Rabbit production in tropical zones

By

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Rabbit's origin and adaptation to the environment

Rabbit is a prolific small mammal the origin of which is the Iberian peninsula and south of France (Callou *et al.*, 1996). It was really domesticated only during the Middle Ages even if some attempts of controlled raising could be suspected in south of France during the first and second centuries A.D. (Gardeisen and Valenzuela-Lamas, 2004). Needs and behaviours of rabbit are then highly influenced by it's geographical origin. One of the main effect of domestication is the increase of the adult weight of rabbits raised for production : up to 5-7 kg live weight to be compared to 1.3-1.7 kg of the wild rabbit. A second consequence is the acceptation by the rabbit to live near of humans and to end to be alarmed by their presence.

Figure 1 : A group of wild rabbits

From it's geographical origin rabbit benefits of an adaptation to the Mediterranean climate, with hot and dry summers and winters that can be cold. A great part of this adaptation consists for a wild rabbit to spend the hot hours of the day in it's burrow, and to go outside for grazing and other activities, only during the colder hours of dusk and dawn. For the cold period rabbit has also the advantage of high quality fur cover, and mother kindles in a special burrow where a comfortable nest is built for the defenceless kits. Rabbit is also adapted to the variability of feed resources : abundant in spring, modest in summer and scarce in winter. In particular rabbit has adapted it's reproduction cycle that begins early at the end of winter in February or early March when the day length increases and vegetation will begin to grow up. Speed of reproduction is reduced and then stopped when the day length begins to reduce and the feed resources too. Then from it's close wild ancestors, domestic rabbit has conserved a high sensibility to day length which is the main regulation factor of it's reproduction, … if the breeder has no specific intervention.

Dispersal of rabbits around the World and adaptation

Peoples from South Europe (mainly French, Spanish, Portuguese and Italian) have disseminated domestic rabbit raising all around the World, the tropical countries included. In the mean time, the Anglo-Saxons have disseminated wild rabbits as potential game animal, with many unsuccessful attempts and only few but spectacular technical "successes" as in Australia and New-Zealand. Rabbit settlement was "successful" were climate was close to that of the country at the origin of rabbits, but particularly where the ecological niche was free and where correlatively don't exist predators for a 1.5 kg prolific herbivorous mammal living one part of the day below ground. At the moment, it's reasonable to consider that rabbits were introduced repeatedly in all parts of the world and consequently there is no new risk to see introduced rabbit pullulate as it was observed one and a half century ago in Australia, the

harm is done. Thus we consider that their is also no risk to see any swarm of domestic rabbit that have eventually escape breeding cages.

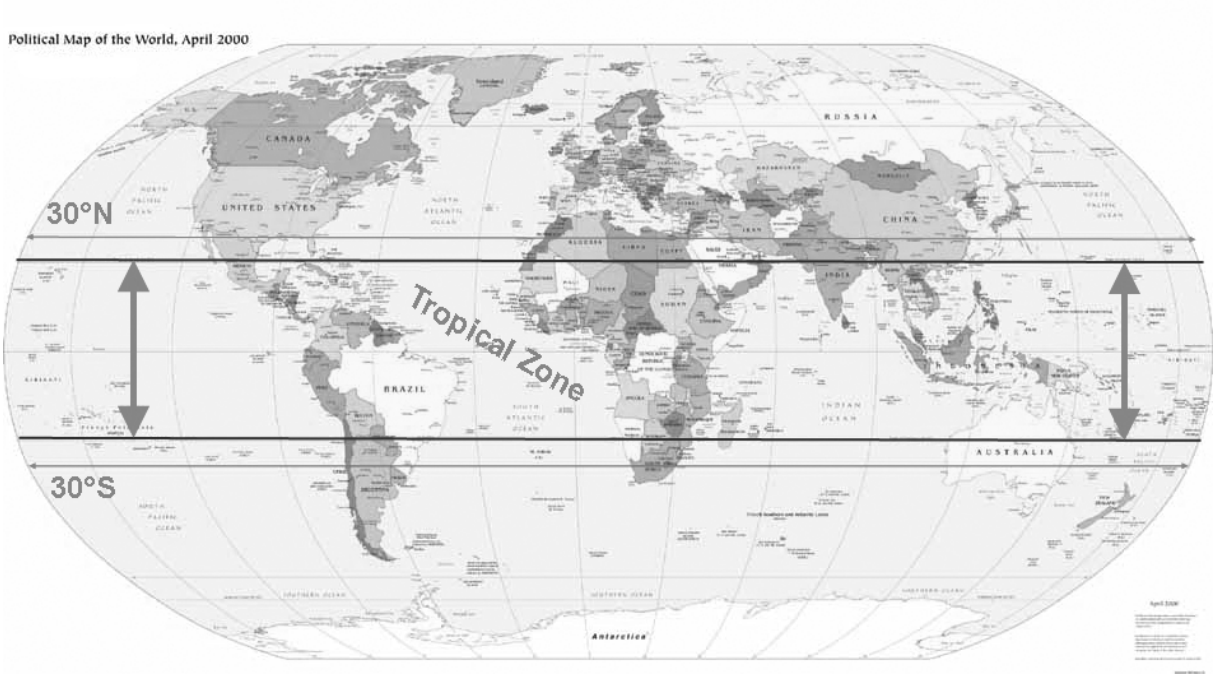
Dissemination of rabbit breeding outside of it's historical belt faced few predators problems because rabbits are kept in cages : no escape but also no (or only few) entry possibilities. In addition the breeder-man is in charge of food providing. Thus domestic rabbit is relatively independent of the temporary or locally periods of food shortage because of stocking harvested feed to face the bad seasons or because of possibilities of food importation from other countries.

On the other hand, domestic rabbit remains affected by direct climatic conditions : lighting, and temperature combined with relative humidity. Diffusion of rabbits outside of Europe is a quite recent phenomenon observed since 2-3 centuries and frequently only during the last hundred years. According to this recent situation, domestic rabbits used in different countries, the tropical one included, didn't had enough time for a real adaptation to the local climate. The only parameter that really has been changed was the adult weight of a named breed, which was reduced by 20-25% in hot countries. Effectively, a lower weight increases the relative surface per kg live weight and then facilitates the excess of metabolic heat evacuation, and then the hot temperature tolerance. Due to the various rabbit sensibilities, breeders have to adapt their practice but also their demand to the rabbit species according to the local climate.

Main characteristics of topical climates and limiting factors for rabbit production

Countries located between the 2 tropics and more generally between the 30th north and the 30th south parallel, don't have a single climate but a large range of climates. Nevertheless they have in common a small annual variation of sun lighting duration, and a tendency to have hot temperature all along the year. Main sources of variation of temperature are the distance from the equator and the local relief, modulated by the balancing effect of altitude and of some oceanic streams.

Figure 2 : Map of countries included in the tropical zone



For a simplified description, and according to rabbit's heat tolerance, it's pertinent to consider in one hand countries or regions were average temperature does not exceed 25°C-28°C with maxima rarely above 34-35°C, and in the other hand those countries or regions were during a large part of the year average temperature exceed 28-30°C with daily temperature maxima above 35-36°C. In the first group, and specially if temperature is moderated by altitude as in the central part of Africa or in Mexico, rabbit breeding is possible and even easy. On the contrary, in the second group rabbit breeding is difficult as it is for example in the Sahelian part of Africa. Nevertheless the performance of the rabbit breeding unit of the Avikanagar research Centre in the Rajasthan desert (India) demonstrates that with partly buried breeding buildings it's possible, but it's not easy and results are far of the maximum.

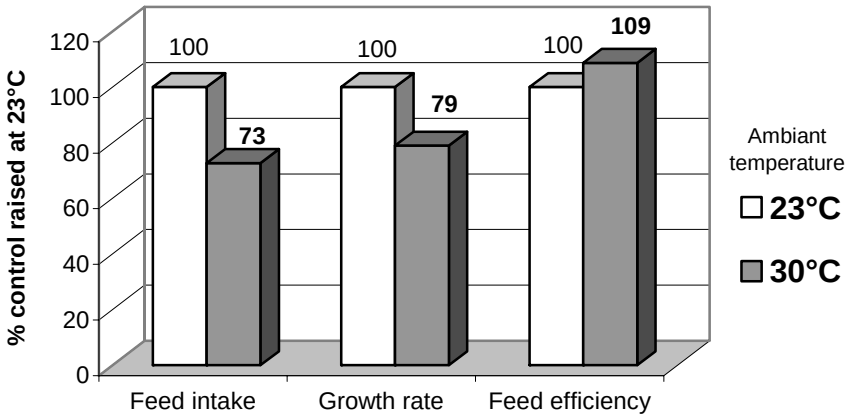
Impact of temperature on rabbit's performance

As a general situation, temperatures higher than 24-25°C induce an important feed intake reduction as demonstrated on table 1. Between 5 and 23°C feed intake is regulated by the digestible energy required for maintenance and constant production. But at 30°C, rabbits are heat stressed and both feed intake and production are reduced. Water intake may be reduced or not, but in all cases the water/feed ratio is increased. The consequence of the reduction of feed intake is always a reduction of performance, for example of milk production as is table 1 or of growth rate as in figure 3.

Table 1 : Effects of various ambient temperatures on lactating rabbit does performance (according to Szendrö *et al*., 1998)

Performance	Temperature			
	5°C	**15°C**	**23°C**	**30°C**
- Feed intake (g/day)	289	278	269	185
- Water intake (g/day)	505	521	536	436
- *Water / Feed ratio*	*1.91*	*2.02*	*1.99*	*2.53*
- Milk production (g/day)	159	161	161	114

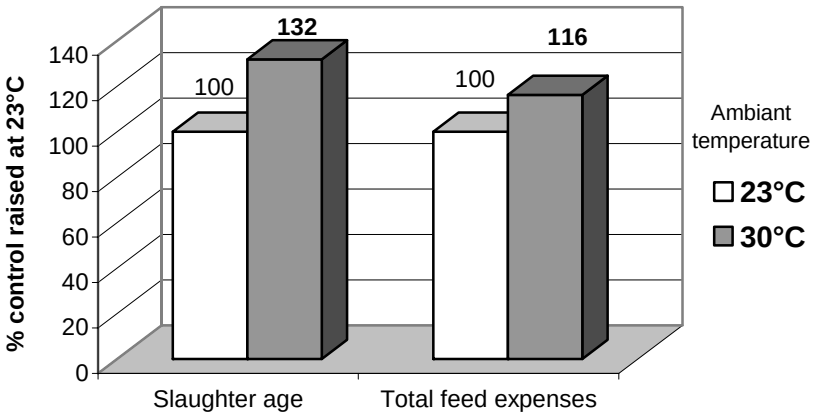
Figure 3 : Relative feed and water intake, and feed efficiency of young rabbit does raised at 23°C (relative humidity 70%) or at 30°C (relative humidity 80%) from 5 to 12 weeks of age. According to Matheron & Poujardieu, 1984.



At 30°C feed intake was reduced by about 25% in reference to the 23°C control. The corresponding growth rate was reduced only by about 20% only, inducing a better feed efficiency (+9%), which could be considered as a positive effect of the highest temperature. But if, whatever the temperature, are considered the age and feed quantity necessary to arrive at the same final live weight (2.4 kg in the example), the age was increased by 30% (112 *vs* 84 d.) and the

quantity of food eaten during the whole "fattening period" was increased by 16% (8.2 *vs* 7.1 kg) for rabbits raised at 30°C compared to those raised at 23°C (figure 4).

Figure 4 : Relative slaughter age and fattening feed expenses for the same slaughter weight, of young rabbit does raised at 23°C (relative humidity 70%) or at 30°C (relative humidity 80%) from 5 weeks of age until 2.4 kg. According to Matheron & Poujardieu, 1984.



In the above experience, authors have raised the young does until 16weeks of age and then they have measured the ovulation rate. Number of ova per ovulation was only 7.4 for does raised at 30°C compared to 9.2 observed for those raised at 23°C. This difference was essentially the consequence of the lower live weight of young does raised at 30°C : 2.45 vs 2.93 kg. Effectively if the classes of weight were considered, in one hand the intra-class ovulation rate was independent of raising temperature and, in the other hand, ovulation rate increased with live weight.
A lot of studies was conducted in different countries on relations between ambient temperature and rabbits nutritional requirements. A precise conception of the diet can reduced the negative effect of hot conditions, mainly through an increase of the protein / digestible energy of the diet (Lebas and Ouhayoun, 1987), but in no case the composition of rabbit's feed is able to erase the negative effect of hot temperatures (Cervera and Fernandez-Carmona, 1998). One of the consequences is that for a given genotype the adult weight is lighter if rabbits are bred in a hot environment than if they are bred in a temperate one.

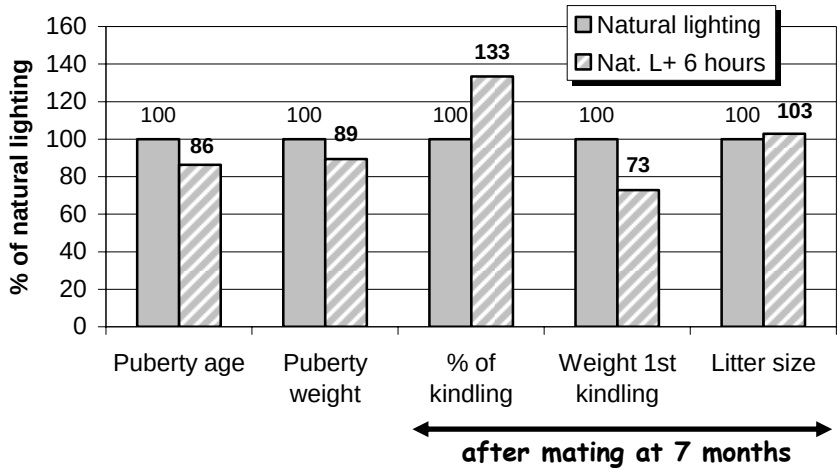
Lighting and rabbit production

As previously mentioned, tropical climates are also characterized by a relative stability of the day length all around the year, and the remaining variation decrease down to zero with the proximity of equator. Different experimental works conducted in temperate conditions have demonstrated that daily duration of lighting has no influence of growth performance, but on the contrary it's one of the main factors of regulation of reproduction. Conclusion of these works and of many field observations are that 15-16 hours of lighting per day are more efficient to promote rabbits reproduction than 12h/24h (Lebas *et al*., 1996), precisely the duration observed under the equator. Different studies were conducted to determinate if under tropical condition a daily light / dark 16h/8h cycle is as efficient as it is observed in temperate countries as for example in France, where it is the natural situation in June.
A first short time study was conducted in the INRA centre of "La Guadeloupe" (French West Indies). Young sub-adult rabbit does, 113 days old, were placed in a building where natural lighting was completed up to 16h/24h during 7 days. Then, their aptitude to accept mating was tested 4 times and compared to that of does raised in a similar building but without light

supplement. On 1st day, 34.1% of does with supplementary have accepted mating and only 2.5% for the control under natural lighting. On the 3rd day the cumulative proportion of does that have accepted the mating were 58.5% and 35% for does in the same order. On the 4th day the observed numerical advantage of light supplementation was no more significant. Conclusion : a short term light supplementation is beneficial.

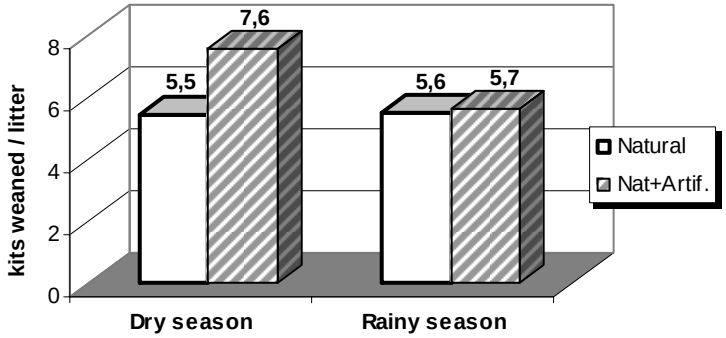
In a longer study conducted in Nigeria at the University of Port Harcourt (Berepubo *et al.,* 1993) the effect of a 16L/8D cycle was also compared to natural lighting. Young does were included in the test at 90 days of age for a 4 month study. Sexual comportment and reproduction parameters was tested every day during the 4 months.
For does with light supplementation puberty was observed earlier than for the control : 144 vs 167 days of age (figure 5). All does were mated at the age of 7 months. The proportion of fertile matings was higher with light supplementation : 67% vs 50%, but without effect on litter size (6.7 kits/litter on average). In this second study light supplementation was also beneficial.

Figure 5 : Relative effects of a lighting supplementation applied during 4 months (+ 6 hours from 18:00=>midnight) starting at the age of 3 month, on reproduction performance of rabbit does in Nigeria, in comparison with natural lighting (Berepubo et al., 1993)



A third study was conducted in the same research centre than the first (French west Indies) : during one year a group of commercial crossbred does was submitted to a lighting supplementation in order to obtain a 16L/8D cycle, and the reproduction performances were compared to that of a control group submitted to the natural lighting. The number of kindlings

Figure 6 : Effects of a natural lighting (12h/24) eventually prolonged with artificial lighting up to 16h/24 on the average litter size at weaning during the 2 main seasons in the French West Indies (Deprés *et al.*, 1994)



per doe and per year was similar in the 2 groups. On the contrary with the artificial light supplementation, number of kits/litter at birth or at weaning (6.6 vs 5.5) was higher, without modification of weaning weight (505 and 501 g at 28 days). Nevertheless this average effect on kits number was the combination of an important effect observed during the dry season (figure 6) when climate is relatively temperate and air humidity low, and of an absence of

effect during the rainy season when temperature and humidity are high (uncomfortable period for rabbits as for humans). This situation demonstrate that an important interaction between different climatic parameters and on the side the interest of long term experiments.

Average productivity observed in different tropical countries

Productivity is most generally expressed as number of young produced per rabbit doe and per year. Sometimes the litter size and number of litters per doe and per year is also indicated. The reference values generally used are those observed in France, Spain or Italy where average productivity per doe and per year is more or less 50 young produced (ready for slaughter) in commercial rabbitries. This corresponds to an average of 6.8 litters of 9.5 born alive and 8.0 at weaning (table 2). It is possible to estimate the specific effect of tropical

Table 2 : Average performance observed in commercial rabbitries in France and in French tropical territories (overseas Departments of *la Guadeloupe, la Martinique* and *la Réunion*) Data from Casse (2002), Hénaff et Surdeau (1995), Deprés et al, (1996), Anonyme (2005)

	France	**Tropical**
- N° Litters /doe /year	6.8	6.4
- Weaning litter size	8.0	5.5
- Rabbits / doe / year	50	35
- Average slaughter weight	2.40 kg	2.35 kg
- Age at slaughter (days)	70-72	82-87

climate through performances observed in the French tropical Department (La Guadeloupe and La Martinique in the Caribbean Sea, and La reunion in the Indian Ocean). Effectively, genotypes are the same than those used in France, pelleted feed are most frequently the same (manufactured in France and then transported), breeding equipments are the same and breeders benefit of the same technical training. In these French Overseas Departments, with tropical climates (main crop production : bananas and sugar cane) average productivity is 35 rabbits per doe and per year, with a slaughter weight of 2.3-2.4 kg. By reference to the Metropolitan France performance (table 2) the main difference is in the number of young per litter : 6.5 vs 9.5 born alive. The average number of litters per year is similar in the 2 climatic conditions. This comparison make possible to conclude that tropical climate reduces numerical productivity of rabbits by about 30% in comparison with temperate climate. For growth rate , the reduction is only 15-20%.

In other countries where some big rabbitries are more or less prosperous and where purchasing power of such breeder is quite high as in Brazil for example, annual productivity of rabbit does varies from 20 to 34 young ready for slaughter , depending of the production system adopted. In other countries where the purchasing power of rabbit breeders is lower, as in Indonesia or in Nigeria for example, productivity is limited to 10-15 young / doe & /year only (table 3). This situation is a consequence of small litters size combined with high mortality and of a small number of litters per year.

Table 3 : Average rabbit does productivity and growth rate of young, in some tropical countries (Colin and Lebas, 1995, Kpodekon *et al.*, 2004, Habibie and Raharjo, 1996 and Hassan and Owolabi, 1996 and)

Countries	**Young /doe & /year**	**Daily growth rate (g/day)**
- Brazil	20-34	28-34
- Benin	18-25	20-25
- Indonesia	10-15	15-18
- Nigeria	10-15	10-15

This situation is a consequence of the bad technical knowledge of breeders (general educational problem mixed with low specific technical training) combined with low purchasing power. In these conditions they are not able to buy the necessary complete balanced feeds or more productive rabbits (but with higher requirements), and too frequently breeders spend the few money available in purchasing low cost miraculous products or animals without any effect in the best situation.

Some possible ways for rabbit production improvement.

Training and education**.** The most short term efficient method that can improve rabbits productivity is certainly the technical training of breeders, and more of the managerial staff. A relative failure of a program of promotion of rabbit production was for example observed in Mexico at the end of the 70's : breeders were well trained but not personnel in charge of the local promotion and of the follow up care of new breeders (they had only a general formation in agriculture, but none or a too short one in rabbit production).

The positive impact of breeders and staff training can be measured for example in Benin, one of the poorest country of the world. A simple training of breeders, the organisation of mutual aid and the organisation of the logistic circuit for locally produced complete feeds, have make possible the evolution of productivity from 12-15 at the beginning of the 90's to the present 20-25 (table 3), despite a dramatic epidemic VHD phase (followed by a vaccination campaign and the reconstitution of the rabbit population). In this country the new breeders are supported by more ancient ones formed to this activity, themselves supported by regional technicians: for small everyday problems ask your referent neighbour, for more important or recurrent problems ask the regional technician (intervention in presence of the local referent, a simple method for continuous formation of referents).

Genetic improvement. An other possible way to improve rabbits productivity, is the genetic improvement of the animals. Most of breeders are convinced it is a or **THE** solution of all their problems, sometimes with reason, but sometime without. Too frequently breeders forgot that bigger rabbits (big adult format, with correlative high absolute growth rate) or more prolific strains must receive feeds adapted to their [also higher] requirements, in quantity as in quality. If raising conditions are in a high status (hygiene, quality of feeds, …) as it is for example in the INRA research Centre of La Guadeloupe, the improvement observed in temperate conditions as a consequence of specialised crossbred lines utilisation, is also observed in tropical conditions (table 4).

Table 4 : Reproduction performance of purebred New Zealand White rabbit does (line INRA 1077) or crossbred ones (line INRA 1067) raised in temperate or tropical conditions. (average of one year) (according to Brun and Ouhayoun, 1990 and Deprés *et al*., 1994)

Climate	Parameters	Does genotype		
		Purebred (1077)	Crossbred (1067)	Advantage of crossbred
Temperate (Toulouse)	- kits alive / litter	7.6	9.0	+18%
	- kits weaned / litter born	6.7	7.3	+ 9%
	- N° matings for 1 kindling	*1.12*	*1.12*	*0*
Tropical (La Guadeloupe)	- kits alive / litter	6.4	7.3	+14%
	- kits weaned / litter born	5.7	6.5	+14%
	- N° matings for 1 kindling	*1.3*	*1.3*	*0*

On the contrary, if nutritional requirement are not satisfied, and/or if hygienic conditions are not correct, the higher potential of crossbred rabbits cannot be shown and more, can become a handicap. The use of such ameliorated lines must be limited to rabbitries (countries) where

general conditions of production are good, included the conditions of renewal of breeding rabbits. It's important to remark that the used of crossbred rabbits implicates to buy new selected animals at each generation. In countries where the economic situation don't allow such a renewal method, the use of purebred rabbit is more advisable. In this system breeders produced the renewal does for their own rabbitry and have to buy regularly only some selected males. For these breeders, the introduction of selected males in the herd is most generally a real improvement. In fact this solution for the management of the breeding rabbits renewal is independent of the country, but it could be applied in most of the tropical countries.

Feeding improvement. A third way that can be used to improve rabbit's productivity is to work on the qualitative and the quantitative aspects of rabbit's feeding. The first step, as explained above, is the breeders training. They need to know what can become a rabbit food, how to feed the animals and how to organize the different feedstuffs into a hierarchy also in case of food shortage. In the same time it is necessary to work at regional scale on possibilities of complete feeds supply involving the highest possible proportion of local ingredients. It is preferable to propose a not completely balanced feed but locally manufactured with local ingredients than a well balanced feed that needs the importation of most of it's ingredients. The main risks with imported ingredients are the stock shortage without possibility of local replacement of the missing ingredient, and the temptation for the responsible of the importation to buy at low price a product claimed "high quality feed grade " but in fact of low quality.
Control of the hygienic quality of feeds and of the ingredients included in the feeds is also a key point of the rabbit's productivity improvement that pass through rabbit's feeding. Too many rabbit projects have failed because their promoters have forgotten that it was necessary to import all feed ingredients (see above the associate risks) and/or because they have not establish a program that included the control of the feeds quality. A local production of feeds (by the breeders or in the country) is not by itself a guaranty of quality. It can escape some problems of availability but has also frequently difficulties to solve some others, mainly of qualitative order, in relation for example with the cost of analysis that must be paid for themselves for small amounts of products. It must be for example underlined that rabbit don't support mycotoxins the origin of which could be moulds development in the complete feed itself as well as in the feeds ingredients during storage before complete feeds manufacture (Lebas *et al.*, 1998). The risk of development of mould producing mycotoxins is particularly high in tropical countries, above all if storage conditions are not perfect.

Conclusion

At the end of this short overview of rabbit production in tropical zones, it can be underlined that rabbit may be bred in most of the tropical countries. Nevertheless productivity performance under this type of climate should not be as brilliant as under temperate climate as it is observed Europe for example. But local populations are more interested in the availability of product than in an inscription in the great book of records. Rabbit breeding may be a suitable solution for animal protein supply of population in the tropical zone even if partial, but at condition that previously to the promotion of this production, promoters make a complete analysis of technical and economical conditions. This analysis must indeed take in account the tropical climate but also local resources, needs and possibilities of the populations, and human resources to locally promote and supervise the project. This is not really specific to rabbit production but the small size of the animal should not be the excuse of a small preparation of a promotion program.

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