc. In this programmes of livestock production in Mozambique, the rabbit holds an important place because of its special characteristics, such as:

a) Rapid multiplication, low cost of production and the possibility of concentrating production into small areas. Eighty tons of rabbit meat can be produced annualy by 1,100 females on 20 hectares, whereas the same output of beef would require 5,000 cattle and 20,000 hectares under Mozambique's conditions.

b) Good rabbit production technology is perfectly within the ecological and material conditions of the country and can be adapted to little rural or urban production.

c) Good installations using local material can be made, avoiding the dependence on manufactured articles and reducing costs. Installations should be adapted to technical levels from the industrialized urban centres to the rural exploitations for local sale or home consumption.

d) Good nutrition can be obtained from local by-products and natural pastures, without sofisticated technics and variations of concentrates. Besides this, the nutrition of rabbits does not compete with humans.

e) The intensive system of production collectively organized and with high returns in the markets, stimulates the organization of the rural population in communal villages and the scientific investigation of new technics which in turn will contribute to the rational nutrition for animals and men openning new ways of development.

f) The absence of tropical diseases in this species in Mozambique is an advantage over other domestic animals.

g) Rabbit meat is rich in protein, has a low cholestrol content and is easier to digest, which is an advantage to old people, children and the sick.

The implementation of rabbit production in Mozambique is divided into 3 phases:

1 - Technical trials, training of personnel and production of breeding stock.

2 - Installation of regional infrastructure and the collection of data.

3 - Production in collective units.

During the first phase a National Centre was established with the following functions:

1 - The study of the most appropriate technology at different economic levels and climatic conditions.

2 - The standardization of the buildings, breeds and management for each type of technology, e.g.

- Sophisticated technology needing imported material
- Intermediate technology using local wood and netting
- Basic technology for rural areas using all material acquired locally.

3 - Production of breeding stock to supply the various provincial centers, by crossing local breeds with imported males of the Californian and white New Zealand breeds.

4 - Training supervisors, which are essencial for operating the provincial centers and production units. These supervisors will train workers from the production units and other persons engaged in rabbit production.

A manual was produced in the first phase for distribution to the persons responsible for rabbit production in the units. These manuals were written in simple language and profusely illustrated for permanent consultation.

In the second phase we established provincial centers in each of the ten provinces of the country. These centers have the same function as the national center but at a regional level.

These provincial centers function as units of multiplication for the breeding

breeding stock to the units of production. They also function as training centers for the peasants. During this phase a selection of the production units was made. This selection was made through the agricultural regional structures, so they can meet minimum standards to respond positively to the campaign. Their personnel assumed a solid dedication.

In the case of cooperative they must have a high level of organization ability. A part from this characteristic they must have minimum conditions such as:

- easy access so that technical assistance can be continous and effective.

- sufficient water and forages.

Once the cooperatives are selected the peasants come to the provincial centers for technical courses. These courses are at regular intervals for all personnel of the units.

In the third phase of this campaign, called descentralization phase, the peasants return to their units and establish installations in the units. The installations will conform with the basic or intermidiate technology, according to the grade of development of each unit.

Following this stage is the introduction of the animals provided by the provincial centers.

In the beginning these units receive a permanent assistance from the supervisons. This assistance will stop to be continuous when its own production is established and they are able to become endependent.

Following this strategy it will be possible in the next year to make a second selection of more units to be included in the campaign, because the technical assistance for the first group of units are decreasing and can be directed forwards new units.

A NEW METHOD FOR RABBIT PRODUCTION

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SUMMARY

To produce rabbits on a large scale using less labour, they should be kept in large groups for mass services and bred by plan for continuous production. Owing to the behaviour patterns of rabbits, it is very difficult to keep them in large gangs peacefully except in accordance to their sex, age and physical condition. Therefore the "Penta-Sectional Grouping System" was introduced along with the "Rotary Breeding Plan" which make fuller use of the rabbit housing, easy division of labour, routine work and ease of operation.

REPRODUCTIVE BEHAVIOUR IN RABBITS IN RELATION TO THE NEW SYSTEM

Generally, rabbits kindle after thirty-one days of gestation. Gestation starts immediately after mating. When a rabbit is kindling and gets shocked by an intruder or an unusual noise, it tries to destroy the young and run away from the place. Before kindling, the Doe finds a secluded place and makes a nest. Thirty days after kindling the Dam starts restricting the young from sucking. After six weeks, the young should be weaned. The Dam takes two weeks to regain weight and then will be ready for mating again. At eight weeks it is very easy to identify Bucks from Does in the young. At fourteen weeks to sixteen weeks, the testicles appear to be well developed. Although by nature rabbits live in groups, they have their own social systems and rabbits violating these suffer biting from the stronger. When a Doe is receptive to the male, it looks for and starts climbing the back of the Buck even if the Buck is ready to mount her. Where there is no Buck, it will mount her fellow Does. Similarly when the Buck is matured, it mounts any rabbit, young or old, Buck or Doe and in such circumstances fighting erupts.

These observations prompted the development of the new system.

THE PENTA-SECTIONAL GROUPING SYSTEM

In this system there are five main sections in which the rabbitry must be divided. These are:

1. The Quarantine
2. The Weaners Section
3. The Mating Section
4. The Kindling Section
5. The Colony Section.

Every section has a specific part to play in the production network and careful integration is necessary for proper commercial husbandry.

1. The Quarantine

This is an isolation base and is very much important in animal husbandry. This section must be roomy enough to accommodate the different possible cases to be treated at any one time. It is however advisable to make it out in cubicles for individual accommodation as isolation cases may be treated here.

2. The Weaners Section

This section is meant for very young rabbits that are weaned from the kindling section. The weaners alone can stay together in large groups. These should be organized according to age, size, weight and health.

3. The Mating Section

This section is meant for breeding only. The Bucks are kept here permanently in a cubicle each and the Does are brought here for breeding.

4. The Kindling Section

This section keeps heavy Does for at least three days before they kindle. Four or more weeks could be spent here with the young before weaning. This section must be made up of cubicles designed to take one or two Does and their young only at a time.

5. The Colony Rearing Section

This section can take large groups of rabbits. The groups or colonies in this section are production stock grouped into light and heavy Does, and sales stock grouped into Bucks, Does and table rabbits.

This system of grouping is based on sex, age and physical conditions. Neglect of these factors will result in restlessness and fighting among any group of animals especially rabbits. Also with this system, it is possible to use expert rabbit husbandry to increase production by weaning bunnies earlier than natural, to allow the Dam to regain weight quicker for programmed mating and production. It is easy to make mass visual inspection and spot out weak ones immediately. Service is easier and production is precise. It is not difficult at all to operate the system since it is a matter of transfers from colony to colony according to a specific order and time in relation to their biological conditions.

Apart from daily sanitary practices, watering, feeding and other production operations, the operation involves weekly weaning of bunnies from the kindling section to the weaning section; transfer of young to their sex groups at the sales stock section; Dams to the light Does section; heavy Does to the kindling section; mated Does to the heavy Does section; and castrated Bucks to the table stock section.

HOUSING ARRANGEMENT

Incorrect housing arrangement is another important way of minimising inefficiency in production, labour and excessive paper recording. There are many types of housing that are suitable for rabbits depending on climate and size of breed to be kept. Thus we cannot be strict on dimensions and materials. However, whatever materials or style which may be used in housing, it is necessary to divide the rabbitry into two sections, i.e. the Production Section and the Sales Stock Section adhering strictly to the principles of the "Penta-Sectional Grouping System".

The Sales Stock Section, which must be designed to accommodate what can be produced by the production Does in six months 1/ (assuming each Doe litters average five young every quarter) must be further divided into the following groups:

The Table Buck group for castrated Bucks, table Does for matured Does that are not needed for production or are too old for breeding. Breeding Does group for young Does that may be sold for breeding and Breeding Bucks groups for young Bucks not yet castrated.

1/ Most people in this area like a carcase from a rabbit six months of age. Also enough room should be provided in case the average litter per Doe rise above five.

In fact, in all commercial rabbitries' Sales Stocks sections must be arranged in the above manner otherwise they cannot be kept in intensive groups which is the major key to cutting down operational labour costs.

The Production sections, however, are not the same. There are three methods of production housing arrangement. The first of which should be called subsistence rabbitry, is to keep each producer Buck or Does in a cubicle. There should be one Buck to every six Does and there should be special recording of date mated, kindled and weaned associated with each producer Doe. Strictly the Doe must be sent to the Buck when it is to be mated. After the mating the Doe must be sent back to its own cubicle. When it kindles, the young rabbits must remain with the Dam for eight (8) weeks before weaning. Immediately after weaning the young rabbits are sexed and sent to Sales Stock section and the Dam is sent for mating. This is called "subsistence rabbitry" because the labour involved in the operation is so high that the return on the working capital cannot allow for expansion and repayment of constructional expenditure.

The second method of housing arrangement which we call the commercial rabbitry has in the Production section intensive groups of light Does which are the matured Does to be mated. Four heavy Doe gangs are arranged in sequence: A, B, C and D, or 1, 2, 3 and 4. These are Does mated over the weeks and waiting to be taken to the Kindling section. It also has a Mating section with matured Bucks ready in their own cubicles to mate with any Doe that enters, a Kindling section and a Weaners section.

The light Does section must be large enough to contain one-quarter of the production Does. The four heavy Doe groups must contain one-twelfth each of the Does. The Mating section must contain one Buck to ten Does. This must be sited so that their scent will not flow directly to the light and heavy Does 1/. The Kindling section which should have cubicles for each heavy Doe must be arranged into six groups, each group to contain one-twelfth of the Does. The Weaners section also must be arranged into four groups, each to contain what can be produced weekly.

With this system, the Does stay for only six weeks at the Kindling section when they would have littered and finished lactating. The hutches can then be cleaned and new heavy Does brought in. Thus eight litters a year can be obtained in one cubicle.

1/ The scent of the receptive Doe causes restlessness in the Bucks while the scent of the matured Buck causes restlessness in the light Does, fear and anxiety in the heavy Does and subsequent mishaps.

Considering the cost involved in construction of the cubicles, it will be found that it is more economical to make fuller use of them. Also considering the labour and attention it takes to keep a rabbit in a cubicle, it will be found that the intensive groups of weaners, light and heavy Does help to reduce labour to the minimum. And these are the reasons why we describe this system as a "Commercial Rabbitry".

There is not much difference between method two and method three, except that the kindling hutches are so designed to accommodate two heavy Does in a cubicle at a time. Thus sixteen litters can be obtained in one cubicle in a year. More attention is needed at this Section so as to avoid shortage of feed and water in the hutches. It has been discovered that the Does do not discriminate between litters when feeding. Therefore this system is more advantageous in that, when one of the Does is producing insufficient milk, the other will often feed both litters which results in less mortality. Owing to the tendency of rabbits to fight, it is not recommended that more than two pregnant Does are kept in one cubicle at a time.

Production management in methods two and three are the same and the system is described as "Rotary Breeding".

In "Pairing", which is the only difference between the two, attention must be given to the physical condition of the rabbits. They must all be at approximately the same stage of pregnancy, have similar body size, be similar types of breeds and have similar physical fitness. Incorrect pairing results in fighting, starvation of the weaker individuals and increased prenatal mortality.

Any problem involving incompatibility between Does using the same cubicle should be noted and dealt with well before kindling. Experience is especially important in the management of this system.

THE BREEDING PLAN

The advantages of the Penta-Sectional Grouping System are:

- High levels of production;
- Continuous production and supplies of meat rabbits;
- Easier and less labour;
- Precision.

With the above points in mind the "Rotary Breeding Plan" can be described.

Rotary Breeding

To produce rabbits in large numbers many Buck and Does are needed. According to experience in the unit described in this paper, the Does reproduce quarterly and they must be kept in seclusion before kindling. Therefore, if all the Does should be mated at the same time individual accommodation would be needed for each of them. Also, large numbers would have to be sold at intervals rather than on a continuous and steady basis. In this way the work force would be subjected to alternating periods of full and under employment. Also certain equipment would be left idle for periods of time.

With the Commercial Housing arrangement recommended here, adherence to the following plan of action will remove any unnecessary waste and give massive, continuous, and precise production with a very low labour cost.

Stage I

According to the arrangement of the production section, it will be found that the light Does, heavy Does and the Kindling sections have been divided into eleven groups. The light Does section must take one-sixth of the production Does, the remaining five-sixths must be divided equally among the remaining ten groups. This means the production Does have been divided into twelve groups, two groups living at the light Does section at a time; and that is the twelve weeks forming the quarter. The animals should be arranged within the rooms accordingly.

Stage II

The first groups from the Kindling section should be sent for mating and returned to their cubicles from the third to the seventh days of the week. As a guiding principle, they must be mated on two consecutive days of the week. It is advisable not to choose the first two days of the working week. This is because the days following a week-end are usually particularly busy, and less attention can be devoted to the supervision of mating. The groups are crossed weekly, in the sequence A, B, C, D, E and F, or 1, 2, 3, 4, 5 and 6. In these starting stages of the rotary breeding system, after the fourth mating section, the first group of the Kindling section should be prepared for kindling.

Stage III

At the end of the sixth mating session, it will be found that the first group has kindled and the young rabbits are about one and half weeks old. The rabbits from the mating section are then moved to the heavy Does section. After mating the fourth of the last group of heavy Does section, it will be found that

28 days have elapsed. But because they were not mated on the first two days of the week, the first group crossed at the heavy Does section will be twenty-six days pregnant and the last group will be twenty-one.

If the plan laid down here is followed the situation where the Does kindles in the colony (group range) will be avoided. The first young littered in the Kindling section would then be thirty-seven days old and the last in that group would be thirty-two days old.

The young rabbits can then be weaned and passed to the weaners section where they will have special attention including treatment with prophylactic drugs and feeding with vitamin supplements for fast development. The Dams should also be transferred to the light Does section and the cubicles then sanitised for the arrival of transferred heavy Does. These should be done in the first two days of the working week.

Stage IV

After the first two working days of the week, one twelfth of the production Does should be sent from the light Does section for mating and then to the empty and sanitised heavy Does section, from the third day to the seventh working days.

From this time onwards, one twelfth of the Does should be mated and passed to the heavy Does section in sequence during the course of a working week. Transfers to the weaners section should also be in sequence and when a group of weaners completes four weeks at the section it must be sexed and transferred to the Sales Stock section.

The following programme of transfer would eliminate excessive paper recording and make operation easy for the attendant:

General programme of transfers

First day of the working week:

From: (a) Kindling to light Does section;
(b) Kindling to weaners section;
(c) Weaners to Sales section;
(d) Castrated Bucks to Table section;
(e) Culled Does to Table section.

Second working day of the week:

From: Heavy Does to Kindling section according to the sequence of mating.

Third to the seventh working days of the week:

One twelfth of the successfully mated Does should be moved to the heavy Does section in sequence.

It should be carefully noted that confusion in the sequence of transfer may result in the Doe kindling in the wrong places and young rabbits being weaned at the wrong times.

It is believed that as time goes on, experience will result in the introduction of innovations which will improve the basis system described here. The only recording necessary with this system is concerned with the number of Does kindling daily, mortality, number sold and balance of stock in hand. Records should also indicate the approximate ages and physical conditions of the various sections and groups.

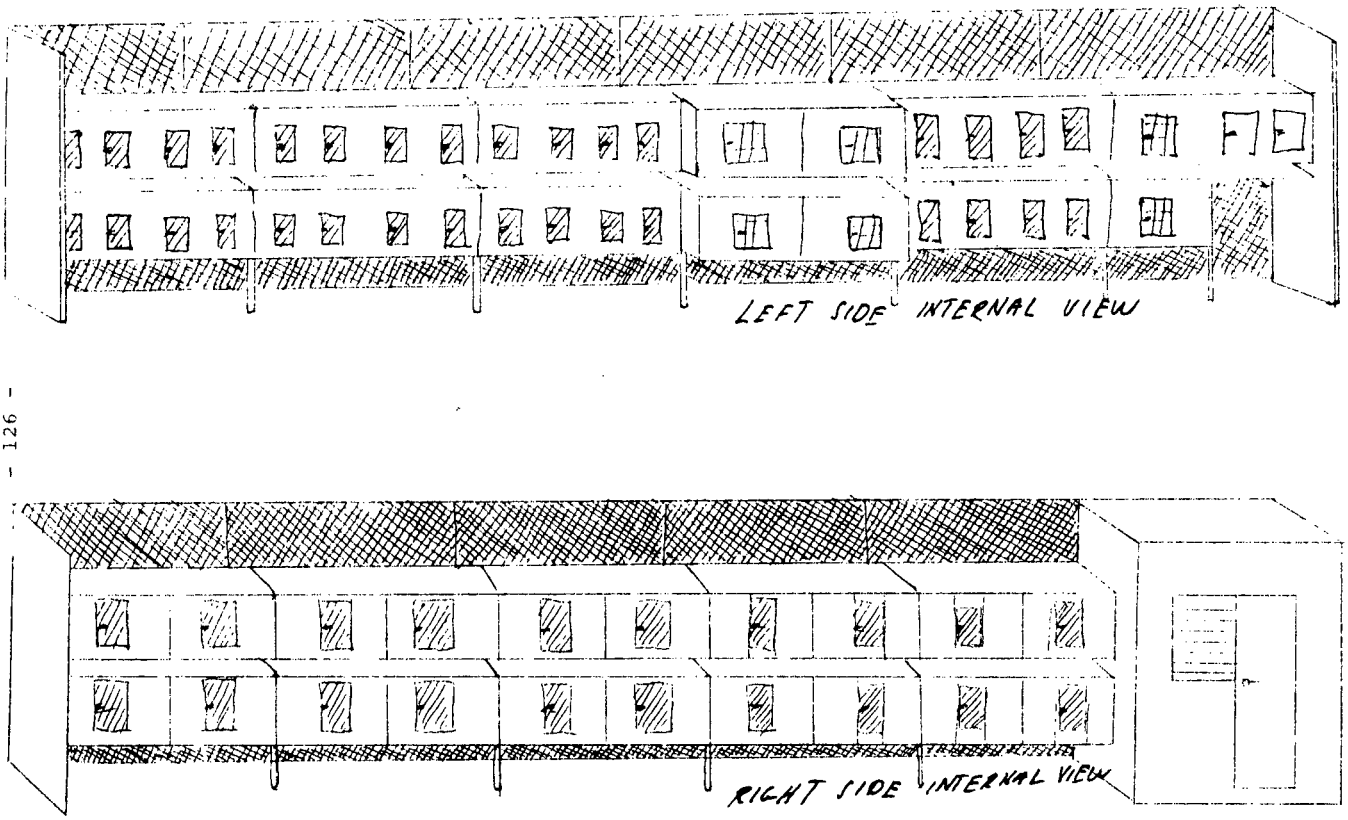
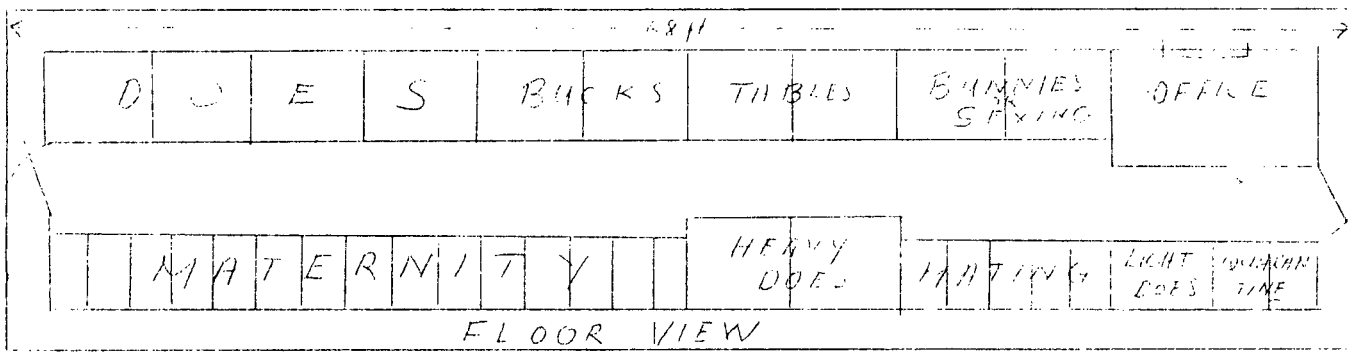
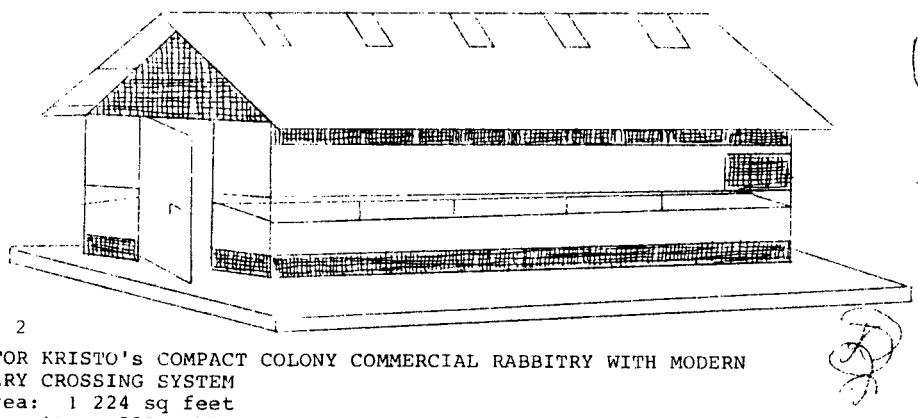


Fig. 1





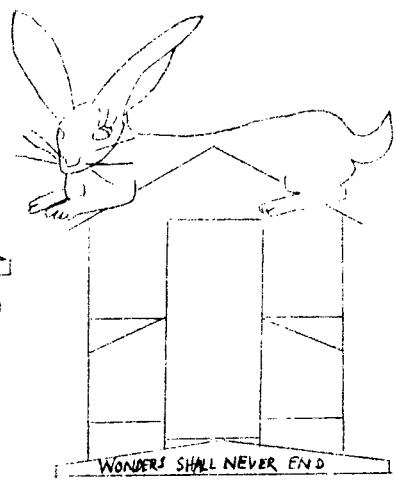
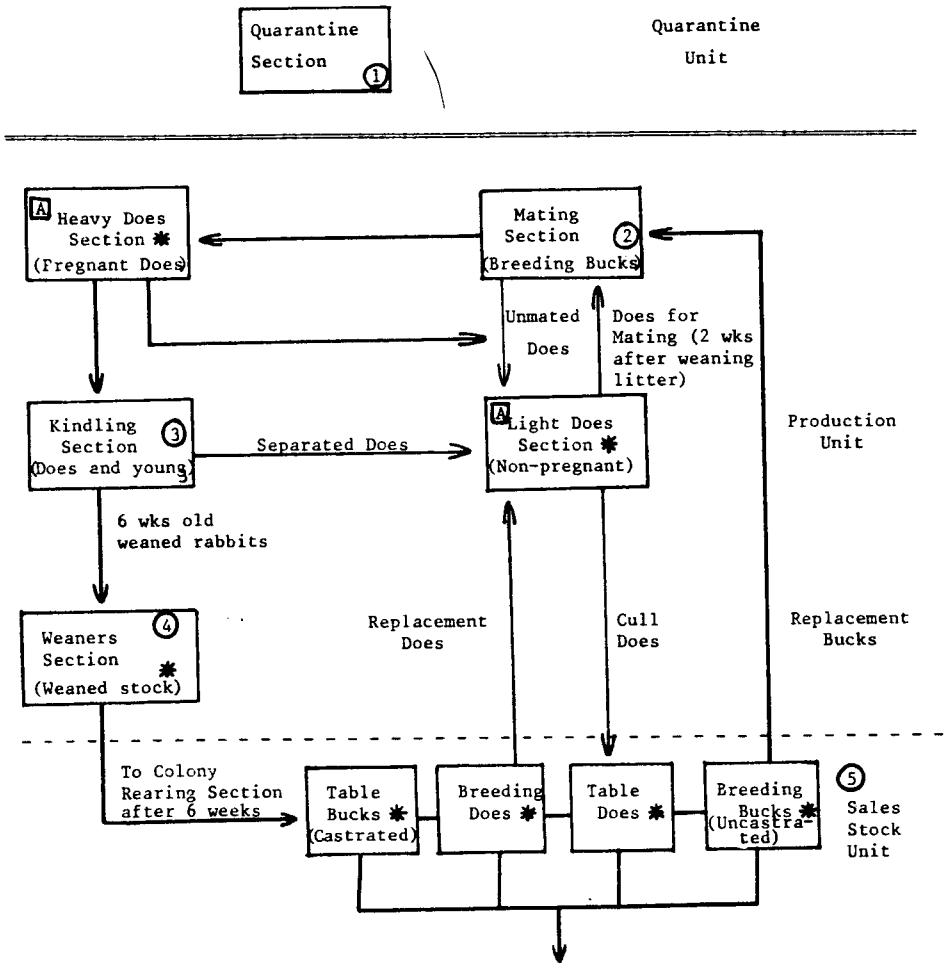


Fig. 2

PASTOR KRISTO's COMPACT COLONY COMMERCIAL RABBITRY WITH MODERN ROTARY CROSSING SYSTEM
Area: 1 224 sq feet
Capacity: 580 rabbits
Production capacity: 80-120 monthly
Durability: 10 years minimum. Major material: iron, wood and cement
Features: Automatic feed boxes, records office and feed storage
Temperature controlled

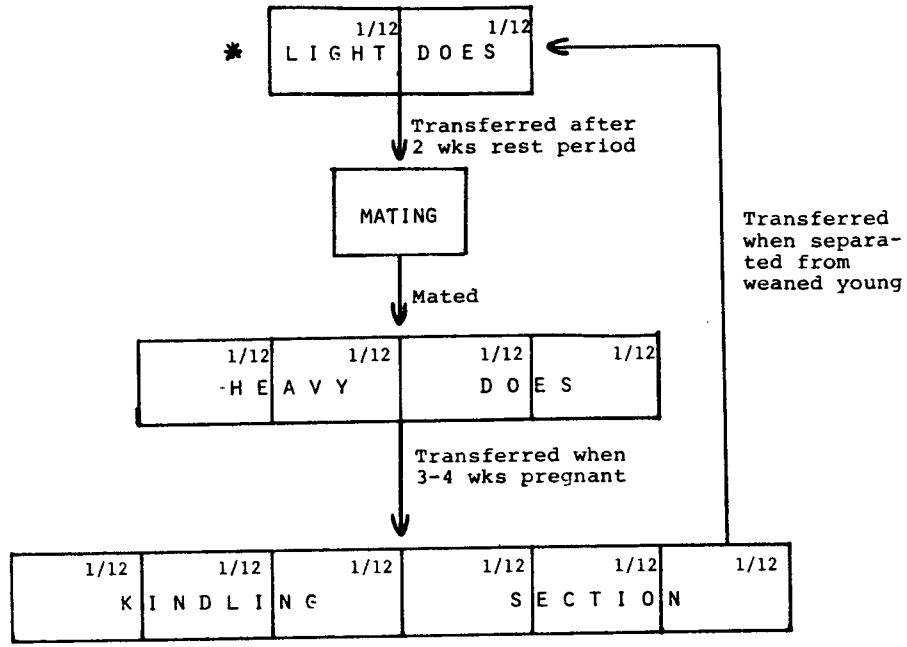
Fig. 3: THE ROTARY BREEDING PLAN AND GROUPING SYSTEM



✱ - Signifies that the rabbits are kept in groups or gangs. All others in single cubicles.

① - ⑤ - Five major sections (penta sectional grouping system).

Fig. 4
SYSTEM OF DOE TRANSFERS IN THE ROTARY BREEDING PLAN



✱ - Light does section must be large enough to house 3/12 of the production does.

Explanatory note

Each week 1/12 of the production does are transferred from the kindling to the light does sections. A group of does equivalent to 1/12 of the total are then moved from the heavy does to the kindling section, thus occupying the vacated space. For a time the light does section holds 3/12 of the total number of does, which is why it must be large. 1/12 of the does are moved from the light does section through the mating section to the heavy does section, leaving 1/6 of the does in the light does section at the end of the week.

The number of does mated at any one time depends on the space which will be available in approximately one month's time.

NEW FOOD RESOURCES FOR RABBITS IN MAURITIUS

by

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REDUIT - MAURITIUS

SUMMARY

The possibility of using Saccharum officinarum, Leucaena leucocephala, Stenotaphrum dimidiatum, Chloris gayana and Pennisetum purpureum was studied. In the first experiment all these species were compared with a prepared standard feed. There was no significant difference between the standard diet and Saccharum spp. and Stenotaphrum spp. Leucaena sp. proved to be better than the standard diet. In the second and third experiments with different levels of Saccharum sp. and Leucaena sp. results showed that the replacement of up to 40% of the standard diet in growing rabbits seems to be possible without affecting the performances of the animals.

The major task in the field of Rabbit Production in Mauritius since 1977 has been to investigate into the causes of the fast declining industry. Three major rabbit enterprises were compelled to close down (1). In 1975, there was an estimated number of 17,000 rabbits (2). This was reduced to less than 5,000 (3) by the end of 1977. During the past three years the Ministry of Economic Planning has invested and lost over half a million rupees during an attempt to encourage rabbit keeping as back yard farming. In this direction, the main effort at village level has lied with the Young Farmers' clubs and Agricultural Youth Clubs.

The problems have been those of husbandry, disease and nutrition. Most of the time spent during 1977 and 1978 by the investigator has been on improving upon the general management, including housing and combating the prevalent diseases. There has subsequently been a marked improvement in the survival rate. Mortality rate which was found to be over 80% (signalled in 1977 to International Foundation for Science) was reduced to nearly 10% at the place of investigation before works on nutrition were started.

Nutrition studies became necessary when a survey revealed that New Zealand White and Chinchilla rabbits kept under village conditions on grasses gathered from the adjacent sugarcane fields, took up to nine months to reach a weight of 2500g. On the other hand, the Ministry of Agriculture sells to rabbit keepers N.Z.W. rabbits weighing about 2500g after five to six months. The Ministry uses mainly sweet potato leaves, Setaria spp. and Stenotaphrum spp. supplemented by concentrate manufactured by the Government Livestock Feed Factory containing the following ingredients: Groundnut cake, maize, cotton seed (all three being imported), Dicalcium phos, molasses, vitamin mineral supplements with an overall protein content of 18.7%.

The primary step was therefore to import a complete rabbit feed which could then be used both as a standard diet and to boost up the nutritional status.

Coincidentally, at the beginning of 1978, a new private commercial feed factory became operational and has provided a reasonable complete rabbit feed using Lucerne, Wheat bran, Fish meal (all three being imported), Limestone, pre-mix vitamins and minerals as ingredients and with the following composition: Protein (min 16.0%, Fat (min 2.5%, Fibre (max) 17.0%, Calcium (max) 1.5%, Phosphorus (min) 0.7%.

Although the growth rate has improved (rabbits reached 2500g in three months), the cost is far above what the farmer can afford. Consequently, the few remaining commercial rabbit producers are seriously thinking of closing down their business (4).

The aim of the investigation is to find out the growth rates using locally available substitutes for the imported ones to ultimately produce a feed that will be both cheap and comparable with the standard diet while still producing an acceptable growth rate.

The work studies the possibility of incorporating new products, rich in protein and energy, so far not utilized to meet the nutritional needs of growing rabbits. The values of these products cannot be judged solely by their composition. In fact, the performance depends on all nutritional elements and their interaction. Only an experiment carried out directly on the growing animals will enable us to determine the extent to which these products can be used as rabbit feeds. The species selected were Saccharum officinarum, sugarcane; Leucaena leucocephala, Mauritian Acacia; Stenotaphrum dimidiatum, Herbe Bourrique; Chloris gayana, Mauritian variety; Pennisetum purpureum, Mauritian elephant grass. They are commonly available, abundant, with high yield and can easily be cultivated.

Experiment I

Thirty six of almost equal weights with age ranging from forty-five to fifty-two days. N.Z.W. rabbits, were divided into six groups with six animals in each group, each animal kept in a separate cage. The treatments were as follows:

Group I - Complete Rabbit Pellets (CRP)
Group II - 50% CRP + Saccharum spp. (Ad lib)
Group III - 50% CRP + Leucaena spp. (Ad lib)
Group IV - 50% CRP + Stenotaphrum spp.(Ad lib)
Group V - 50% CRP + Chloris spp. (Ad lib)
Group VI - 50% CRP + Pennisetum spp. (Ad lib)

An electrical humus chooper was used to grind the sugarcane. The other species were fed without physical modification.

Proximate analyses gave the following information

TABLE I

Species	Moisture	C.P.	C.F.	Ether Extract	N.F.E.	Ash
Saccharum	74.5	1.7	24.6	3.6	70.1	0.5
Leucaena	77.1	28.0	12.5	4.6	49.2	56.0
Stenotaphrum	79.2	14.0	28.0	4.1	47.9	6.0
Chloris	79.0	6.7	29.3	2.7	53.3	8.0
Pennisetum	87.1	13.0	27.0	5.6	43.4	11.0

RESULTS AND DISCUSSIONS

TABLE II - Liveweights and Daily Liveweight Gain

Group	LIVE WEIGHTS (group Average) Initial (g)	Final (g)	D.W.G. First (15 days)	Second (15 days)	Final (30 days)
I	795	1805	31.8	39.0	33.7
II	800	1745	35.4	31.4	31.5
III	805	1960	43.9	37.5	38.5
IV	790	1771	34.3	37.2	32.7
V	792	1587	26.1	32.0	26.5
VI	807	1677	32.9	30.7	29.0

During the first fortnight the daily weight gain was the best in case of Acacia, followed by sugarcane, Stenotaphrum, elephant grass and Chloris. However, in the third and fourth weeks, the daily weight gain for pellets surpassed the rest. However, rabbits on Acacia and Stenotaphrum performed fairly well.

At the end of the experiment, results of a randomised block design analysis showed no significant differences between Group I and Groups II and IV. But there were significant differences at 5% level between Group I and Groups III, V and VI.

The mean difference between the groups were as follows:

For Groups I and III..... 4.83
For Groups I and V 7.17
For Groups I and VI 4.67

It can be assumed that Leucaena sp., Saccharum sp. and Stenophrum sp. can be used to cut down the use of the complete rabbit pellets by 50%. The performance of Pennisetum sp., having a high protein content, would have been improved had it been ground with the humus chopper. Rabbits found the ground elephant grass more acceptable. The good performance of sugarcane may be attributed to its high energy content and an adequate amount of protein obtained from the pellets.

Animals from each groups were slaughtered and no abnormality was found in the carcases.

The experiment was not carried out for longer period for technical reasons and it has to be observed that the results and conclusions are based on only one experiment which in the opinion of the investigator is a pilot trial.

Experiment II

Thirty N.Z.W. rabbits of almost same weight and weaned at forty days were divided into six groups with five animals randomly allocated to each group. Each animal was housed in a separate cage. The groups received the following treatments:

Group I - 100% Complete Rabbit Pellets (CRP)
Group II - 80% CRP + Saccharum spp. (Ad lib)
Group III - 60% CRP + Saccharum spp. (Ad lib)
Group IV - 40% CRP + Saccharum spp. (Ad lib)
Group V - 20% CRP + Saccharum spp. (Ad lib)
Group VI - only Saccharum spp. (Ad lib)

The sugarcane fed was ground with an electrical humus chopper. Water was provided in semi-automatic drinkers. The experiment was carried out for eight weeks until the rabbits were 96 days old.

RESULTS AND DISCUSSION

TABLE III. - Liveweight (group average) and Daily Weight Gain

Group	I	II	III	IV	V	VI
INITIAL WEIGHT (g) at 40 days	640	636	650	645	642	635
DGW(g) for 1st	33.5	32.0	30.1	23.2	15.5	6.5
WEIGHT at 69 days (4 weeks)	1579	1532	1493	1295	1073	817
DGW(g) for 2nd 4 weeks	27.7	27.0	27.3	15.6	7.7	1.9
FINAL WEIGHT(g) 96 days	2354	2288	2257	1731	1296	870
DGW(g) for 8 weeks	30.6	29.5	27.7	19.4	11.6	4.2

Throughout the experiment the growth rates decreased with the decreasing percentage of CRP used. With each animal caged separately a randomised block design analysis using six treatments and five replicates was carried out.

There was no significant differences between Group I and Groups II and III. There were, however, significant differences at 5% level for 20 d.f. between Group I and Groups IV, V and VI.

The mean differences between the groups were as follows:

For Groups I and IV ... 11.2
For Groups I and V ... 19.0
For Groups I and VI ... 26.4

Table III shows that the group fed with pellets alone performed slightly better than that fed with sugar cane, ad lib, supplemented by 80% and 60% pellets. However, it can be assumed that sugar cane can be used to cut down the use of the complete rabbit pellets by 40%. Sugarcane may be used with 40% CRP to produce rabbits weighing 2500 g by around four and a half months. Sugar cane supplemented by pellets below 40% level would produce slow growth rate. Some rabbits in Group V showed signs of alopaecia. Others, on sugar cane alone, started losing weight by the end of the experiment.

However, animals slaughtered from each group showed no abnormality in carcase quality except for those of Groups IV which were skinny and bony.

Experiment III

Forty-eight N.Z.W. rabbits of almost same weights and weaned at forty-two days were divided into six groups with eight animals randomly allocated to each group. Each animal was housed in a separate metallic cage. The first group received 100% complete rabbit pellets (CRP) while four groups were given Leucaena leucocephala (Mauritian Acacia) ad lib, supplemented by 80%, 60%, 40% and 20% CRP in respective groups. The last group was fed with only acacia. Water was provided in semi-automatic drinkers. The experiment was carried out for eight weeks until the rabbits were ninety-eight days old.

RESULTS AND DISCUSSIONS

TABLE IV. - Liveweights (group average) and Daily liveweight Gain

Group	I	II	III	IV	V	VI
INITIAL WEIGHT(g) at 42 days	703	682	692	685	699	687
DWG(g) for 1st 4 weeks	32.7	36.2	31.5	27.3	20.9	10.1
WEIGHT at 70 days	1620	1695	1574	1449	1285	770
DGW(g) for 2nd 4 weeks	25.4	20.9	22.6	22.7	13.4	8.9
FINAL WEIGHT(g) at 98 days	2330	2281	2207	2085	1661	1219
DWG(g) for 8 weeks	29.1	28.6	27.1	25.0	17.2	9.5

In the first month, the growth rate of rabbits fed on 80% CRP was the best followed by those fed on pellets alone. On the whole, the growth rates decreased with decreasing percentages of CRP used. With each animal caged separately it was possible to carry out a randomised block design analysis using six treatments and eight replicates.

There was no significant differences between Group I and Groups II and III. There were, however, significant differences at 5% level for 35 d.f. between Group I and Groups IV, V and VI.

The mean difference between the groups were as follows:

For Groups I and IV ... 4.06
For Groups I and V ... 11.88
For Groups I and VI ... 19.56

Table IV shows that the group fed with pellets alone performed slightly better than that fed with Leucaena spp., ad lib, supplemented by 80% and 60% CRP. However, it can be assumed that Leucaena leucocephala can be used to cut down the use of the complete rabbit pellets by 40%. The use of Mauritian acacia supplemented by 40% and 20% CRP would depress the growth by 14% and 40.9% respectively. Mauritian acacia may be used with 40% CRP by rabbit keepers who should then by expected to produce rabbits weighing 2500g by around 115th day and with 20% CRP the same weight can be obtained by around five months which is comparable to the present performance of rabbits at the Ministry of Agriculture and which is better than the performance of rabbits kept under village conditions.

No rabbits showed any signs of alopaecia or diarrhoea. There was also no death or mimosine toxicity symptoms as reported from works done on other animal species (5) and (6). Animals slughtered from each group showed no abnormality in carcase quality.

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Reproductive Performance of Rabbits Selected for Post-weaning Growth Rate

By

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Introduction

There is a special relationship between litter size and body weight. This relationship can be divided into 2 parts:

a. The relationship of the dam and her litter.

b. The relationship amongest the members of the litter.

Several studies reported on litter size in rabbits (Sittman, Rollins, Sittmann and Casady, 1964; Rollins, Casady, Sittmann and Sittmann, 1960; and Venge, 1963) and in various other species have indicated a favourable positive phenotypic correlation between post-weaning growth rate of the dam and the litter size she produces. It would be rather difficult to know the exact nature of this correlation because of the associated environmental artefacts mediated through the

dam (Castle, 1929; Venge, 1950; Yao and Eaton, 1954; Rollins and Casady, 1960; Leplege, 1970; Macarthur, 1949; Falconer, 1953; Bradford, 1971; and Wilson, 1973). Therefore, selection for increased growth rate is expected to increase litter size at birth. On the other hand, Doolittle, Wilson and Hulbert (1972) and El Amin (1974) showed that young born in larger litters tend to be smaller at birth and at weaning. Thus, selection for an increased post-weaning growth rate will produce larger litters but with smaller individual birth weights.

The present work is undertaken to show some litter traits and their association with other closely related characters. This will be useful in supplying information about their inheritance and about factors influencing them.

Material and Methods

Two strains of rabbits were obtained for this experiment. The first designated as NR, was a pure New Zealand White (NZW). The second strain, called PS, was a Californian breed. The New Zealand White strain was divided into 3 lines selected for different traits while the Californian strain was divided into 2 lines. The following description summarizes the lines on the selection criteria:

Line No.	Line designation	Description
1	GR	Selected for rapid post-weaning growth rate from NR strain.
2	GRX	Selected for rapid post-weaning growth rate initiated as a cross from GR males and PS females.
3	CL	Random bred control from NR strain.
4	PS	Random bred control from PS strain.

The means and standard deviation are presented for the traits studied. Males were mated to a group of 3 does each.

Results

a. Litters produced:

The number of does kindling and those weaning a litter each generation x lines is shown in Table 1.

Table 1. Number of does kindling[a] and weaning litters[b] by generation and line

Line Gen.	GR a	GR b	GRX a	GRX b	CL a	CL b	PS a	PS b
1	50	(34)	-		with GR		10	(6)
2	18	(17)	12	(9)	18	(14)	11	(9)
3	18	(17)	18	(17)	17	(16)	11	(8)
4	18	(16)	17	(15)	16	(15)	10	(9)
5	15	(13)	15	(14)	14	(9)	-	

Since lines GR and CL originated from the same base, they were considered together in generation 1 under line GR for does weaning a litter.

The propertion of does which failed to wean a litter because it was either stillborn or lost prior to weaning varied between lines and generations. The largest loss was at generation 1 where only 68% of the does which kindled raised their litter and 32% lost their litters (Table 1). This has declined to less than 10% in later generations.

Litter size born has shown an increase in all the lines over the first two generations (Table 2). In all lines, there appears to be an upward trend in litter size when comparing the first and fifth generations except for the control, which remained almost at the level of the base population. The low values obtained for the GRX line in generation 5 could be due to sampling since fewer does kindled in that generation. Fig. 1 depicts the fluctuations which occurred in the average litter size in all lines and generations. The most prominant feature of the graph is the drop in mean litter size of the GR line at generation 4.

The overall mean litter size born for the first 4 generations was 7.30 young per litter while the number born alive was 6.84 young per litter.

The frequency of litter size born in each line in the different generations and the total of all lines and all generations are plotted in a histogram (Fig. 2). From the histogram we can see that the most frequent litters encountered were those with 6, 7 and 8 young per litter. In the lines where there was selection for growth rate (histogram 2F and G), there seem to be more litters with larger size then in the other lines. The crossbred line (E), also has its

Table 2: Average litter size born[a] and litter size born alive[b] in each line and generation.

Line / Ger.		GR	GRX	XL	PS
1	a	6.43 ± 2.31	-	with GR	6.21 ± 3.01
	b	(5.73 ± 2.90)	-		(5.96 ± 2.91
2	a	6.84 ± 3.10	7.00 ± 2.90	7.26 ± 2.56	5.90 ± 2.69
	b	(6.11 ± 3.07)	(6.69 ± 3.08)	(5.74 ± 2.70)	(5.60 ± 2.50)
3	a	8.72 ± 3.14	8.73 ± 2.30	6.47 ± 3.06	6.67 ± 3.00
	b	(7.94 ± 3.40)	(7.95 ± 2.52)	(6.23 ± 3.47)	(5.86 ± 2.90)
4	a	6.36 ± 2.80	8.83 ± 3.67	7.06 ± 3.54	7.10 ± 2.90
	b	(5.56 ± 3.18)	(7.33 ± 3.27)	(6.11 ± 3.85)	(6.90 ± 2.73)
5	a	7.38 ± 2.31	7.26 ± 3.04	6.33 ± 2.18	-
	b	(6.56 ± 2.73)	(7.04 ± 2.00)	(5.25 ± 2.09)	-

Figures in brackets represent number born alive.

frequent class at the highest level ($\geq$ 10 young). In the unselected lines, CL (D) and PS (A) small litters were quite frequent.

b. Size of litters weaned

The size of the litter weaned is an indication of the dam's direct contribution to production. Also, larger litters weaned mean more number available for testing and consequently higher selection intensities. The average numbers weaned per litter are shown in Table 3 for all lines and generations. When comparing generation 5 with the first generation there seems to be an improvement in average litter size at weaning. There was some moderate increase in the GR and GRX lines. Both the CL and PS lines remained almost at the initial level. The overall litter size weaned in all the lines for generation 1 to 4 was 5.47 young per litter. The coefficients of variation have indicated a fair amount of variability which can be utilized in selection (Table 4).

Table 3. Average litter size weaned by line and generation

Line / Gen.	GR	GRX	CL	PS
1	4.72 ± 1.95	-	same as GR	4.93 ± 2.10
2	5.24 ± 2.66	4.90 ± 2.40	4.79 ± 2.15	4.01 ± 3.09
3	5.48 ± 2.44	6.64 ± 1.90	5.76 ± 1.78	4.63 ± 2.90
4	5.43 ± 1.83	6.47 ± 1.25	4.93 ± 2.28	5.33 ± 2.42
5	5.69 ± 2.59	6.67 ± 2.50	4.80 ± 2.08	-

Table 4. Coefficients of variation in per cent for litters born of the lines in each generation.

Line / Gen.	GR	GRX	CL	PS
1	35.90	35.90	35.90	48.50
2	35.10	41.43	40.89	45.60
3	36.01	26.35	47.60	45.00
4	43.90	41.60	50.10	41.10
5	31.30	41.90	34.40	-

c. Age at first kindling

This is one of the measures of the reproductive ability of the females and probably of the males as well (since both are mated at about the same age), but this was not tested. It is also the generation interval from the birth of the does to the birth of their first offspring.

From Table 5, it can be seen that there is a decrease in age at first kindling in all lines except for the GRX line. Age at first kindling decreased between generation 1 and 5 by 8 days for the average of the lines. However, the GR line reached sexual maturity earlier than the other lines ($P < .05$). The last to kindle was the GRX line. This could be attributed to the fact that the GRX lines was heavier in body weight which might have delayed its sexual maturity (Table 6).

Table 5. Age at kindling first litter by generation and line

Line / Gen.	All lines	GR	GRX	CL
1	162 ± 14	162 ± 14	-	162 ± 14
2		177 ± 18	-	178 ± 15
3		163 ± 16	156 ± 13	160 ± 22
4		149 ± 19	172 ± 22	163 ± 20
5	154 ± 15	151 ± 16	165 ± 12	158 ± 16

Table 6. Weight at mating of males (M) and females (F) and weight of females at birth of litter (gm).

Gen.	3		4		5	
Line	M	F	M	F	M	F
Mating weight						
GR	2936	3430	3101	3295	3191	3433
GRX	3034	3660	3390	3490	3492	3537
CL	2860	2967	2857	2996	2791	3020
Weight at birth						
GR		-		3590		3697
GRX		-		3816		3766
CL		-		3431		3490

d. Inbreeding

The effective population size intended for all the lines (6 males and 18 females) is expected to be 18.05 with an increment in inbreeding ($\triangle$ F) of 0.0277 each generation. Up to generation 5, the cumulative inbreeding from the expected effective population number would be 0.0610 for each line.

Actual inbreeding coefficient calculated from the effective number of breeders in the selected lines at generation 5 was as follows:

GR line: 0.1309; GRX line: 0.1161; CL line: 0.240 and PS line: 0.1756 at generation 4.

The departure from the expected values due to inbreeding was not large indicating that inbreeding did not cause serious deterioration of reproductive performance. This was supported by a lower level of inbreeding calculated from the pedigree (5 - 8%).

Discussion

Generally, litter size in rabbits varies between breeds and strains within breeds. In this study litter size was larger than that reported by Rollins et al. (1960) for New Zealand Whites.

In animals which have their young in litters, there is a special relationship between litter size and body weight. Young born in larger litters tend to be smaller at birth and at weaning. Furthermore, selection for high post-weaning weight gain (lines GR and GRX) will automatically produce genotypes which increased mature weights (Sollar and Mosv, 1973). A larger mature body weight (Table 6) will provide an improved maternal environment, thus increasing litter size in the following generation (Fig. 2E).

There seems to be an overall improvement in litter size over the initial generation. It is usually expected that inbreeding will have a detrimental effect in small populations especially in reproductive performance but it seems that the mating plan avoided a high level of inbreeding at that stage. However, inbreeding and genetic drift are more important over the long term. It can be seen from the evidence on litter size born (Table 2) and litter size weaned (Table 3) that selection for post-weaning growth (lines GR and GRX) had increased these traits. Falconer (1965) has explained the relationship between litter size born of the dam and body weight of the daughter. The maternal effect alternates between the negative influence of the dam on body weight of her daughters and the positive correlation of the

daughters' body weight and their litter sizes. He suggested standardizing litter size to remove this negative environmental effect.

In conclusion, selection for post-weaning growth rate has led to a correlated response in litter size which resulted in an increase in number born per litter.

Since does feed their young once per day, it seems that there is an optimum litter size of eight young per litter. This will coincide with the average number of eight teats per doe.

Summary

A selection experiment involving two strains of rabbits, a New Zealand White (NR) and a Californian (PS) were divided into several lines selected for post-weaning growth rate between 30 and 60 days of age. In each of the lines GR; GRX and CL six males were each mated to three females while in the PS line there were four males each mated to 3 females.

Litter size born averaged 7.30 young/litter and litter size born alive averaged 6.84 young/litter over all the lines. It has shown a correlated response to selection for rapid post-weaning growth rate. The coefficient of variation for litter size born was high indicating a large variability in the trait.

Litter size weaned 5.47 young/litter over all the lines and generations showed some improvement over the initial levels. It was also shown that inbreeding had little effect on litter traits indicating the success of the mating plan in avoiding inbreeding at the initial generations. There was a correlated response in age at first kindling to selection for rapid post-weaning growth rate.

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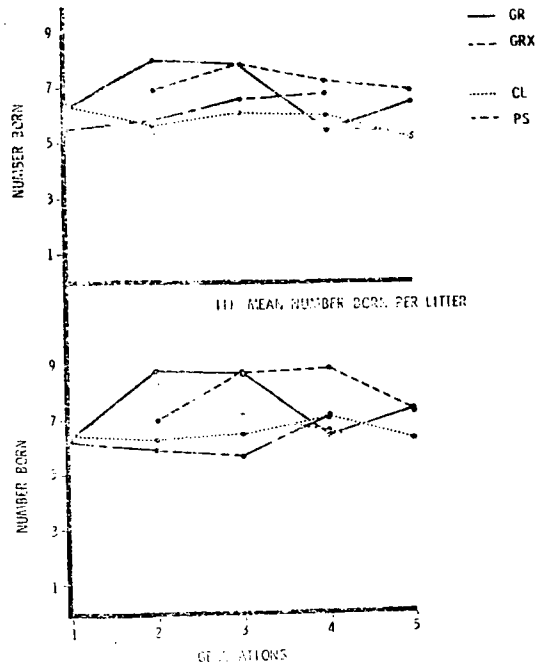
Fig. 1

LITTER SIZE BORN BY GENERATIONS AND LINES.

(1) MEAN NUMBER BORN ALIVE PER LITTER

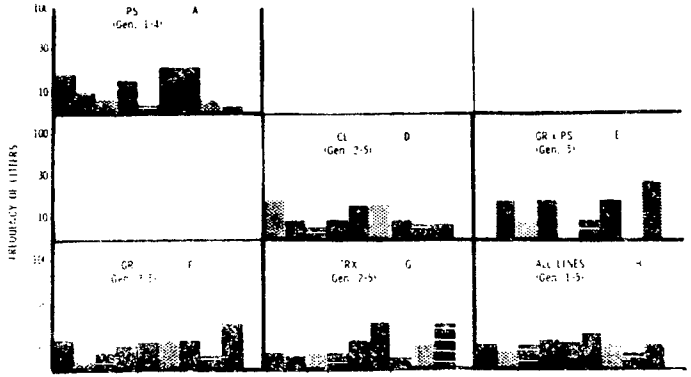


(2) MEAN NUMBER BORN PER LITTER

GENERATIONS

Fig. 2

HISTOGRAMS OF NUMBER BORN.



COCCIDIOSIS IN RABBITS

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S U M M A R Y

A study made over a period of two months in a group of New Zealand white rabbits and later observations at the Egerton College rabbitery showed that the clinico-pathological features of various species of Eimeria can be very much reduced if certain management practices are observed and strictly adhered to. These included (1) Proper construction of cages and pens, (2) Avoidance of overcrowding in the pens, (3) Frequent clearing of pens and cages, (4) Good nutrition and (5) Frequent application of coccidiostats such as Neomycin, Tetracyclines, Amprolium and Sulfaquinoxalline. By maintaining a high sanitary standards, the life cycle of the parasite was either broken or the number of oocysts sporulating greatly reduced; thus allowing for a build up of immunity.

I N T R O D U C T I O N

Rabbit keeping can both be a paying hobby and also a means of converting waste feed and surplus garden produce into edible meat and other by-products of rabbitry. On that account maintenance of good health should be one of the management aspects in rabbit production if the enterprise is to be economic.

One of the diseases that the rabbit raiser has to contend with is coccidiosis. This disease may at times cause serious illness and even death especially amongst young rabbits in intensive breeding establishments. The literature on the pathology of rabbit coccidiosis is limited. Several authors have noted that coccidia tend to be host specific and also site specific within the normal host and that sanitation plays a very big role in the occurrence or non occurrence of rabbit coccidiosis.

This paper describes observations on the symptoms and pathology of the disease at the Egerton College rabbitry and measures which have been taken to minimise its occurrence.

L I F E C Y C L E O F T H E P A R A S I T E

Two forms of coccidiosis are recognised in the rabbit. One is the Intestinal coccidiosis caused by several species of Eimeria of which E. irresidua, E. Perforans and E. magna are some of the important respresentative species. The other is the Hepatic coccidiosis caused by Eimeria stiedae.

Rutherford (1943) and Smetana (1933) all observed the protozoa to be parasitic in epithelial cells during endogenous stage of life cycle. The life cycle involved a period of asexual development (schizogony), followed by sexual development (gametogony).

During schizogony succeeding generations of schizonts are formed and contain invasive particles called merozoites. These eventually form gametocytes which now undergo fertilisation to produce a zygote. The fertilized zygote becomes encased within a resistant wall - called oocyst. It is the oocysts which are passed out of the host faeces; and once outside the host, they undergo exogenous development (sporogony) culminating in the formation of infective forms called sporozoites. This development outside the host only occurs if conditions are favourable (warmth and moistness). Infection occurs as a result of ingestion of the sporulated oocyst. Once inside the host, the sporozoites penetrate the intestinal mucosa to reside in the intestinal epithelium and sub-mucosal tissues (for intestinal coccodiosis). For Eimeria stiedae (liver coccidiosis), excystation occurs in the small intestine and the sporozoites penetrate the intestinal mucosa and pass via hepatic-portal blood system to the liver where they reside in the epithelium of the bile ducts.

M A T E R I A L S, M E T H O D S A N D R E S U L T O F A S T U D Y C O C C I D I O S I S

At Egerton College Rabbitery where a study was conducted by the author during the period September 1976 to December 1976, it was noticed that following ingestion of viable infective oocysts (using disposable syringe and oocysts reconstituted in saline) or following unsanitary conditions in the pens which allowed for rapid sporulation, young rabbits developed symptoms within two to three weeks. The animals lost appetite, progressively became weak and started to diarrhea. The diarrhea was catarrhal to mucoid but non-hemorrhagic. Later on the abdomen distended due to ascites and the liver could be palpated as an enlarged organ. In some cases death occured without any premonitory symptoms.

On post-mortem, the carcasses were found to be emaciated and the perineum soiled with faeces. Pathological lesions were confined mainly to the intestines and the liver.

In the intestines there was in most cases marked enlargement and thickening of the intestines. In some cases the intestines were just dilated and gas filled. There were white-grayish areas in the intestinal mucosa and in the lumen was an exudate which in some cases was catarrhal and in others mucoid. In one case seen in July 1977, there was petechial hemorrhages on the mucosal lining of the intestines (The author thought that this could possibly have been a case of Eimeria perforans but it was not confirmed). In the cases of Eimeria stiedae (liver coccidiosis), the liver was enlarged probably as a result of proliferation of bile duct epithelium. Pus-like material could be seen in the bile ducts. On the liver surface there were numerous white raised or flat lesions which ranged from 2mm. to 5mm. in diameter. The lesions on cutting revealed thick white-yellow fluid.(see table 1).

In an attempt to study an effective drug for the control of Rabbit coccidiosis, the author divided 30 rabbits aged between four and a half and five weeks into six groups named A, B, C, D, E, F, . . Each group was subjected to a different drug as shown in Table I & II with group C being control. The results of this study showed that if rabbits were given prophylactic dosages of drugs like NeoTerramycin (Neomycin plus oxytetracycline). Amprolium and Neomycin, the incidence was greatly reduced. Not only was the incidence lowered but in some antibiotics average weight gain per week was significant (See Table III).

When pens were left uncleaned for a period of 1 week plus, the rabbits later started to develop symptoms. However if cleaning was regular and cages kept high up, faecal oocyst count went considerably down. A liver oocyst count conducted at the end of the trial showed considerably low figures for the various (McMaster) groups of rabbits on different drugs (Table IV). It should be mentioned that the rabbits throughout the trial never had access to pellets as these were supposed to contain coccidiostats. They were fed mainly on maize meal, wheat meal, green lucerne, vegetables and hay. Thus there was insufficient supply of protein supplement and this may have been responsible for the low weight gain shown. In another trial by the author (March to July 1978 - unpublished) it was shown that sulfaquinoxaline given in the drinking water at a concentration of 0.025% very greatly reduced the incidence of coccidiosis.

TABLE I

Liver Post-Mortem Results

Group	Drug	Observations
A	NeoTerramycin	Liver enlarged. Six white yellow lesions sized 2mm - 3mm in diameter, lesions revealed thick white-yellow fluid.
B	Amprolium	Liver of normal size. No hepatitis.
C	(Control)	Liver enlarged. Very many large white-yellow lesions sized 3-5mm in diameter. Bile ducts enlarged. Some degree of hepatitis.
D	Neomycin	Liver of normal size. Six white lesions. Slight hepatitis.
E	Terramycin	Liver of normal size. Six white lesions. Slight hepatitis.
F	Nitrofurazone	Liver enlarged. White lesions. Slight hepatitis.

TABLE II

Rabbits, Drugs, Dosage and Route

Group	No. of Rabbits	Drugs	Dosage	Route
A	4	NeoTerramycin	14 mg/kg. bodyweight	Oral
B	4	Amprolium	50 mg/kg	Oral
C	6	Not applicable (control)	Not applicable	Not applicable
D	5	Neomycin	20 mg/kg.	Oral
E	5	Terramycin	40 mg/kg.	Oral
F	5	Nitrofurazone	6 mg/kg.	Oral

TABLE III

Average Weekly Weight Gain

Group	Drug Used	Average Weight Gain
A	Neoterramycin	0.19 kg.
B	Amprolium	0.11 kg.
C	Control	0.15 kg.
D	Neomycin	0.12 kg.
E	Terramycin	0.17 kg.
F	Nitrofuragone	0.14 kg.

TABLE IV

Liver Oocyst Count

Group	Drug	Oocyst per gm. of liver
A	NeoTerramycin	1000
B	Amprolium	380
C	(Control)	5080
D	Neomycin	740
E	Terramycin	1700
F	Nitrofurazone	3060

DISCUSSION AND CONCLUSIONS

From the results of the trials and later observations it was evident that hygiene plays a big role in the occurrence or non-occurrence of coccidiosis. By frequently changing the beddings and properly cleaning the pens, the oocysts were not given a chance to sporulate and become infective. Proper feeding and watering was essential if the animals have to be in good state to be able to resist infections. By combining high sanitation with high feeding as well as application of coccidiostats the rabbits then are able to only ingest low infective doses of oocyst and subsequently develop coccidiasis(immunity). This can be seen from the liver lesions. It is significant that these animals never later on showed clinical coccidiosis and the likely reason as explained above is that they later on became immune as a result of previous exposure to low levels of oocysts and frequent use of coccidiostats. The most critical age appears to be in the four weeks. Therefore it was proper that high management be maintained from the start.

Apparently there seems to be little or no differences in breed susceptibility. All breeds seem to go down with the disease. It is therefore important that whatever the breed, age or sex high hygiene and proper housing is essential to make rabbit keeping commercially viable.

A C K N O W L E D G E M E N T

I wish to express my gratitude to employees of Tatton Farm, Egerton College, who work in Rabbit Section for helping with the care and feeding of the rabbits.

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OBSERVATIONS ON RABBIT DISEASES IN TANZANIA

BY

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INTRODUCTION

Though the keeping of rabbits in Tanzania is not yet widespread (on commercial basis), even then on those few frams and diagnostic laboratories that have kept rabbits, certain diseases, some causing great loss, have been observed. As more people get to keep rabbits, I think it worth highlighting some diseases that they are likely to encounter. The diseases so far experienced by us in this country may be the same as in other parts of Africa or be totally different.

It is not intended to give details of the diseases here in the short period allowed but rather give a summary of each disease under etiology (cause of the disease) clinical features and pathologic changes. Treatment and control are not given in this paper.

PASTEURELLOSIS:

This is the group of diseases associated with members of the genus Pasteurella and in particular the species Pasteurella multocida (P. multocida). Apart from P. multocida as the major cause of pasteurollosis in the rabbit, another agent is P. pseudotuberculosis which causes the form of pasteurellosis called pseudotuberculosis.

The disease manifestations by P. multocida are varied and include snuffles (a form of rhinitis), pneumonia, pyometra orchitis, otitis media, conjunctivitis, subcutaneous abscesses and septicaemia. In our experience in this country, so far, we have observed snuffles (rhinitis), pneumonia and septicaemia.

S n u f f l e s (rhinitis) results from the inflammation of the nasal and sinus mocous membranes (rhinitis) because of its invasion by P. multocida. These bacteria are sometimes resident on the mucosa of the nasal passages and only get the opportunity to invade the mucosa as a result of stress, e.g. high humidity, high temperature, pregnancy and even lactation stresses.

Rabbits can also acquire the bacteria in the inspired air or by direct contact with contaminated objects.

Clinically, snuffles is characterized by sneezing followed by nasal discharge which is initially catarrhal (freely flowing mucus-like material) but later thickens to look almost like pus. The rabbit will paw at its nostrils in an attempt to wipe away the exudate.

Depending on the invasiveness (virulence) of the bacteria and the susceptibility of the host, the infection in the nose may spread to the lower respiratory tract leading to bronchitis and pneumonia. Also infection can spread from the nose & sinuses to the eyes resulting in conjunctivitis.

P n e u m o n i a - This may arise from infection of the upper respiratory treat by P. multocida, with spread to lower respiratory tract; the disease may also arise as a primary infection of the lower respiratory tract as well as in the upper respiratory tract. Some debilitating influences precipitate the development of the lesions in the lower tract. Such influences can be high humidity, unsanitary housing, inadequate bedding and even drafty housing and presence of other diseases, for example coccidiosis.

Clinically, the rabbit with pasteurella pneumonia is depressed, has laboured breathing, nasal discharge and in the albino rabbit there may be bluish eye coloration (cyanosis). There may be pyrexia.

Mortality among rabbits from pneumonia can be up to 20% and among adult rabbits, pneumonia is an important cause of death. It has been observed by us as second to coccidiosis in the causation of death in rabbits in this country.

Pathologic changes in pasteurella pneumonia include red or purple areas of consolidation particularly in the anterior lung lobes and sometimes the anterior ventral portions of the diaphragmatic lobe.

There may be abscesses under tha lung capsule and sometimes there are adhesions between parietal and visceral pleura over the affected lung.

Other bacteria may cause pneumonia in rabbit, e.g. Klebsiella pneumoniae and Bordetella bronchiseptica and these bacteria have been isolated in connection with pneumonia in this country but only a few occassions.

Septicaemic pasteurellossis - This has on few occasions been observed and is characterized by hemorrhage on mocous and serous membranes. Death often occurs in about 36 hours from beginning of signs of disease. In this acute form of disease the bacteria are present in large numbers in blood and exudations.

Pathologic changes in septicaemic pasteurellossis are, grossly, those of hemorrhage (petechiae) and fluid (serofibrinous) exudations into body cavities. The hemorrhages are found on serous & mocous membranes; liver and spleen may be enlarged.

So far in this country, at least by my own experience, the other forms of pasteurellosis namely pyometra, orchitis, otitis media, conjunctivitis, have not been observed. However, with increase in rabbit keeping under variable management systems such disease conditions may too be observed.

Pseudotuberculosis - This is caused by Pasteurella pseudotuberculosis. We have on occassion come across this disease in rabbits. Clinical manifestations in this disease are anorexia, gradual loss of body condition and dyspnoea. The disease develops slowly and the rabbit dies after profound emaciation. Infection occurs through ingestion of contaminated feed and or water.

Pathologic changes observed include round white foci with central caseation and may be pin head to approximately 1 cm in size. These lesions are found mainly in the spleen, liver and sometimes lung and kidneys. They are tubercle-like lesions hence the name pseudotuberculosis.

C O C C I D I O S I S

This is an important diesease and we consider it number one in causation of mortalities particularly in young rabbits.

Both liver and intestinal forms of coccidiosis have been observed in this country; they seem to be equally important. Eimeria stiedie was found to be responsible for liver coccidiosis while intestinal form was caused by E. magna and E. irresidua with E. irresidua infection being the more prevalent.

The subject of coccidiosis has already been adequately covered by someone else and therefore I need not go into any details about the disease and only wish to reiterate that coccidiosis is the number one killer of rabbits (especially young ones) in this country.

The high incidence of coccidiosis in some rabbit colonies observed by us is probably related to management practices exisiting there. Management practices that encourage contamination of feed, water and the floor of the rabbit houses, will lead to high incidence of coccidiosis. Deep-litter type of floor for rabbit houses is likely to encourage and perpetuate coccidiosis.

E N T E R I T I S

This condition was observed in many young rabbits at the Central Veterinary Laboratory rabbit colonies and at first was thought to be a result of coccidiosis. Attempts to isolate the coccidial parasites or even observe them in the intestinal sections gave negative findings. It was obvious that there was enteritis. The cause of the disease was not clear but in some cases E. coli and other coliforms were isolated. However, probably certain feed and microbial factors interplay to cause this enteritis. This enteritis syndrome is similar to what has been named as Mucoid Enteritis in the U.S.A.

Clinical features in the affected rabbit are anorexia, lassitude and rough coat. There is diarrhoea as shown by soiling of the perinium and faeces may show clear viscid mucoid material.

At necropsy, the stomach and anterior part of the small intestine may contain fluid, gas and sometimes undigested food, the colon is filled with jelly-like mucoid material. Mucosa of the intestine and cecum may be reddened.

A few other bacterial disease we have encountered on few occassions are Salmonellosis, staphylococcosis and Colibacillosis.

Salmonellosis caused by Salmonella typhinurium was observed in rabbit colonies at the Central Veterinary Laboratory (CVL). S. typhinurium is a cause of paratyphoid in many animals including man and the infected rabbits, particularly those that cover and become carriers, are a source of infection for other animals.

A salmonella infections are difficult to get rid of even after treatment, the policy adopted at CVL has been to eliminate the whole unit from which the infected rabbit came from; this way spread to other units is minimized or cut off completely.

Staphylococcosis, caused by Staph. pyogenes has been observed in the form of abscesses. These we noted to arise as a result of contamination of fight wounds (mainly in males). The abscesses were seen on the trunk, lower jaws and scrotum. Similar abscesses were seen in heart and lungs probably as a result of spread from other affected parts of the body.

Apart from abscesses due to Staph. pyogenes, P. multocida and Pseudomonas aeroginosa have been isolated in connection with abscess in some rabbits.

Colibacillosis - observed in connection with scours especially in young rabbits.

M I S C E L L A N E O U S C O N D I T I O N S:

A few conditions which may lead to death or poor doing in the rabbit have on occassion been met with in Tanzania. Those met with are Cannibalism, Hairballs, Toxaemia.

TOXAEMIA, also known as ketosis, is most commonly noted in first litter females. The disease occurs in the last week of pregnancy and is more prevalent in the obase animals. The affected animal is sluggish, dull, shows repiratory distress and may die 1 - 4 days after onset of signs of disease. The liver is fatty and appears yellow and soft. For some reason there is loss of appetite leading to mobilisation of body fat for energy and formation of ketones which enter the blood stream. Injection of fluids containing glucose may reverse body fat breakdown.

CANNIBALISM

Many times young does kill and consume their young. The cause of this cannibalism is not exactly known but most cases are thought to be a result of diet which is inadequate either in quality or quantity or because of disturbing the does when giving birth. Proper feeding and seclusion at time of parturition will usually prevent this tendency. Does which destroy their litter should be destroyed unless the doe is very valuable in which case it can be given a second chance.

HAIRBALLS (WOOL EATING)

It is not unusual to find small amounts of hair in the stomach contents of rabbits and such a situation usually does not lead to impaction. However, sometimes several rabbits, because of deficiency of fibre (roughage) in their diet, may eat body fur, eyelashes or even whiskers. Single rabbits may eat fur on their sides, back and rump. Some hairballs may obstruct the stomach at pyloric end in which case the rabbit stops eating, loses weight and may die.

CONCLUSION:

Obviously other diseases of rabbits not mentioned above and occuring in other countries may have been observed by others in this country. I have only reported on those that I have come across and some that were received at the Central Veterinary Laboratory, Temeke, for disease diagnosis and or investigation. It is my opinion

that the more people go into rabbit keeping the more we are likely to come across a wide spectrum of rabbit diseases. Thus we should be on the lookout for these diseases.

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HOUSING OF RABBITS IN AFRICA

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SUMMARY

Rabbits are raised in a variety of conditions, including batteries of cages in a commercial rabbitry, backyard hutches made of boards and wire screen, cages made of bamboo, dirt floors in mud huts, and even in their natural habitat in the wild. In this paper the author reviews some of the different housing in which rabbits are raised and some of the basic criteria to keep in mind when designing housing for rabbits. Two types of housing appropriate to African village conditions are dealt with more specifically; the wood and bamboo hutch commonly used in forest areas; and alternatives for savannah areas where even these materials are difficult to obtain.

A. LEVELS OF HOUSING

Rabbits live in a wide variety of housing. This can range from rows of battery cages several layers high in a commercial rabbitry to a warren in the wild in the rabbit's natural habitat.

1. Commercial Rabbitry - These usually contain cages made entirely of wire, or wood or metal frames with wire screening, in long rows under a large shelter. They can contain many thousands of rabbits raised on a commercial basis for sale to a wholesale packing house

or other commercial outlet. Such commercial rabbitries do exist in Africa but it is not the scope of this paper to say any more about them.

Even in developed countries there is some evidence that it is more productive to raise rabbits in small family units than in large commercial farms (Laursen-Jones, 1976; Owen 1976). Surely the same holds true for Africa, especially for rabbits raised for domestic consumption.

2. Urban Backyard - Many of the people who have become interested in raising rabbits are teachers or persons with other professions, many of whom live in or near urban areas but who want to raise rabbits in order to have meat for their tables. Though not calculated on a purely economical basis in terms of profit or loss, most of these persons are willing to invest some capital into their rabbit hutches. They are, therefore, willing to purchase boards, wire screening, zinc roofing material, and possibly even pay someone to construct the hutch. There are a variety of designs possible for these hutches (Zwann, undated). Again, the focus of this paper will not be on this level of houseing, though much of what will be said below will apply to the urban rabbit raiser.

3. The Village Hutch - It has been found that raising rabbits at the village level is both feasible and practical. The special advantage is that the meat is raised and consumed by those who most need it. Hutches made of bamboo or sticks are becoming quite common, especially around development projects which are promoting rabbit husbandry in village areas. This topic will be dealt with in more detail below.

4. Confined Dirt - Due to a scarcity of wood, bamboo, screen or other preferable materials, especially in the savannah areas, there are a number of examples of rabbits being raised on dirt floors. These usually have walls made of cement, adobe brick, or other hardened earth. In many cases the floor is also compated earth to keep the rabbits from burrowing. Otherwise, the rabbits are allowed to burrow as long as they do not tunnel out from under the walls. There are problems with raising

rabbits in this way and it is not recommended where more traditional hutches can be built. However, raising rabbits in this fashion can enable people to raise their own meat who could not otherwise do so. This level of raising rabbits, with a case study, will be given below.

5. Warren in the Wild - Of course the natural habitat for the rabbit is not a confined domestic situation at all. Rabbits can thrive in the wild. The main problem with this is that they are not easily available for man to eat when he wants. Hunting is one solution. In Adams' story (1973) of rabbits, mention is made of the practice of encouraging wild rabbits to continue living in a burrow near a farm by leaving garden scraps where they can get them. Individual rabbits can be occasionally caught by setting traps for them.

With the increasing human population, in West Africa especially, hunting of any wild game is getting more and more difficult as the populations of these species diminish. The same holds true for rabbits, so it would seem that for the person interested in assuring himself of a supply of rabbit meat, obtaining rabbits in the wild is not a very reliable method.

The observation can be made that the capital and level of management involved decreases in levels of housing No. 1 - No. 5.

B. DESIRED CHARACTERISTICS OF HOUSING FOR RABBITS

1. Confinement of Rabbits - Rabbits need to be confined in order for them to be managed, including the control of mating. As opposed to the possibility of hunting and trapping rabbits in the wild, the purpose of housing is to have them easily available to the owner when he wants them.

When building a cage, care should be taken that young ones cannot fall out through holes in the walls or floor.

2. Protection for Predators - Rabbits can be attacked by a variety of predators and one of the purposes of housing them is to protect them from these. Predators include cats, dogs, mice, rats, driver ants, snakes, hawks and thieves.

It may be necessary to put the feet of the cage supports in tins of water or kerosene if ants are a problem. Likewise, if rats are bothersome, a funnel of tin around the support might help. Suspending cages by wire from overhead could be a solution to both of these problems (Zwann, undated).

In some areas, unfortunately, among the most persistent predators are one's neighbours. Protection against them can be helped by a fence of bamboo or other material, and by keeping the hutch near one's own home. (This lends itself to closer surveillance and better management of the rabbits).

3. Protection from the Elements - The rabbit hutch should be well aerated but the rabbits should be protected from too much direct wind. The hutch should be placed in a shady area. Rabbits should not be subjected to direct exposure to the sun in tropical areas as the heat can adversely affect them. Likewise, rabbits should be protected from the rain, for if they get wet they can get diseased, especially young ones.

The location of the hutch should, if possible, be in a quite, peaceful area where there is not too much noise not too many visitors.

4. Clean - It is preferable that a rabbit cage be self-cleaning with either wire screen or bamboo slats used for the floor. The holes in the floor should be large enough to allow the faeces to drop through. The interior of the cage should be easy to clean, especially where food and dust and dirt may collect. Clean hutches help prevent diseases.

5. Comfortable - Each cage should be large enough to adequately accommodate the rabbits kept therein. Allow approximately 0.4 m^2 for each adult rabbit and 0.6 m^2 for each doe with bunnies.

The cage should be free of sharp objects which could hurt the rabbits and it is a good idea to have a shelf or a board on which they can rest (Zwann, undated).

6. Easy Access - An opening in the cage should be adequate in order to reach the rabbits, to put in food and water, clean the cage, and to put nest boxes in. A flexible cover on the top of the cage is recommended as this allows for easy access into the cage. Many cages are also built with a door on the front. The type of opening will determine the desire height of the cage.

7. Separate Compartments - For management and control of reproduction, it is best to keep bucks and does in separate cages. The doe can be brought to the buck's cage for mating. The young females can be put in a larger cage on their own upon weaning, until they are either sold or placed in their own individual cages for use as does. Young bucks should be kept in separate cages after they are about three months' old.

8. Nest Boxes - dark secluded place should be made available for the doe to make her nest and to kindle. It should be large enough for the doe to be able to turn around and to feed her babies without stepping on them. The recommended dimension is 30 x 40 cm (World Neighbors, 1975; Mamattah, 1976). This can be a box made of boards or bamboo, a basket, or a clay pot. It is preferable that the nest box be removed when the young leave the nest (2-3 weeks old). The nest box should then be cleaned and stored until the next does is about to kindle.

9. Solid Construction - The choice of materials for the rabbit cage depends on what is available locally. Boards and wire screen are best if sufficient capital is available to pay for them. Bamboo requires more upkeep but it is much cheaper for villagers in forest areas. In the savannah, where wood is very expensive and bamboo does not grow, bricks or cement can be used for the construction of the rabbit hutch.

Wood or bamboo should be protected from premature deterioration due to gnawing by the rabbits or rotting due to mositure. Zwann (undated) suggests treating the wood frame with Carbonyl to discourage the rabbits from gnawing on the wood. If wire screen is used, it should be on the inside of the wood frame to deter the rabbits from gnawing on the wood. If bamboo is used, the hard outer surface of the

bamboo should be turned towards the inside of the cage. Vines or cord used to tie the bamboo should be kept on the outside wherever possible.

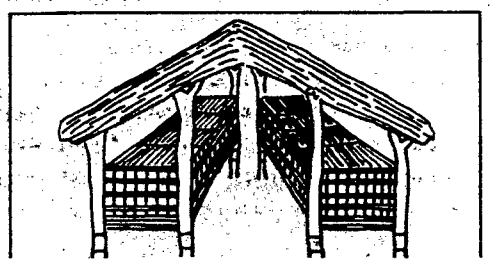
10. Inexpensive - The rabbit hutch should be built within the means of the owner, keeping costs to a minimum without sacrificing quality.

C. RECOMMENDED HOUSING FOR VARIOUS AREAS

Zwann (undated) gave plans, costs, advantages and disadvantages of 5 different types of rabbit hutches built and tested at the Centre de Formation Horticole et Nutritionelle at Ouando, near Porto Nuovo, Benin. These were all made of locally available materials and cost less than $30 for an 8-cage hutch.

Attfield (1972) recommended 2 types of hutches for Nigeria: bamboo and wood. He recommended that the cages be 0.75 m. deep and 0.60 m. high and 1.25 to 1.80 m. long for each adult rabbit. These cages were waist high, single tier, and self-cleaning (using wire mesh on the floors); straight mats or burlap bags could be hung over the ends of the hutch to protect the rabbits from sun and rain.

Mamatah (1976) recommended an all bamboo, three compartment hutch with wire screen doors and floors for village use. These hutches were self-contained, with their own bamboo roofs. Each compartment was 75cm wide, 60cm deep, and 50cm high in front and 45cm high in back to allow for the slope of the roof. The floor was 50cm above the ground, held up by legs made of boards. Bamboo strips 10cm apart were nailed under the floor wire screen to support it and to prevent dogs from tearing the screen from below. The kindling box was 30cm x 40cm with 30cm high walls and no top.



Rabbit hutch made of locally available materials in forest areas. (World Neighbors, 1975)

World Neighbors (1975) translated a booklet in Chulaba prepared by the SEDA program in Zaire. They gave instructions for building very simple housing made of materials easily available in forest areas. This type of housing has been seen in use by villagers in a number of countries and so will be described in a little more detail.

As illustrated above, this hutch contains 2 rows of cages each facing the inside of a long shed. The shed is covered by a roof made of thatch supported by wood posts and bamboo rafters. The cages are waist high with roll-back bamboo tops for easy access. The dimensions of the cages are approximately 60cm deep x 60 - 100 cm long.

The walls of the cages can be made entirely of bamboo or raffia palm stems. These are tied to the vertical supports with whatever cords or vines are used in the construction of local houses. These should be tied on the outside of the cages wherever possible so that the rabbits cannot gnaw on them. The slats in the walls should be spaced close enough together, especially near the floor, to keep small rabbits from falling out. The spaces can be larger near the top of the cages to allow for good ventilation.

The floors of the cages can be made with bamboo slats or by splitting and weaving strips of bamboo. The latter are preferred as the slats can cause problems with the rabbits, especially young ones, slipping and getting their legs caught. The woven bamboo floors should have openings large enough for the manure to fall through to the ground below. With the outer surface of the bamboo facing up, the rabbits are less likely to gnaw on it. Keeping a sufficient supply of greens available to the rabbits should reduce the rabbits' need to gnaw on the floor or walls of the cage.

Where wire screening is available, it is preferred because it is easier to keep clean. The disadvantage is that it is expensive and rusts easily. If only a few cages can be floored with wire, these are the ones reserved for very young rabbits.

The nest boxes can also be made cut of bamboo. The recommended size is 30cm wide, 30cm high and 40cm long, covered on top. The front opening should be 10cm from the bottom to prevent the babies from leaving the nest boxes too early.

D. POSSIBLE ALTERNATIVES FOR SAVANNAH AREAS

In the savannah regions of Africa, wood or bamboo are often scarce and expensive. A variety of types of housing have been tried for raising rabbits in these areas.

Cages made of cement block have been seen by the author in Upper Volta. These have either wire screening floors or cement floors from which the manure must be swept daily. Each cage has only a door on the front. The thick cement walls help to keep the temperature moderate in these areas where the wind can be very hot and dry.

Another suggestion for arid areas is the construction of underground compartments with inspection hutches (Templeton 1968). A similar alternative recommended using a deep litter system with stone walls and floor (Regier, 1975). It is important that the litter always be kept dry. Does can make their nests right in the litter.

Allowing rabbits to burrow underground would assist in keeping them cool in hot climates. However, Owen (1977) observed that these burrows would be difficult to clean and could increase parasitic disease problems such as Coccidiosis. Adams (1973) claims that rabbits will not drop faeces underground but will do so only above ground outside of their burrow. The author does not know whether or nor this would hold true for rabbits in a confined area which are allowed to burrow, though he has observed that rabbits on wire screening tend to use the same corner of the cage every time they pass faeces. If this is true, the problem of disease in a dry burrow would not be quite as bad as one might suspect. The places where droppings did collect would have to be swept clean regularly.

The author's experience in 7 countries of West and Central Africa has indicated that at the village level, the housing recommended in the World Neighbors newsletter (1975) is best where those materials are available. In efforts to make rabbit raising available to other places, however, the possibility of raising them on the floor cannot be totally discarded, though more village-level research should be done to see how this method can be improved.

A P P E N D I X

Rabbit Raising in Saboba Area

by

Denice Williams

The Saboba Family Health Program, situated in north-west Ghana, has as one of its objective the encouragement of the village women to raise rabbits. Rabbits had never been raised in these villages and housing would prove a big problem. Rabbit hutches could not be constructed as wood is scarce in the savannah areas of northern Ghana. The women must walk miles into the bush just to obtain firewood for cooking. Bamboo is only found in the south of Ghana in the rain forests. Any type of screening or roofing material is very scarce and extremely expensive, thus completely out of the reach of the budget of the subsistence farming family.

It was therefore necessary to try to make do with what the

local type of housing and rabbits will probably never be raised commercially in this manner, but it seemed the only solution for a woman who wanted to raise a few rabbits for her family.

The traditional house of the Konkomba tribe around Saboba is made up of a round mud hut with a thatched roof. Chickens, pigs, goats and sheep are often housed in similar but smaller dwellings. In these small huts there is usually a small opening in the wall big enough for a small boy to crawl in and out of.

It is in this type of small round hut that the women keep their rabbits. The woman's first problem was to find something suitable to cover the hole to protect the rabbits from dogs and cats, both of which are natural predators of rabbits. More rabbits have been killed by dogs and cats than have been killed by disease. If the women are not very careful about securing the opening, the rabbits can and do escape. Some women have found a piece of zinc roofing, while others have used woven grass mats or pieces of boards to put in front of the opening. It is good if some light is allowed to enter through the opening.

One of the most important things to determine in trying to judge if a hut is suitable for rabbits is whether its floor is dry throughout the rainy season. This means that the grass roof must be in good condition. If the roof needs repair it must be done in the dry season when the grass can be collected. If the floor does become wet, the rabbits must be moved immediately. The opening of the hut should be large enough for a small child to enter and sweep daily and collect the rabbit manure. In places where the women were lax about sweeping and the ground was damp, the rabbits developed worms in their feet, some of which got infected and the rabbits died.

Some women have made an extension with mud walls about 1.25m high on each side of the opening, creating a small yard for the rabbits to come out into and yet be safe from dogs.

The buck and doe are kept together until the doe kindles and then the buck is removed. In some villages several women share a

buck on a rotational basis. There has never appeared to be a problem of the doe trying to fight off the buck as he is put into her hut. Perhaps it is because the huts are large enough so that they have adequate room to move around.

Clay pots place on their sides are used as litter boxes. A large circular bowl originally used for bathing the children can be used, but a water pot with the rather narrow opening provides a more secure nest in which the female feels more secluded.

The best results for litters surviving have been in those huts where the rabbits were able to burrow deep holes. Of course, if they were surfacing outside of the compound, the holes must be filled immediately with rocks before the rabbits escape. In cases, however, where they burrow under the compound floor and the holes are dry, litters born there usually survive. It is not unusual for the doe to cover over the hole after the litter has been born so the babies are completely hidden. When she wants to feed them, she digs away the dirt and enters the hole. This pattern has been observed in about 6 instances. In one case, all six of the litter survived. If the doe has a choice between a clay pot and burrowing a hole, she always digs a hole. In some huts where the floor has been pounded down and covered with cow dung, the rabbit cannot dig and then is forced to use the clay pot. In the beginning the doe may reject the clay pot and just have the litter on the ground. In these cases all the young usually die.

A substitute for a clay pot is a wicker basket completely covered except for a small opening in the side, which the people use for carrying fowls to market.

The women are advised to watch carefully for any signs of illness among the rabbits and to immediately isolate those that are sick. Common illnesses observed include mites in the ears and on the nose. Coccidiosis has also been observed and a powder containing sulphamezathine has been put into the food to help to prevent the outbreak of the disease. As mentioned earlier, some have developed worms in the

feet due to dirty huts and damp ground. When discovered, the worms are removed by putting pressure on the leg and then the wound treated with gentian violet and sulphanamide powder.

The rabbits are fed greens found locally. In the dry season the children must go far to find them but in the rainy season this is no problem. The residue from the local millet beer called "pito mash" is also given. Left over millet, guinea corn and groundnuts are given if food at the time is not scarce. Yam peelings are also given.

If the huts are well maintained and swept frequently they can be adequate to house several rabbits. There have been cases where the buck apparently ate the babies. These were where the buck was left with the doe after kindling in a small hut. It appears that in large huts, where the doe can defend her own territory (pot or burrow), this has not been too much of a problem. The mortality rate has been high among the babies, mainly where inadequate provisions were made for nesting. Allowing the mother to burrow seems to be more successful. Few adults have died, in spite of the conditions in which they live. Although this is a much less efficient method than is usually recommended, in this environment there seem to be few other alternatives due to the lack of building materials.

Thirty-five women in 13 villages around Saboba are raising rabbits in this way. Some of them have been doing it for over five years with enough rabbits to sell to their neighbours and to eat on special occasions.

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Session II - Discussion 1

Speakers:		
	Mr J.I. MCNITT:	Methods of small holder rabbit production
	Mr O. COSTA:	Rabbit production in Mozambique
	Mr L.N. ODONKOR:	A new system of rabbit production

H.Y. KAYUMBO, (Director-General Ranzania National Scientific Research Council), said that he believed Leucaena had the same toxic effects to classes of livestock other than rabbits and asked what happened if this plant was fed to other animals e.g. goats and sheep.

J.I. MCNITT, replied that leucaena was known to contain a toxic compound mimosine, whose toxicity varied with the species of the animal to which it was fed; the season of the year, the part of the plant fed etc. The young growing shoots and leaves appeared to have more toxic effects when fed to livestock than the older parts of the plant.

M.L. KYOMO, (Dean, Faculty of Agriculture, University of Dar es Salaam), said that the toxicity of leucaena occurred if too much of the feed stuff was given to animals. It appeared that the toxic compoung accumulated in the animal's body, so that even if only small amounts of the feedstuff were offered at a time, toxic effects might be apparent after a prolonged period of using the feedstuff. These toxic effects might even affect human beings who ate meat from affected animals. There was need for more research in this field.

N. MAMATTAH, (Ghana), said that does fed on leucaena had been observed to develop fungus on the skin coupled with shedding of fur.

Mr MSHANA, (Tanzania), asked what was the distribution of mimosine in leucaena.

J.I. MCNITT, replied that the toxin appeared to be mostly concentrated in young parts of the plant, but more research was needed to confirm this.

L.D. KANGNI, (Togo) pointed out that in Togo dried leucaena had been fed to rabbits up to 8-12% of the ration without any ill-effects being observed.

J.I. MCNITT, commented that he fed fresh leucaena to rabbits and that the same ill-effects had been observed even if the feedstuff were dried before being offered to the animals. It appeared that it was the amount of leucaena given to the animals that mattered, rather than the form in which it was offered.

L.D. KANGNI, commented that in the Togo experience dried leucaena had beneficial effects when given to rabbits and chickens.

M.I. KYOMO, added that it certainly appeared to be the total amount of leucaena offered to the animals which was important. In some countries they had tried to feed pelletted leucaena to animals but the same toxic effects had been observed.

J.E. OWEN, asked what was the mortality rate among the rabbits in Mr Odonkor's unit in Ghana, when was mortality rate highest and what were the most probable causes of these deaths.

L.N.ODONKOR, answered that the mortality rate experienced under his system of production was 8-10%. Most of the deaths were due to poor feeding of the newly weaned rabbits.

B. GOHL, (International Foundation for Science, Sweden), asked if palm-oil leaves were fed regularly to the rabbits and asked if any analysis had been made on the composition of these leaves.

L.N. ODONKOR, replied no, palm-oil leaves were not regularly offered,only when other types of forage could not be easily obtained. So far no analysis had been done on the composition of palm-oil leaves.

M.L. KYOMO, said that the toxicity of mimosine in animals was manifested only after a long period of feeding because the effects were cumulative.

J.P. LUNGU, (Zambia) asked how recording work was minimised in the 'New System of Rabbit Production' in Ghana.

L.N. ODONKOR, replied that the recording work was minimised by keeping records on batches of animals rather than on individual animals.

M.L. KYOMO, commented that in practical animal husbandry recording work is normally simplfied by working with group identifaction rather than individual identification.

M.E. SHAYO, (Tanzania), aksed how many rabbits could be kept in a single cubicle and was it possible to mix animals from different litters.

J.I. MCNITT, replied that a doe and her litter were housed in a 65 x 81 cim cubicle for two months. It was possible to mix the litters, but it had not been necessary to do so.

M.L. KYOMO, asked if Mr Odonkor experienced any problems of fighting when rabbits from different litters were mixed.

L.N. ODONKOR, answered that they did experience such problems. This had been the main reason for designing the kindling section.

M.L. KYOMO, asked what was the estimated number of rabbits in Mozambique, would they sell some of the rabbits to Tanzania.

O. COSTA, replied that there are about 2,000 breeding units and they would be willing to sell some of the rabbits.

J.E. OWEN, asked if Mr Odonkor castrated the male rabbits.

L.N. ODONKOR, replied that he did castrate the rabbits at 3 months of age. This made the animals docile. After this the animals were given carbohydrate feeds to fatten them.

D.M. MABEBA, (Tanzania) asked what was the recommended male/female ratio.

L.N. ODONKOR, replied that the recommended ratio was 1 male to 10 or more females. The idea was to avoid a situation whereby the buck would force the doe to mate.

N. MAMATTAH, said that square cubicles had the advantage that whenever the doe was not in the mood to mate she went into a protective corner but in round cubicles the buck was likely to chase the doe around until she finally gave in.

J.I. MCNITT, answered that hand mating was the normal practical system used. The round cubicles were not meant to be mating-chambers.

L.N. ODONKOR, added that the situation whereby the buck forced himself on the doe did not occur if the doe was introduced to the buck when she was in heat.

J.E. OWEN, asked how he could tell when a doe was ready for mating.

L.N. ODONKOR, replied that the vulva became red, the doe mounted other rabbits or was mounted by them, and the doe readily accepted the buck.

Session II- Discussion 2

Speakers: R. RAMCHURN: New feed resources for rabbits in Mauritius.

F.M. EL AMIN: Reproductive performance of rabbits selected for post-weaning growth rate

C. GIATTAS, (University of Dar es Salaam), referred to the paper by R. Ramchurn where he mentioned that feeding sugarcane only had no problems but feeding it with 40% complete rabbit meal showed problems of hair loss.

R. RAMCHURN, reiterated that this was true, that no ill effects were observed when feeding sugarcane only.

C. GIATTAS, replied that there was no examination of the livers of affected animals and that the relationship of the disorder with the feed was only an observation.

N. MAMATTAH, (Ghana), cautioned the workshop on the use of the terms 'concentrate' and 'ration' as these might be confusing.

M.L. KYOMO, (Dean, Faculty of Agriculture University of Dar es Salaam), wanted to know whether the sugarcane was fed as pellets or in loose form as these different forms of feed affected feed intake.

R. RAMCHURN, agreed with M.L. Kyomo as to the effect of feed treatment on feed intake but added that he did not see any necessity of pelleting sugarcane.

E.M. SHAYO, (Ministry of Agriculture, Tanzania), asked why Mr Ramchurn was carrying out his experiments in isolation as he had mentioned in his paper.

E. RAMCHURN, replied that this was because of there being few animal scientists in Mauritius.

J.M. RUGH, (Voisins Mondiaux-Togo), asked whether they had analysed the feeds used in the experiment because he found it interesting to note the higher growth rates on sugarcane than on leucaena.

R. RAMCHURN, agreed with the observation and said that the analyses were made on the feeds.

H.Y. KAYUMBO, (Director-General, Tanzania National Scientific Research Council) observed that the humus chopper used to chop sugarcane was rather expensive and questioned if this was to be used by peasant producers. He also asked why sugarcane was used instead of the by-products.

R. RAMCHURN, replied that the chopper was actually cheap and chopping was necessary as rabbits will not accept the entire sugarcane. He added that trials using molasses and bagasse were under-way.

M.L. KYOMO, added that in certain circumstances it is more economical to feed whole sugarcane than by-products.

P.I. SUNNI, (University of Dar es Salaam), asked what were the advantages of pelleting rabbit feeds and was this not expensive.

R. RAMCHURN, explained that feed pelleting improves feed intake and reduces feed wastage. He added that feed pelleting was cheap because it was done on a commercial scale.

K. BRUHN, (University of Dar es Salaam), asked Dr El Amin to give some estimates of heritability in rabbits.

F.M. EL AMIN, replied that the heritability (h^2) for growth rate was high at about 40% and that for littersize at weaning about 20%.

N.MAEDA, (Tanzania), pointed out that breeders of other species bred for increased milk production to improve weaning weights and postweaning growth rates. Was this not possible in rabbits? This would also help in increasing the size of litters.

F.M. EL AMIN, noted that the rabbit suckles her young only once in 24 hours and this was for a short time. Thus increasing the litter size to over 8 would wxceed the number of teats on the mother. He proposed that selection for increased number of teats would allow increasing litter sizes but the extra teats so far observed had been non functional.

N. MAMATTAH, asked if the rabbits used in the breeding experiment were local or imported and also if there were rabbits which could be considered local to Sudan.

F.M. EL AMIN, replied that the New Zealand White and Californian breeds were used in his experiment but there were local rabbits in the Sudan.

Session II- Discussion 3

Speakers:	J.P. ADUMA:	coccidiosis in rabbits
	W.D. SEMUGURUKA:	Observations on rabbit diseases in Tanzania
	J.M. RUGH:	Housing of rabbits

B.U. KOTHARI, (University of Dar es Salaam), asked about the effectiveness of available drugs against coccidiosis.

J.P. ADUMA, noted that the faecal oocyst count was not always a good indication of the state of the disease and that animals with low counts might suffer considerably and visa versa. The most effective drug depended on circumstances, including the drugs used previously.

J.E. OWEN, (Tropical Products, Institute, Britain), from his experience noted that coccidiosis was often associated with white spots in the intestine. The intestinal walls were apparently often thin and the intestines filled with gas.

J.P. ADUMA, noted there were many organisms in the intestines which could be confused with coccidiosis.

J.E. OWEN, asked about salmonella problems in rabbits with reference to lizards which were sometimes found running over the cages.

W.D. SEMUGURUKA, noted that there were many animals that could transmit salmonella and that lizards etc could be implicated in certain conditions.

N. MAMATTAH, (Ghana) asked about the possibility of producing vaccines against coccidiosis.

J.P. ADUMA, answered that vaccines against protozoans were relatively difficult to produce and were of limited effectiveness. He felt the need was to make maximum use of good management and available drugs in combatting coccidiosis.

N. MAMATTAH, asked if the mud houses discussed by J.M. Rugh suffered from problems with insects such as fleas, and asked how were such houses disinfected.

J.M. RUGH, replied that he had not encountered any cases of insect problems with the mud houses and that these were maintained clean by daily sweeping. He added that sunlight was perhaps a factor in their natural disinfection in some cases.

J.P. ADUMA, mentioned the possibility of irradiated oocysts as vaccines.

M.E. SHAYO, (Ministry of Agriculture, Tanzania), commented that irradiated oocysts had not given good results.

D. GASPARI, (Mozambique), pointed out that hepatic coccidiosis was most serious in smaller scale units and intestinal coccodiosis in large units.

J.M. RUGH, observed that there were certainly more disease problems in larger units.

Mr MELLA, (Ministry of Agriculture, Tanzania), asked if it was possible to recommend a best housing system for Africa.

J.M. RUGH, replied that the possibilities were so diverse as to make this impossible. He suggested that promotion projects should have various designs and types on display so that farmers could choose which was most appropriate to their circumstances.

N. MAEDA, (Livestock Development Division, Tanzania), added that even in Tanzania different areas required different hutch types according to climate conditions.

J.P. ADUMA, asked if there were problems of mastitis in Tanzania.

W.D. SEMUGURUKA, replied that mastitis was not a problem in Tanzania.

P. WARNER, (Tsetse-Fly Research Project, Tanzania), reported that his unit of around 150 rabbits had only 2 cases of mastitis in 3 years.

W.D. SEMUGURUKA, warned against the continous prophylactic use of antibiotics for reasons of inducing resistant strains of bacteria and the risk of residues in the meat.

P. WARNER, stated that in his unit there had been no case of coccidiosis in 3 years as a result of good hygiene and management.

J.E. OWEN, commented that mastitis was a particular problem in intensive units using post partum mating, because of the stress that this practice induced.

H.Y. KAYUMBO, (Director General, Tanzania National Scientific Research Council), asked in the light of the potential importance of rabbits what was the situation with regard to the teaching of rabbit husbandry in African Faculties of Agriculture.

N. MAMATTAH, (Ghana), said that the University of Ghana was showing increasing interest in rabbit production. He stressed the use of short 3-week courses to illiterates, school-leavers and literates in promoting rabbit production in Ghana.

M.L. KYOMO, (Dean, Faculty of Agriculture, University of Dar es Salaam), stated that in the past the Association of Dean's of African Faculties of Agriculture had not considered detailed curriculum matters such as the time given to the teaching of rabbit production. However, he felt that in Faculties generally the attention given to rabbits was very small.

J.P. ADUMA, said that the University of Nairobi gave no courses in rabbit production. At Egerton College, Kenya, the students worked in the rabbit unit but there was no formal teaching in the subject.

R. RAMCHURN, agreed that some immunity to future attacks could develop although he was unable to say anything about the actual mechanism involved.

R. RAMCHURN, asked what was the tolerable level of oocysts in the faeces.

J.P. ADUMA, answered approximately 2 000 o.p.g. although it was difficult to be categorical because lower levels might result in actual disease and higher levels have apparently no effect.

Mr MELLA, pointed out that coccidiosis was to some extent self curing provided tissue damage was not extensive and there was no re-exposure, however the animal often died because of initial tissue damage.

A.J. NGOMUS, (Tanzania), asked what was the order of importance of the rabbit diseases at Egerton College.

J.P. ADUMA, replied that the disease conditions in order of importance were 1. coccidiosis, 2. pasteurellossis, 3. mastitis, 4. skin conditions.

CONCLUSIONS and RECOMMENDATIONS

1. Conclusions concerning the workshop

The workshop on rabbit husbandry in Africa was, in the opinion of the participants, an unqualified success. This was considered to be due to:

1.1. The excellent support and hospitality received from the Tanzania National Scientific Research Council and Faculty of Agriculture, Forestry and Veterinary Sciences, which was extremely important, and also that from the International Foundation for Science without which the workshop could not have taken place.

1.2. The response and level of support from the participants who came from several different countries.

1.3. The broad spectrum of participants, which included farmers, extension workers and scientists, representing a wide range of experience and viewpoints.

1.4. The arrangement of a pre-conference tour, which was especially useful in allowing many of the participants to know each other on an informal basis before the start of the formal sessions. This facilitated a freer and more enthusiastic interaction and exchange of ideas and information.

2. Recommendations concerning specific areas of rabbit husbandry

2.1. Breeds. No particular breed can be recommended but the wide variety of improved meat breeds available can be used both in their own right and to improve 'local breeds'.

2.2. Breeding. Breeding stations should be set up by governments to provide a supply of improved breeding stock to farmers. The kind of breeding policy employed is highly dependent on local circumstances and no particular system can be recommended.

2.3. Feeding. There is a considerable potential for the achievement of reasonable levels of rabbit production based on [illegible] feeding materials. These include herbage

2.4. Housing. There is considerable scope for the construction of housing suitable for use in a variety of climatic conditions using locally available materials, provided that the following principles are followed:

2.4.1. The rabbits must be confined and prevented from escaping;

2.4.2. The rabbits must be protected from predators;

2.4.3. The rabbits must be protected from bad weather;

2.4.4. The housing must be easily cleaned;

2.4.5. The housing should be easily maintained and reasonably durable;

2.4.6. The rabbits should be comfortable;

2.4.7. Easy access should be provided for the farmer.

It was noted that where building materials for housing rabbits are not available, rabbits can be raised with reasonable success on the ground. The above principles should still be observed.

2.5. Health. Common diseases can be avoided by a high standard of hygiene and careful management. There is a need for local veterinarians to become more interested in rabbit diseases and their treatment.

2.6. Escaped stock. If domestic rabbits escape on the African mainland, there is very little danger of them becoming pests because of natural predators and a lack of adaptability to a tropical environment when unprotected.

2.7. Equipment. Nest boxes are essential and should always be provided in breeding cages. They should provide privacy, adequate room for a doe and her litter and the sides should be high enough to prevent very young rabbits getting cut. Nest boxes and also other items of equipment such as feeders and drinkers can be constructed satisfactorily from locally available materials.

2.6. Acceptability of rabbits. Although rabbit meat is acceptable in many African countries and there appears to be no religious taboes concerning it, more promotion is needed to make rabbit meat more generally accepted.

2.9. Provision of employment. Because rabbit husbandry is in general a labour intensive operation in many African countries, it is suitable for the creation of employment and should be encouraged in areas where unemployment is high.

3. Future action necessary

3.1. There is a need to form national associations and branches of the World Rabbit Science Association in African countries to facilitate the further exchange of ideas and information. The International Foundation for Science is willing to aid this by the payment of either one individual or one group membership for each African country. It is recommended that those countries represented at the workshop take advantage of this and encourage other countries to take similar action.

3.2. There is a need for more literature dealing with extension, management and research on rabbits. The participants recommend that scientific papers and articles related to rabbit production are submitted for possible publication in Tropical Animal Production.

3.3. There is a need for more research on all aspects of rabbit husbandry but in particular urgent attention is needed in the following areas:

3.3.1. Feeding and nutrition, especially in the investigation of locally available tropical feeds;

3.3.2. Major rabbit diseases occuring in African countries.

4. The participants of the workshop on rabbit husbandry in Africa recommend that in two years time there should be a similar meeting held in an African country.

MISCELLANEOUS

NOTES ON SLAUGHTER AND CARCASE PREPARATION

J.E. OWEN

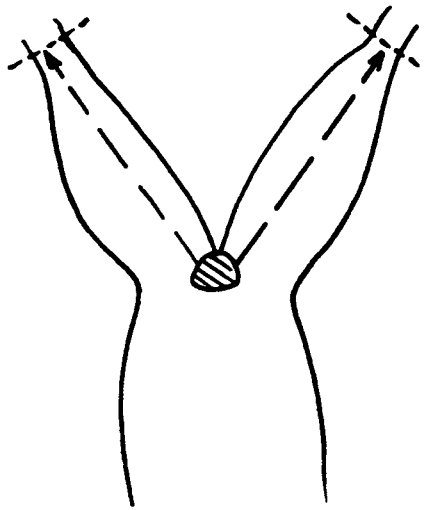
The rabbit should be handled firmly but as gently as possible both before and during slaughter.

1. Animal held by hind legs and neck broken by downward bending movement. Alternatively the animal can be stunned by a blow to the back of the head.

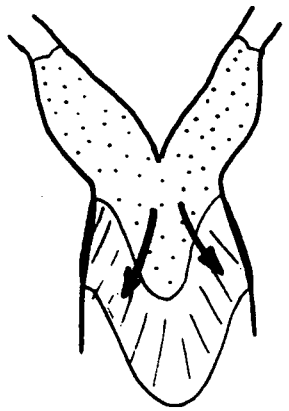
2. Carcase hung by hind legs on chicken shackles and immediately bled by severing the large arteries in the neck. Head restrained during bleeding to avoid splashing of blood.

3. Head and fore legs cut off, also tail (carried out with clippers). In some countries the head is left on and skinned with the carcase.

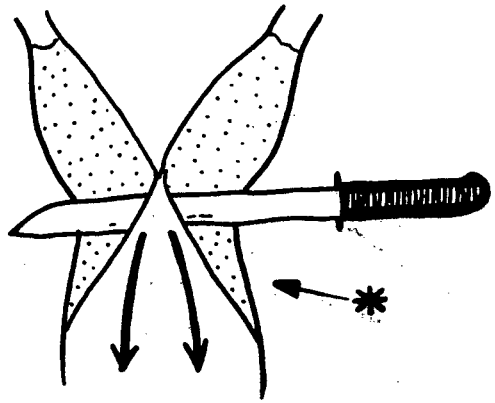
4. Start skinning at back where tail has been removed.



5. Pull skin halfway down back leaving on the hind feet (metatarsals)



6. Turn carcase around on shackles and separate skin from pelvic region with knife.



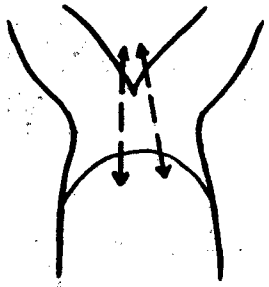
✱ When pulling the skin away from the abdominal region, cut the underlying connective tissue with a knife to avoid tearing the abdominal wall.

7. Pull off skin completely from carcase in one movement when freed from pelvic area.

8. Remove bladder, taking care not to spill the contents on the carcase.

9. Remove gut and liver, leaving behind the kidneys.

10. Remove anus by cutting section of pelvic girdle away with clippers, taking care not to leave any faecal material in the body cavity.



11. Cut through rib cage at sternum.

12. Remove lungs, heart and trachea and oesophagus.

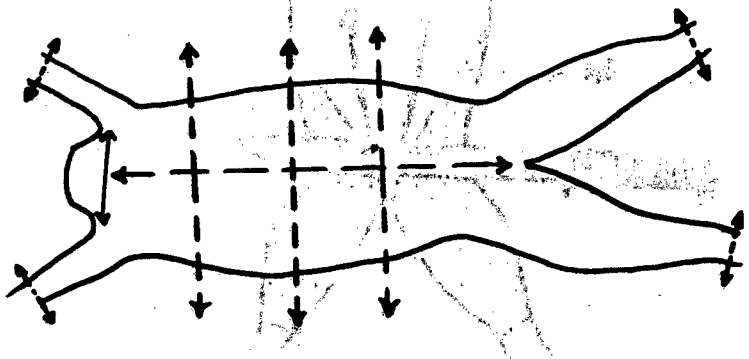
13. Cut off hind feet.

14. Wash with cold clean running water.

N.B. It is extremely important to use sharp and clean knives. Slaughter and carcase preparation should be carried out in a clean and sheltered area, which should be also free from disturbance (i.e. onlookers).

PACKING

1. Carcase cut as following.



2. Portions equivalent to half of carcase placed in plastic or cardboard tray with kidneys and are wrapped with polythene.

3. Livers packed and sold separately.

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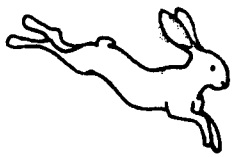
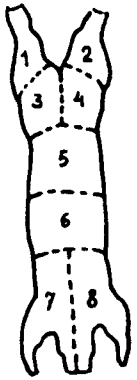
N.B. Here again sharp and clean knives should be used. If the carcases are not consumed on the slaughter day, they can be stored for 2-3 days in a refrigerator ($2^{o}C$). After this they must be consumed or stored in a freezer at $-15^{o}C$ or below. Preservation can also be carried out by smoking, drying and also slating the fresh carcase.



RECIPES
ON
COOKING RABBITS

Rabbit meat is light in colour, rich in proteins and with low calorie value. It does not need hanging to become tender. The meat can be stored for a few days in the refrigerator. In the deep-freezer it will last as any other kind of meat; it should be put into the freezer as soon as possble after slaughter.



To cut the rabbit into portion size pieces, see figure to the left on this page.

If the rabbit is big and not too young, it is recommended to marinate the meat a few hours or overnight in a mixture of wine or water, some oil, spices (usually herbs of different kinds), onion, and some vinegar or lemon juice.

A rabbit of 1 - 1 1/4 kilos should last for 4 - 6 persons. The following recipes are calculated for that number.

RABBIT BARBACUE WITH LEMON

1 rabbit in pieces

Marinade:

1/2 cup oil
1/2 cup lemon juice
1 cup water
1 clove of garlic, crushed
1 onion, chopped

==========

flour

Marinate the meat for some hours. Take it up and wipe dry. Powder with flour and fry in oil in a casserole until golden brown. Add the marinade and cover. Bring to boil and simmer for some 30 minutes, or until the meat is tender. Take out the meat and put on a serving dish.

Mix one tablespoon flour with some cold water and thicken the sauce, and pour

RABBIT À LA SILVESTRE (USA)

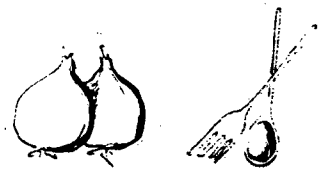
1 rabbit in pieces
oil
salt
1 cup raspings
1/2 cup flour
1 teaspoon salt
1 " pepper
1 " mild chili
1 " thyme
1 egg, whipped
butter and oil

Marinate the meat, as is described in the introduction, for some hours. Wipe it dry. Mix raspings, flour, salt, pepper, chili, and thyme. Soak the meat first in the whipped egg, then turn it in the rasping mixture. Fry it in a mixture of butter and oil until golden brown. Cover and bake in oven in moderate heat. Turn the meat over a few times. Take off the cover a few minutes when the meat is ready, to make a crisp surface.

Garnish with parsley and serve hot with ried potatos.

ETRURIAN RABBIT (ITALY)

1 rabbit in pieces
salt
pepper
2 cloves of garlic
3-4 leeks
mint
8-12 broad slices of bacon
oil
juice from 1-2 lemons



Season the meat with salt and pepper. Rub the bones with garlic. Cut leek length-wise and put one piece with each piece of meat together with a leaf of fresh mint. Wrap in bacon and fasten with a toothpick. Put the 'parcels' on an oven-proof dish and bake in 200°C until the meat is tender and golden brown. Pour over lemon juice and put back into oven for a few minutes.

Serve with mash potato and a mixed salad.

STEWED RABBIT (TANZANIA)

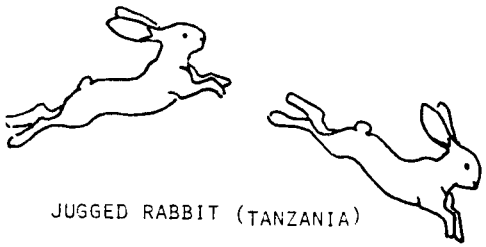
1 rabbit in pieces
2 onions,
2 carrots,
4 tomatoes
4 tablespoons butter or oil
4 tablespoons flour
2 cups water
salt
pepper

Rub the meat with salt and pepper and sprinkle the flour over the meat so that it is thinly covered all over.

Clean and cut up the onions, carrots and tomatoes. Heat the butter or oil and fry the meat until golden brown. Add the onions and carrots and fry for a few moments, then add the tomatoes.

Add the water, cover the pan and stew the rabbit for about 1 hour or until done. Season with salt and pepper and serve.

The tomatoes can also be added 5 minutes before serving.



JUGGED RABBIT (TANZANIA)

1 rabbit in pieces
4 onions, cut
2 carrots, cut
parsley, cut
2 cups vinegar or wine
2 cups water
2 tablespoons sugar
4 tablespoons flour
4 tablespoons butter or oil
salt
pepper

Boil the vinegar or wine with the water and vegetables, (only 2 onions!), add salt and sugar and let the marinade cool.

Put the meat in a bowl, and cover well with marinade, and leave it overnight.

Take the meat out of the marinade and let it dry a little. Heat the fat and fry the meat until golden brown. Sprinkle with salt and pepper. Add the remaining two onions, and the flour and let it become light brown.

Add 1 cup of the strined marinade. Stir well until the mixture boils and is smooth, then add another 2 cups of the marinade. Bring to boil, cover and simmer until the meat is tender, about 1 hour.

Season to taste, and serve.

FRIED RABBIT (SWEDEN)

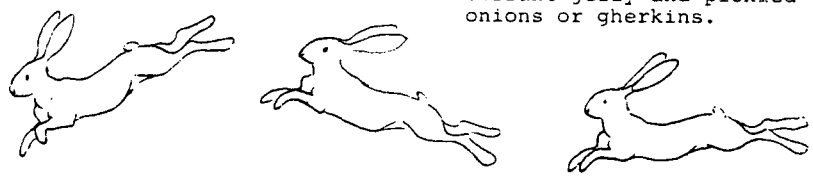
1 rabbit
light beer
2-3 tablespoons butter
1/2-1 tablespoon salt
pepper to taste
1/2 litre broth or water (red wine)
rosemary
sage

Sauce:
4 tablespoons flour
0.6 litres stock
0.2 litres cream
black currant jelly

The rabbit can be prepared whole or in pieces. Marinate the meat overnight in the beer. Take it up and wipe dry, and fry in a casserole until golden. Season with salt, pepper and herbs. Add broth or water (some of which can be replaced with red wine). Cover, and cook in moderate hot oven until the meat is tender (about 1 1/2 - 2 hours).

Take the meat out of the casserole, add some water and thicken the sauce with flour mixed with some cold water. Add cream, and black currant jelly to taste.

Serve with potatos, black currant jelly and pickled onions or gherkins.



RABBIT BAHIANA (BRAZIL)

1 rabbit
1 tablespoon butter
1-2 tablespoons flour
1 cup stock
shreds of orange peel
3/4 cup orange juice
3/4 cup lemon juice
2 green chopped capsicums
1 tablespoon parsley
1/2 cup chopped mushrooms
1 pinch ground ginger

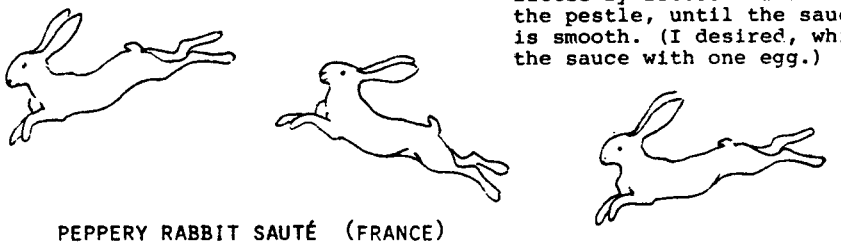
Cut the rabbit into pieces and sift flour over. Fry in a casserole in butter until the meat surface is golden brown. Add stock, orange and lemon juice, orange peel, and the other ingredients. Bring to boil simmer until the meat is tender.

GRILLED RABBIT WITH GARLIC SAUCE (CATALONIA, SPAIN)

1	rabbit
	oil
	lime juice
4-8	cloves of garlic
1	pinch salt
	oil
(1	egg)

Marinate the rabbit for one hour in oil and lemon juice. Take up the meat and season with salt and pepper. Grill the meat in hot oven on all sides; baste with marinade. Put the meat on a hot serving dish with grilled tomatoes or mushrooms.

Prepare the garlic sauce as follows: Crush the garlic in a mortar, add salt. Add oil little by little while stirring the pestle, until the sauce is smooth. (I desired, whip the sauce with one egg.)



PEPPERY RABBIT SAUTÉ (FRANCE)

1	rabbit in pieces
	oil
	salt
1	tablespoon butter
1	big onion, chopped
1	teaspoon pepper, crushed
1	tablespoon flour
1	cup white wine
1	cup broth
5	tablespoons cream

Season the meat with salt and pepper and fry in a casserole with onion until golden brown. Powder with flour and shake the casserole. Add white wine and broth. Cover, bring to boil and simmer some 30 minutes. Add cream and simmer 15 minutes more or until the meat is tender.

Serve with Brussels sprouts, endives or leek.

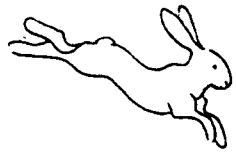
This dish can also be served flambé with brandy.

RABBIT PATÉ (SPAIN)

1	rabbit in pieces + liver
2	pcs of chicken liver
1/2	kilo pork meat
100	grams bacon
1	big onion
2	scallions
1	clove of garlic
2	eggs
2	tablespoons flour
	salt
	pepper
	thyme
	nutmeg
	brandy or calvados

Put the meat in a saucepan with only little water, bring to boil and simmer for 20 minutes. Chill and remove bones. Leave the best pieces of the loin and thighs aside. Mince the rest with the port, bacon, and rabbit and chicken liver (or 100 grams of liver paté). Season with salt, pepper, thyme, parsley and a pinch of nutmeg. Add a small glass of brandy or, better, calvados. Chop onion, scallions finely and crush the clove of garlic. Mix the minced meat with the vegetables. Add eggs and flour and stir well.

Add the whole pieces of meat to the mixture, and put it in an oven-proof pot. Press well, cover and put a weight on top. Put in water bath into medium hot oven. Bake for about 2 hrs. Uncover and chill. (If the top of the paté is dry, cover with lard.)



RABBIT WITH CAPSICUMS (SWITZERLAND)

1	rabbit
4	tablespoons groundnut oil
2	green capsicums
1	red capsicum
2	tomatoes
1	red onion
100	grams smoked ham
1	bouquet garni +
1	clove of garlic
	salt
	pepper
1	pinch of chili
1/2	cup water
+ -	parsley, thyme, laured or other herbs, to be taken away before serving.

Fry the meat in oil in a casserole on all sides until golden brown. Meanwhile, peel and cut onion, wash and dry the capsicums, remove the seeds and cut them into strips. Peel the tomatoes and remove seeds. When the meat is enough fried, put it on a hot plate.

Put onion and capsicums in the hot casserole and stir for 10 minutes with a wooden spoon until the meat juice is well absorbed. Be careful not to burn the vegetables.

Add the rabbit meat, tomatoes, clove of garlic (whole), ham, the bouquet garni, salt, pepper and chili. Add water. Cover and simmer for 1 hour or until the meat is tender.

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