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Raising rabbits for food security
(main paper)

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RAISING RABBITS FOR FOOD SECURITY
(Main report)

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ABSTRACT

The problem of improving rabbit production in very poor rural areas of Developing Countries is considered, taking into account also the macro-economic effects of a wide diffusion of small backyard units. Examples are reported with reference to improving rural traditional systems, building up simple, low or no cost self-made structures and equipment and adopting specific strategies in order to develop appropriate and really sustainable production systems. Examples refer to defence from predators, equipment, genetics, management and feeding. Special attention has been devoted to rabbit keeping as a part of integrated backyard systems.

INTRODUCTION

Originated in the West Mediterranean area, rabbit is there still very popular. Rabbit keeping is rather common in the areas where this activity is traditional like Asia, West part of the Northern Africa, Nile delta and some South American countries, mainly Mexico and Caribbean islands. It is not easy to introduce such activity where the breeding is not traditional, because of cultural reasons, problems of producing cages, relatively complex management, scarce feeding resources and low thermotolerance of the species. But raising rabbits must be considered as an important contribution to assure food security because of the attitude of the species to produce when only some vegetal resource is available. The fact that rabbits are not competitive with man for food is often mentioned.

The most common, traditional way to keep rabbits is to leave them to dig their borrows in the yards or from some room of the house. Sometimes small stone shelters are prepared, from where rabbits begin to dig. It must be considered that most of Developing Countries have tropical climates, thus to permit the animals to find underground a better microclimatic condition during the day accords with the ethology of the species. Rabbits form colonies and reproduce freely. But the control of each single animal is difficult, hygienic conditions are scarce and production is minimal (4 to 8 heads per doe per year). Nevertheless the system is simple, since it is not necessary the control of mating and setting the nest-boxes and its diffusion witnesses for an appropriate management, responding to family needs. It could be improved and made more efficient but it is not wise to discard it before considering its advantages.

This system of raising rabbits is scarcely known and still less appreciated as useful and, when speaking of rabbit keeping, the reference is normally intended to a building containing wire-net cages, where animals are kept to produce meat, adopting a more or less technologised management.

But this way of thinking has become general only since a few decades. Before the development of the industrial system, the reference was only to a limited number of rabbits raised in wooden cages mostly in the open air. Only grass and some grain were administered, reproduction rate was very low and no prophylactic mean was utilised. The genetic material was not particularly valuable but probably fit to produce in those peculiar conditions.

Since industrial production is necessarily based on the exploitation of single species it has also been forgotten that, in the rural and peri-urban reality, rabbit is not bred alone, but together with other species in farms or backyards.
This system is up to day the most diffused all over the world and it still gives an important contribution to production, also in the industrialised Countries of the Mediterranean area where rabbit meat is a traditional food. There is no doubt that its diffusion and antiquity is the best proof of sustainability of raising small animals in the backyard, both relatively to single species and to multi-species integrated systems.
Field technicians and project makers should then begin to think to rabbits not only as to a species able to produce according to technologies that should be specifically related to socio-economic and cultural conditions. Rabbits must be also considered as an element of backyard systems. There, together with other species, they can give a better contribution to food security and, may be, to some extra income for the family, in a complex frame of differentiation, integration or competition for feed, space and person work.

FOOD SECURITY AND BACKYARD SYSTEMS

In figure 1, the general frame and the place where attention should be focused are shown. For centuries, from the origin of domestication till nowadays, the aim of keeping animals has been to exploit properly the vegetal bio-masses present on the territory, which are or grazed or lost. Pastoralism has been, and still is, the appropriate technology. Later on, when populations became sedentary, small species also began to be useful to exploit the small amount of biomasses available in the areas around dwellings or villages. This gave women the chance to enter into the production process, raising small animals in the open or closed areas near their homes. The problem is how to intensify rural production maintaining the original trait of sustainability.
Unfortunately there is a lack of specific know-how for most of the animal keeping situations that need appropriate technology in the low income, food deficit countries. This is because research is nowadays directed exclusively to improve industrial systems, even in the research centres of countries where industrial animal production is still insignificant or non-existent. The latter situation is paradoxical, but the reason is that industrialised systems appear to most people as the only way to development. The result is that it is difficult to sustain family raising systems for lack of appropriate knowledge, while it is now clear that industrial animal keeping systems are mostly unsustainable in the lesser developed areas. Some peri-urban areas where the presence of sufficient infrastructures and favourable marketing conditions makes it possible and convenient to introduce some small commercial activities represent the main exception. However this is frequently done on private initiative without need of any external support coming from projects.
As a matter of fact, if the technical manuals from the beginning of the century are examined, it is possible to observe the abrupt stopping of the slow process of innovation of family keeping systems, mainly based on tradition, and the sudden starting and quick increasing of the research-based industrial ones.
The historical situation is illustrated in figure 2. There was a brusque jump in the passage from extensive to intensive animal raising systems because of the logic of production, which changed radically. One system developed *after* the other but not *from* the other. It was completely new. And the know-how related to the rural system stopped developing to the point where it had arrived. As it is shown in the figure, it is questionable if rural systems can become dynamic again.

Main differences, which explain why there cannot be any contiguity between the two systems, are illustrated in figure 3 (FINZI, 1998). Backyard systems are deeply rooted into tradition; thus they are intrinsically static and resistant also to simple innovations, even if they have been proved to be useful and sustainable. This is not a minor problem when projects are

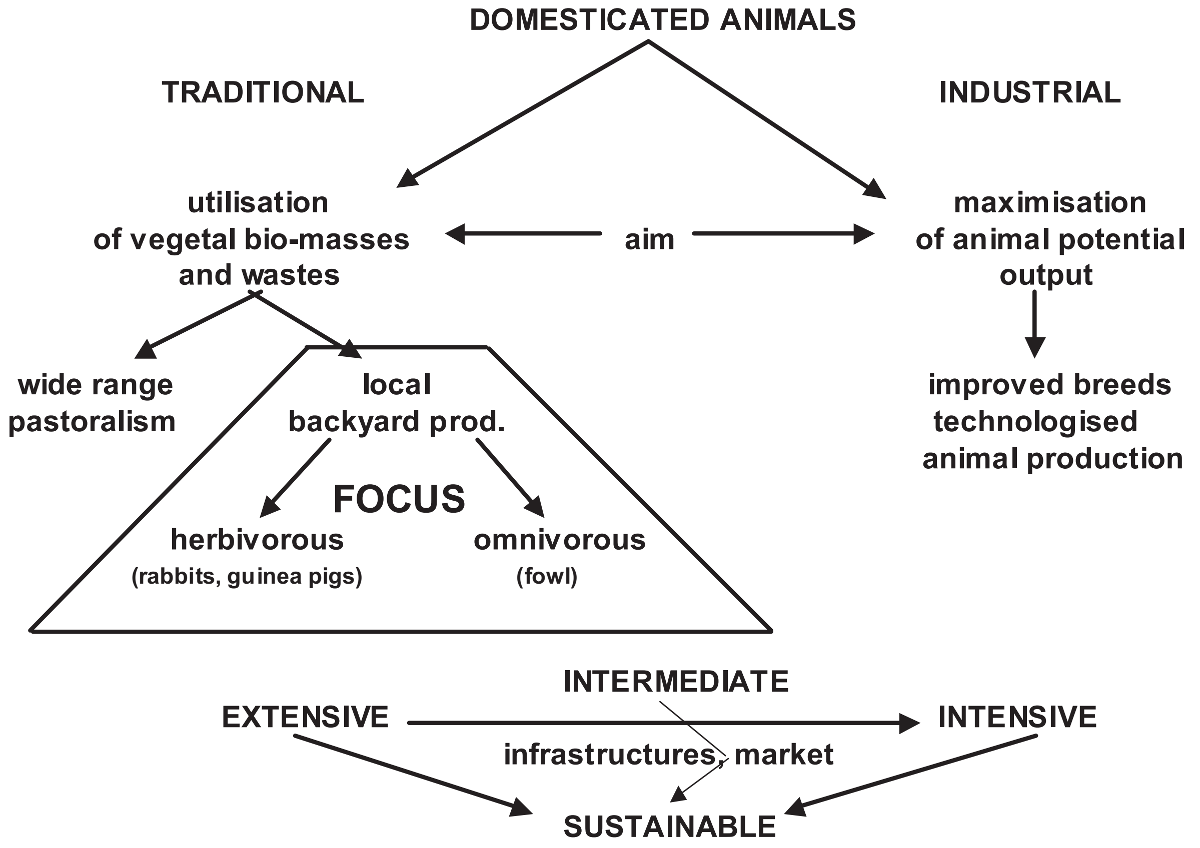

Fig.1 - Family backyard production is part of the system which optimises utilisation of natural bio-masses in opposition to maximisation of animal genetic potentiality

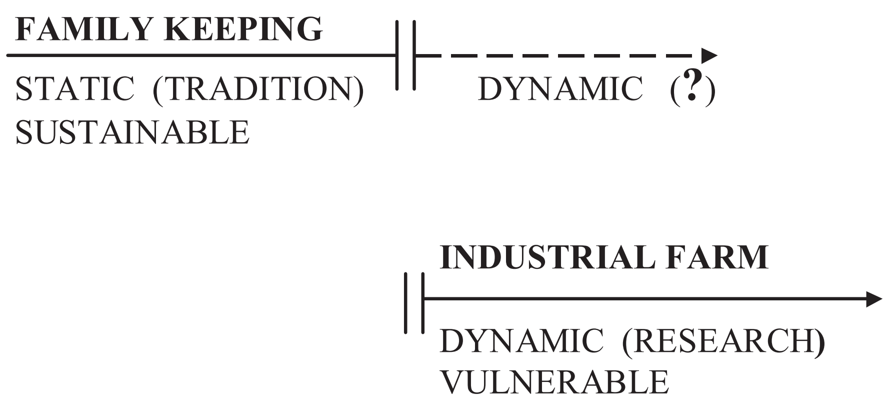

Fig. 2 - Development of industrial units is something new, unconnected with rural tradition. The question is if it can be found again a way of evolution, specific for family keeping.

prepared because it may happen that even simple technologies, or hygiene practices, or nutritional improvements, if not explicitly rejected, are simply left aside as soon as the project is over. But if they are proved to be worthwhile and accepted by someone, then other people begin to imitate and tradition is less impairing the evolution of the system.

The land-detached capitalistic industrial production system needs an advanced infrastructural organisation to support the many sophisticated exigencies of production, which seldom can be satisfied all together in a Developing Country. The aim of the industrial farms is to produce a high profit for few investors, selling to the rich people in towns, and it has no relationship with people food security and welfare.

Also the cultural level of town people is generally enhanced and it is easier to get the management competence to run a more complex production system, based on the exploitation of exotic breeds. The logic of the new system and the need to mortgage the structures is more easily understood and accepted.

Local breeds represent a peculiar germplasm, which frequently adapts to local environmental conditions and may be suitable for conservation and valorisation. On the other hand, exotic breeds or hybrids, which are the result of advanced genetic work, are more exigent and need an industrial frame to be produced, properly utilised and marketed.

Another important difference is that industrial production needs composed balanced feeds, which depend on a specific agro-industrial net. Though some vegetal by-products could be potentially utilised, in practice they should be concentrated, sufficient in quantity, easy to be stocked and transported, and available all the year round. The lack of only one of these traits is the reason why most of the possible feedstuffs, though well known for palatability, chemical composition, digestibility and nutritional value, are not utilised in the industrial feed factories. They are lost in the fields, or, at best, employed as fuel or to produce compost.

Figure 4, for instance, refers to 170 vegetal feedstuffs or by-products, well known for their nutritional traits for rabbits, and many of them available in Developing Countries. Only 27 (15.9%) are utilised by feed mills, only 10 (6.8%) are the maximum used to prepare a single mash, 7 (4.1%) is the average and only 5 (2.9%) is the minimum (FINZI AND GUALTERIO, 1986). As a consequence, more than 84% of well known vegetal spontaneous or cultivated plants or by-products (from point A to point B in the figure), being unavailable for industrial purposes, must be utilised as they are in the very place where they were produced, or they become lost as nutritional bio-masses. Not to be misunderstood, the figure refers to the number of feedstuffs and not to their output, because some cultivated plants such as alfalfa or some agro-industrial by-products as bran or oleaginous seed extraction flour are available in great amounts with respect to other products.

Only the dispersed animals reared in the villages are able to utilise properly these plants or by-products where and when they are available, transforming these bio-masses in low or no cost nutritional resources. This is true also in industrialised countries, but this chance is more important in the low income, food deficit areas. When projects are prepared it is necessary to identify the origin, the amount and the seasonal output of all the nutritional sources of the area, in order to exploit them to the best, through the most suitable combination or by a proper integration of diversified animal species.

If rural and industrial systems are so clearly separated and the latter does not represent an evolution of the first, but must be considered a new independent one, it can be easily understood why the solution of transferring modern genetics, technology and management from the industrial system to the rural one has not the effect of improving the latter. It would be transformed radically to a new one that will only be profitable if basic conditions, mainly infrastructures and market, are present, and unsustainable if not (fig. 5).

Thus the question if, when and how small animal-based family production systems can undergo a specific and appropriate evolution, without losing their original characteristics,

SYSTEM

INDUSTRIAL	FAMILIAR
CAPITALISTIC	SOCIAL
1 (FEW) INVESTORS	MANY SMALL-HOLDERS
PROFIT	FAMILY NEEDS
CONTINUOUS HIGH IMPUTS	LOW IMPUTS TO BEGIN
WORK INTENSIVE	PART-TIME
COMPLEX TECHNOLOGIES	SIMPLE TECHNOLOGIES
QUICK INNOVATION	TRADITION
HYBRIDS	BREEDS
LAND DETACHED	FARM INTEGRATED
CULTIVATED FEEDSTUFFS	NATURAL FEEDSTUFFS
INFRASTRUCTURED	AUTOSUFFICIENT
URBAN MARKET	ANY MARKET
RIGID	FLEXIBLE
RISK EXPOSED	SUSTAINABLE
DEVELOPED COUNTRIES	ANY COUNTRY

Fig 3 - Industrial and family production systems have no points of contact .

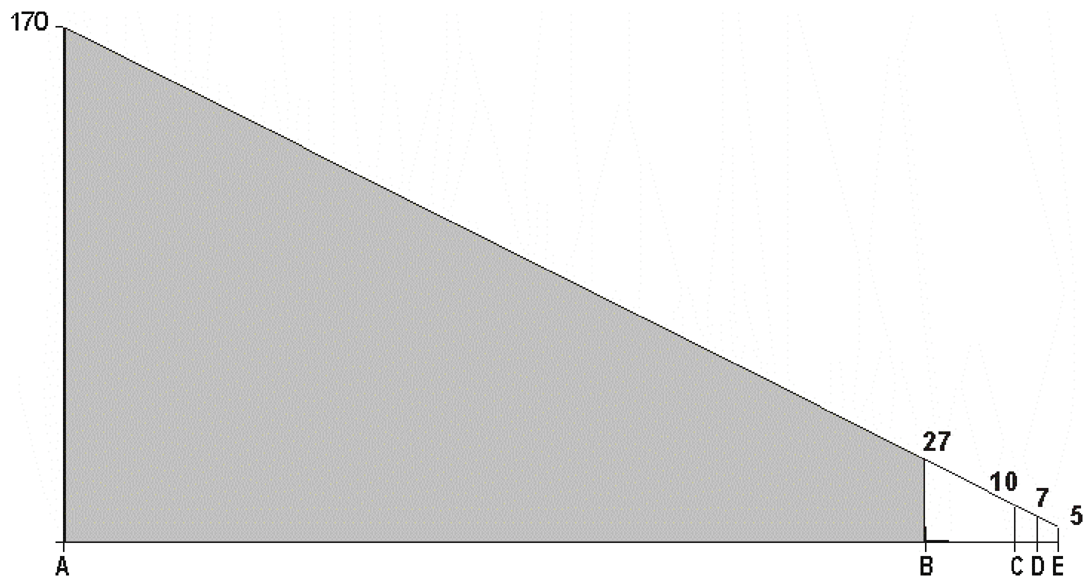

Fig. 4 - Well studied feedstuffs for rabbits: A- potentially available. B - industrially utilised (15.9%). C - maximum in a single balanced feed (6.8%). D - mean (4.1%). E - minimum (2.9%).

remains open and difficult to be answered. Nevertheless, trainers, consultants and field technicians need some basic ideas, rules and lines of action different from the industrial models. They must be provided with realistic means to perform the extremely difficult task of achieving at least some improvement when addressing to nearly no-input production systems. Worst still, as it frequently happens, when environmental conditions are adverse.

BACKYARD CONDITIONS AND DEVELOPMENT GOALS

The hypothesis is to work at the level of rural or peri-urban families, having at their disposal at least a small free area or backyard and access to some communal feeding resources, which can be freely collected. It must also be hypothesised that the persons who will be the recipient of the action have the characteristics below mentioned:

- **are lacking economical resources;**
- **have a very low cultural level or even are illiterate;**
- **have availability of extra person power;**
- **have a tradition in raising small animals or are seriously interested to begin such activity.**

The chances are:

- **to succeed in getting a no or low cost efficient management;**
- **to succeed in getting a no or low cost improved utilisation of resources;**
- **to succeed in building up some no or low cost structures or instruments to allow production or to improve it;**
- **to succeed in utilising better the available inputs through diversification and proper integration of different animal species;**
- **to succeed in integrating backyard horticulture with animal keeping;**
- **to succeed in properly modifying the management according to tested simple technologies.**

To build up structures and equipment, the materials to be utilised must be:

- **original of the place;**
- **in adequate quantities;**
- **available;**
- **freely collected or anyhow very cheap;**
- **easy to be utilised.**

Structures or equipment produced must be:

- **simple;**
- **appropriate;**
- **efficient;**
- **accepted by the persons who have to utilise them;**
- **possibly built or constructed directly by the interested persons;**
- **easy to be imitated.**

When these conditions exist, and the frequently spontaneous innovation is accepted and properly utilised, it is reasonable to consider that a simple sustainable improvement of the system has been attained. Since the modification of the system has a small entity, is dispersed in different places and has been obtained at a very low production level, it is very improbable that negative effects can be produced on contiguous or overlapping systems. Nevertheless its repetition by hundreds or thousands of families can bring to sensible overall improving effects and attain even the macro-economic level.

This concept seems not to be clear to technicians and also projects, based on the repetition of

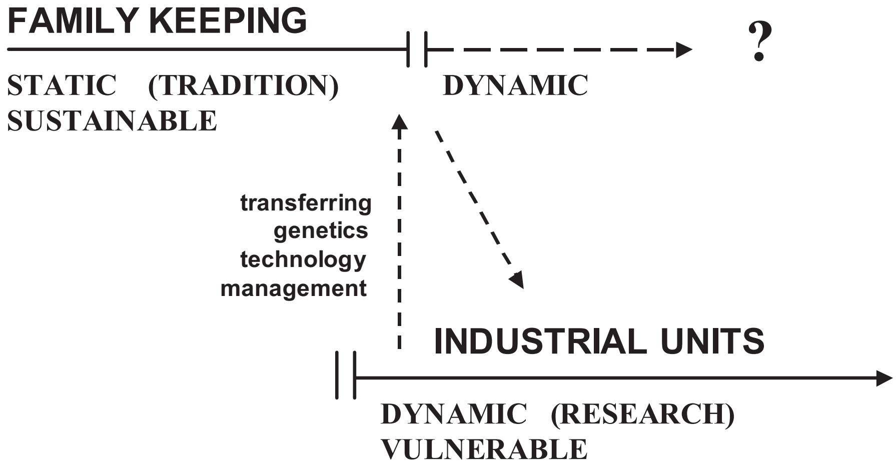

Fig. 5 - Transferring industrial know-how to family breeding permits, if possible, to change it into a profit system, but it is not inducing its own specific evolution.

	A VERY BIG INDUSTRIAL RABBIT BREEDING	A MEAN FAMILY REARING	R : I	20,000 FAMILY REARINGS	R : I
DOES NO.	3,300	5	1 : 660	100,000	30 : 1
OUTPUT / WEEK*	2,800	A 2	1 : 1,400	40,000	14 : 1
		B 1	1 : 2,800	20,000	7 : 1
INVESTMENT / DOE u.s. dollars	300	< 10			
TOTAL INVEST.	1,000,000	< 50			

* PRODUCED / DOE / YEAR :	PART. / YEAR	L. BORN / LITTER	MORTALITY
INDUSTRIAL = 45	7.3	7.5	18%
RURAL A = 20	4.3	6.8	35%
RURAL B = 10	3.5	5.5	50%

Fig. 6. Technical and financial comparison between industrial (I) and rural (R) units.

small backyard activities, generally are seen as a possible relief to family nutritional needs and not as an important quantitative contribution to the national production. This is because the few animals of each species (mainly less then five) raised in a single backyard, when it is matter of rabbits are compared with the hundreds of the semi-industrial and the thousands of the industrial farms. But backyard production, if well diffused, generally exceeds largely the output of any important industrial enterprise.

In figure 6, an industrial unit, in which a capital of one million U.S. dollars has been invested (300 dollars per housed doe), is compared with a rural keeping of only 5 does that requested a total investment certainly less than 50 dollars (<10 dollars per doe, when cages are produced by the owner). As it is shown at the bottom of the figure, in the industrial system (**I**) a quite common production of 45 rabbits per doe per year is assumed. In the rural system two hypotheses are put forward: rural **B**, with a sufficient management in an exclusively grass-fed unit (3.5 deliveries/year; 5.5 live born/litter; 50% mortality; 10 produced/doe/year as a total) and rural **A**, with a little improved management and some concentrates administered (20 produced/doe/year; being the other figures 4.3, 6.8 and 35%).

Looking to the ratio of the industrial to the rural system (**I : R**) the industrial farm keeps 660 more does and produces 1,440 more rabbits per week, if compared with the rural **A**, and 2,880 more, if compared with rural **B**. These figures explain why it is common to think that the economy of a country can develop only through industrialisation. But if it is examined what happens when the same financial input is directed to develop family rabbit keeping, it is surprising to see that as much as 20,000 families can be involved. This means that, thanks to the smaller investment requested per each doe, 30 times more does can be raised and the total output can be up to 14 times (or at least 7 times) higher that the one of the single industrial farm.

Luckily for industrial production, rural production is dispersed, economically feeble and not organized. As the example shows, if it was well organized it could manifest its tremendous power. Anyhow, it is better to take care of the social function, aiming to food security of the many in the rural area than pursuing the development through capitalistic enterprises of the few, working for the market of the rich people in the towns.

EXAMPLES OF POSSIBLE IMPROVEMENTS

The matter of improving rabbit keeping in Developing Countries is very complex and it must touch many different points. To give confidence to field technicians that ways can be found, appropriate to rural systems and not related with industrialization, some examples are here reported. Considering the traits of the examples it is possible to establish that it is convenient to work along some more fruitful lines.

These must be recognized starting from a proper analysis of backyard systems as they are in the reality, frequently showing differences from one backyard to the near one. When common traits have been identified, they must be discussed and trial to improve them must start locally, according to the general conditions that have been mentioned above. The examples reported make reference to protection of the backyard, building of equipment, genetics, feeding, management, differentiation and integration.

DEFENCE OF THE BACKYARD

One of the problems commonly observed when small backyard systems are analysed is the high percent of losses produced by predators. These can come from outside the backyard

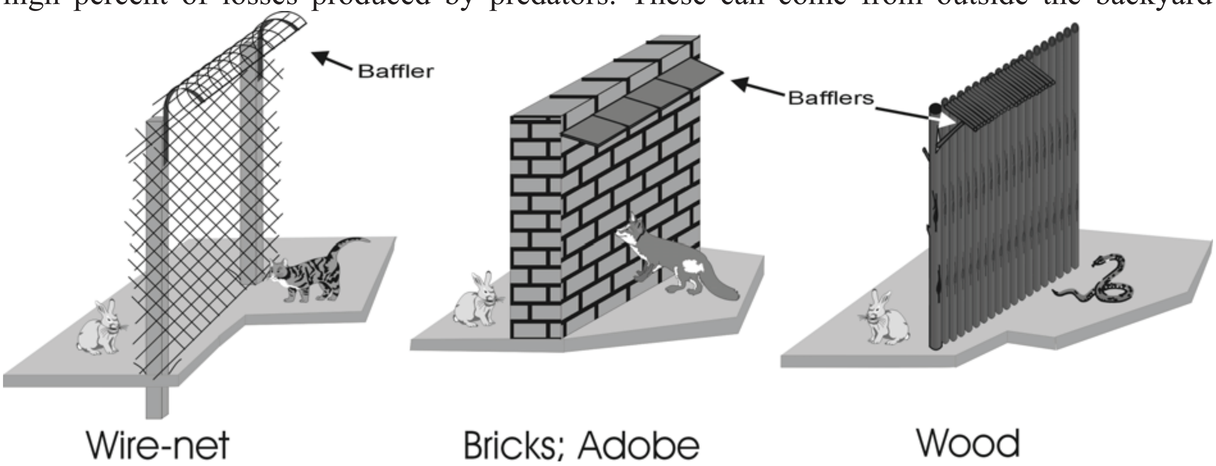

Fig. 7 - Fences or walls can be provided with bafflers on the top to avoid climbing predators to enter the backyard.

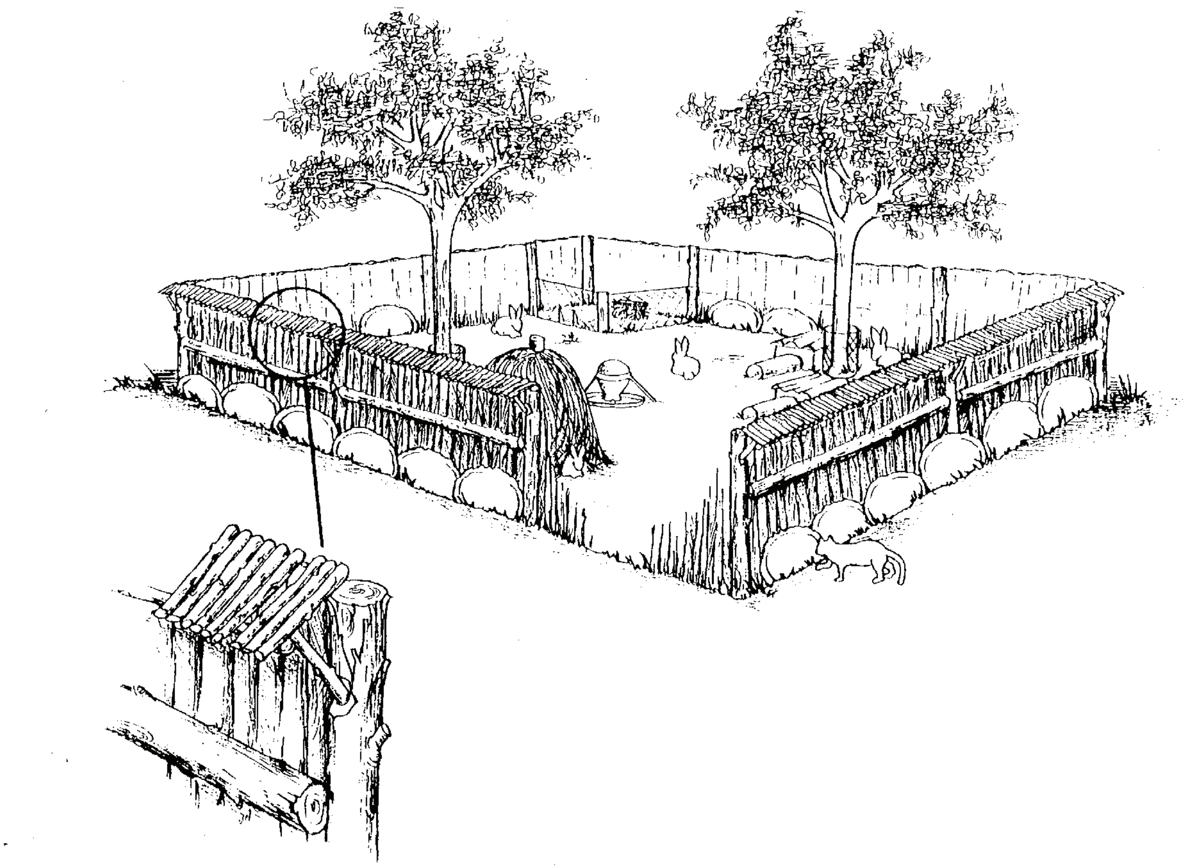

Fig. 8 – Scheme of a fenced free range rabbit keeping.

fence (foxes, mongooses, cats, serpents) and are able to catch the rabbit puppies raised in the free colony systems, or they are present inside the fence (mice) and are able to eat the new-born rabbits in the nest.

Easy systems to protect the fence or the wall are illustrated in figure 7. They are based on the simple principle that a protruding part on the top of a fence or wall is sufficient to avoid climbing animals to enter. The cheapest way is to make cooked clay slides or to open and flatten the cylindrical surface of wasted tins. These can be easily applied on the top of any wall or fence. Also structures independent from the yard can be proposed to raise a single species (fig. 8).

The better known, though seldom utilised system to keep aside mice is shown in figure 9. The limit is that it is not working when cages are inside a building. Mice are able to climb walls and jump on cages from where they are able to find some small passage through, mainly in wood cages. A managerial system against mice is described later on.

EQUIPMENT

Projects should be normally based on training to build and to utilise cages. To furnish metal cages must be considered generally as a mistake because it presumes mortgaging to buy a new cage when the old one is broken down. This concept is not easily understood. Anyhow, to suppose that poor people buy new cages when the old ones are out of use must be considered a not realistic hypothesis.

There are many known systems to build cages and to provide drinkers and feeders. Some of them were invented by the breeders and the only duty should be to find and to diffuse them

after describing and testing them. This should happen when systems are analysed to develop appropriate, sustainable small animals production projects.
An example of a very simple, locally developed three-foot cage is shown in figure 10. Good metal cages were locally produced by a breeder, which was able to recycle the metal wire recovered by burned car tyres. Also the very clever drinker, produced adapting a drip device to a plastic container shown in fig. 11 is a local technology. In figure 12 is shown the way to utilise wasted plastic bottles and a clay or cement handicraft base to prepare cheap and efficient feeders and drinkers, according to a technology developed by the Centre in Viterbo.
Also environmental conditions can be improved. A local population by the Sahara desert has developed a clever solution. They dig pits deep m 1.5 or more in the sandy soil that has become hardened with the centuries and then they introduce rabbits (normally two does and one buck) on the bottom (Fig. 13). From there rabbits dig their burrows where they can found much milder environmental conditions than in cages, avoiding the heath stress and maintaining a normal reproductive behaviour also in the hot season. Temperature to which rabbits are exposed is reduced by nearly 10°C (FINZI et al., 1988). Though it is a colony system it should be more efficient than cage keeping in that area, considering the very low thermotolerance of the species (FINZI, 1990).
A very efficient, simple and cheap housing, able to improve sensibly the ambient temperature in order to reduce heat stress has been developed in the late eighties (FINZI, 1987; FINZI et al., 1992a). It is now a day rather known. It is formed by a shelter that can be made of any material (stones, clay or cement) and more or less wide. It has only to be covered with earth until nearly the top and connected with an external cage through a short tube (fig. 14). In the hot hours of the day rabbits can escape the stress inside the shelter that is insulated by its underground setting.
As it can be seen, chances to develop self-made, cheap and efficient equipment are many and there is no reason to import equipped industrial cages that could not be bought again when the

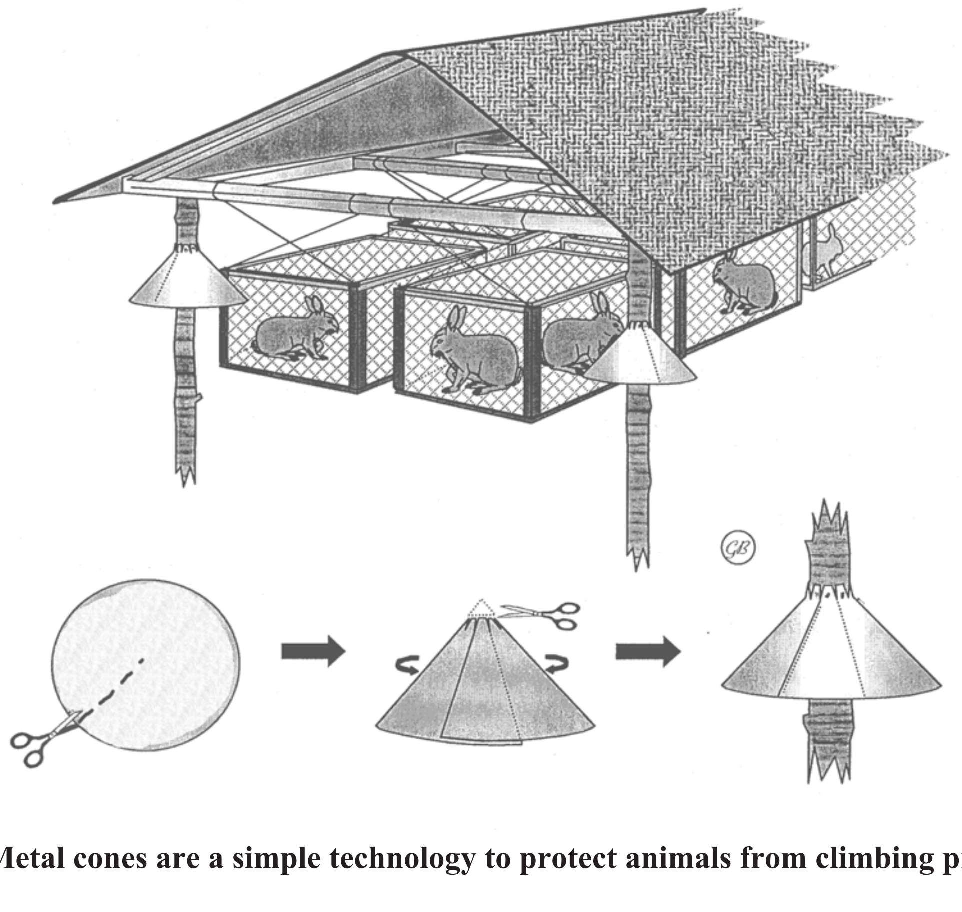

Fig. 9 – Metal cones are a simple technology to protect animals from climbing predators.

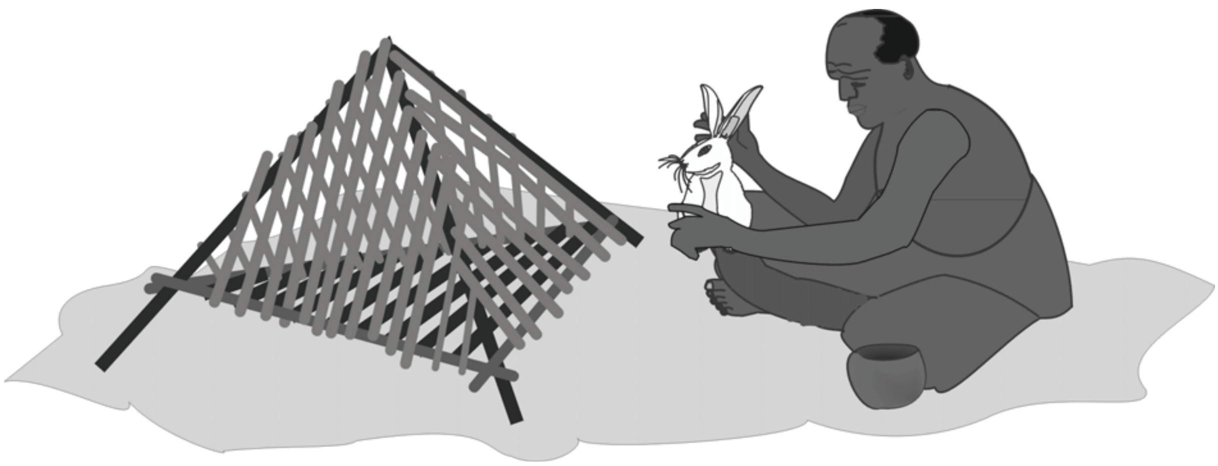

Fig. 10 - A locally developed three-foot rabbit cage.

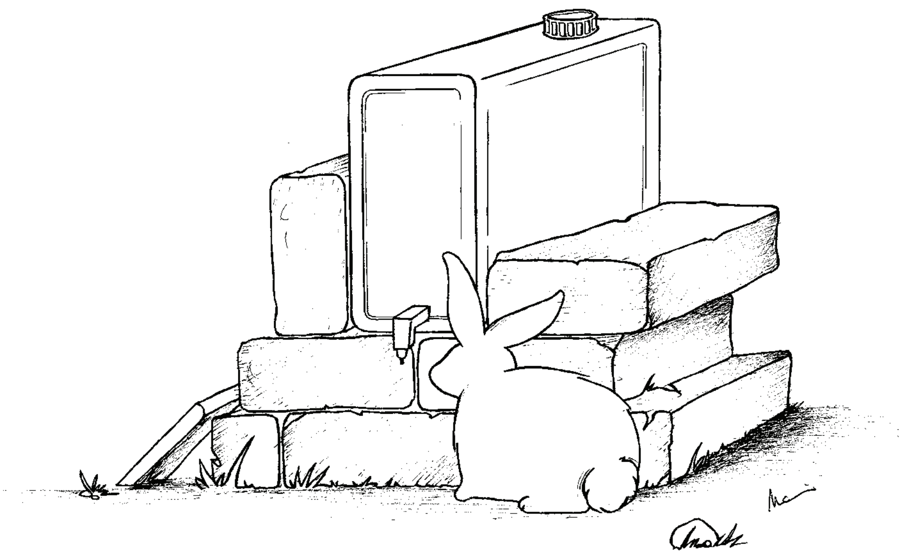

Fig. 11 – A very efficient drip drinker developed by local technology.

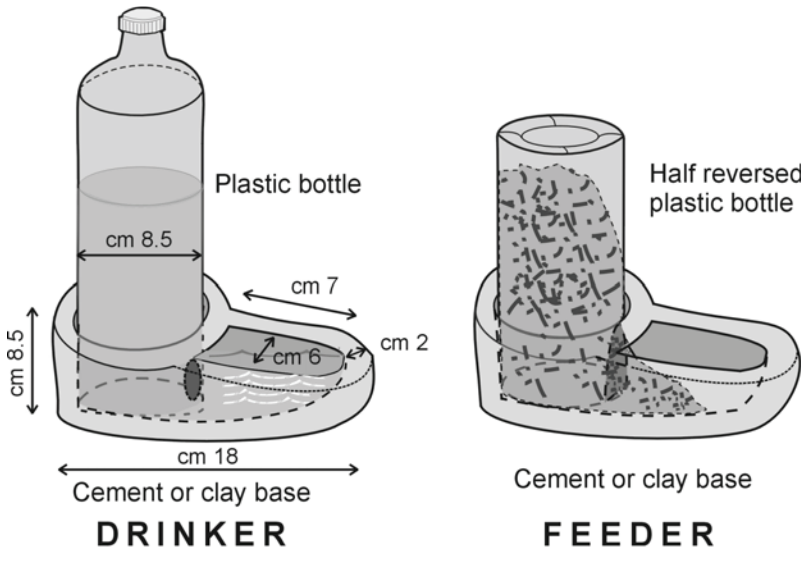

Fig. 12 – Drinkers and feeders made up with recycled plastic bottles.

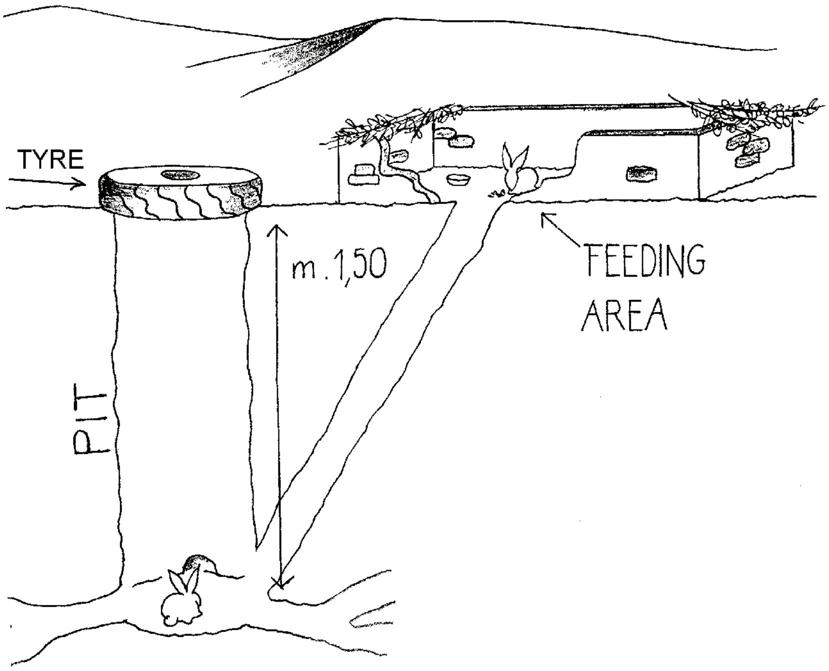

Fig. 13 – Deep pit system adopted by Mrazig people in Tunisia.

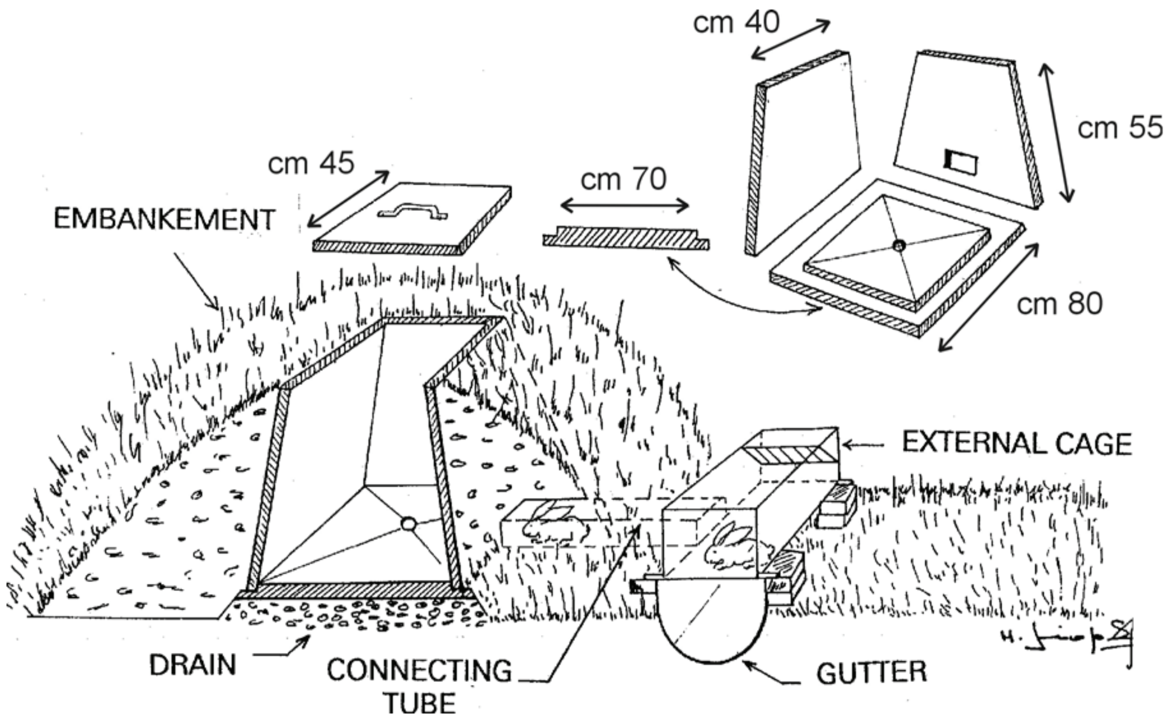

Fig.14 – First prototype of the underground cell housing.

old ones will be wasted down. Anyhow it should require a financial investment that is neither convenient nor even possible to no income, food deficit people. What is necessary is more field analysis and more field applied research for simple tecnologie.

The technique to build appropriate wood or bamboo cages is described in specific manuals. It is important that floor has no points where faeces accumulate (LEBAS et al., 1996). To build

cages without using nails is possible; anyhow, if wood cages are periodically burnt for hygienic reasons, nails can be recovered from the ashes and utilised again.
When rabbits are kept in cages, these should be set in the open air and properly sheltered according to local technologies to avoid exposing the animals to irradiation from the roof. When cages are kept in a room, mostly the environment becomes too hot. The roof should be high and metal should be avoided. Frequently straw is disposed on the roof to obtain insulation; still better is to shadow with climbing plants. Windows should be wide and kept opened in the hot periods of the day or season.

GENETICS

The problem of choosing the best genetics to produce in Developing Countries is frequently solved simply importing exotic breeds, or even hybrids, considering they are more efficient than local strains. If environmental conditions are favourable, feed industry is modern and technology is advanced, there are not reasons to reject this option. But in rural areas of Developing Countries all factors are unfavourable except, may be, the climate in the mountains and highlands, and efficiency of exotic breeds is very impaired.
Local experts prefer frequently to choose among heavy breeds (Flanders Giant and Bouscat Giant). They think that bigger animals give more meat. This is true with reference to a single subject, but heavy breeds are not competitive with medium size animals which are raised in the industrial farms, being more efficient in reproduction rate, prolificacy and feed conversion.
The operative problem that has to be faced is that a breeding value prediction is practically impossible. The only chance, when only one or few bucks are kept, is phenotypic selection based on maternal traits. Recording of reproduction data must be put into practice in the simplest way, which is registering the number of weaned in order to calculate their number referred to 100 or 365 days. The obtained figure can be utilised as a selection index and is enough stable after three or more weanings.
The most simple option is to start with the animals that are at disposal and begin to introduce a selection pressure, breeding in the natural environmental and nutritional conditions in order to maximise both production and fitness in the specific local situation. If the work begins with local strains output will be improved, if possible, and fitness maintained; if it is matter of exotic breeds output will decrease but fitness will be improved to get a sustainable level of production. This kind of selection, based on natural and management factors, is very slow but permits a gradual adaptation to specific production conditions (HAMMOND AND GALAL, 1999)
Multiplication or demonstration centres generally utilise exotic breeds fed with balanced feedstuffs. But when these animals are distributed in the rural area it should be proved if they remain competitive with local strains. The best demonstration of the acquired adaptation of the latter is the smaller size that is frequently only two or two and a half kilo, being the reduction of body size a well known biological adaptation answer to difficult environmental conditions. Other fitness traits are probably present in local strains. For instance they have a better thermoregulation (fig. 15) and are able to maintain a lower body temperature in the stressing hot hour of the day in tropical countries (FINZI et al. 1992b).

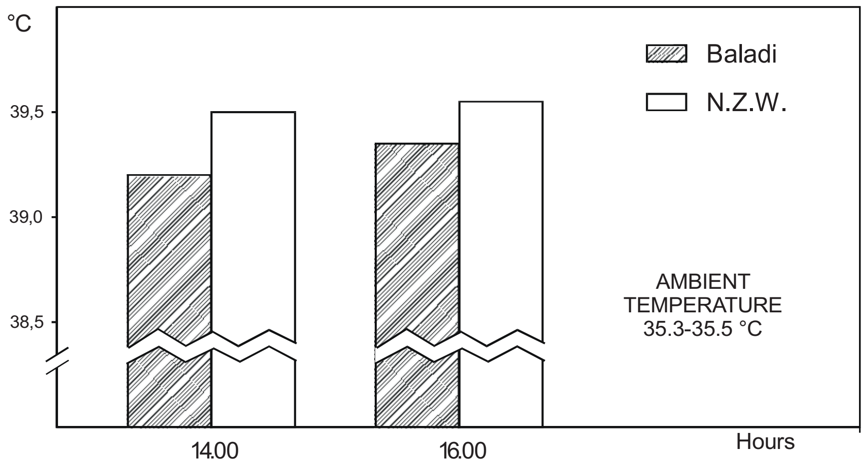

Fig. 15 - Body temperature of N.Z.W. and Baladi does in hot environmental conditions.

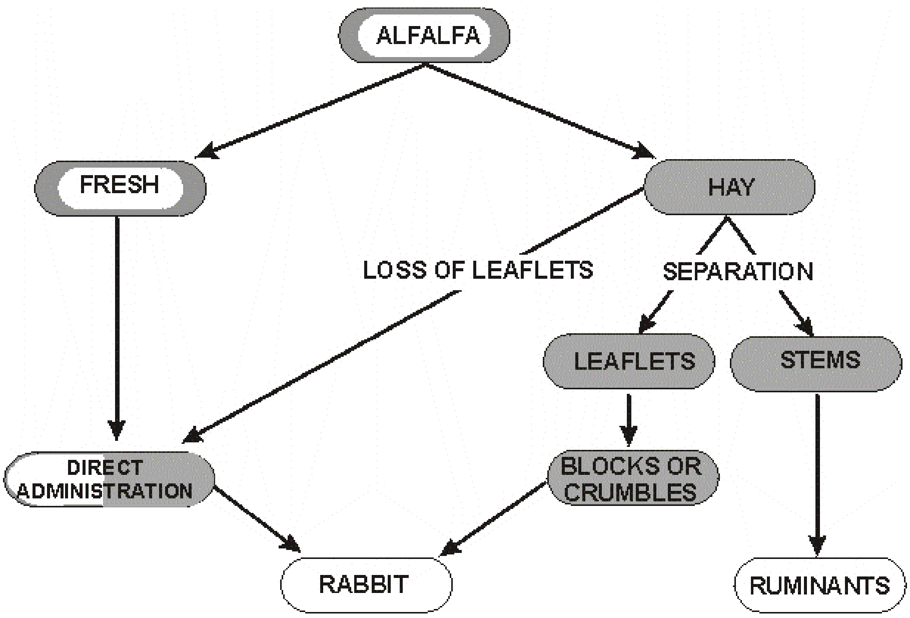

Fig. 16 - Scheme of alfalfa utilization.

NUTRITION

When rabbit production systems are analysed, two main modalities are observed: only grasses are administered (and, in case, kitchen wastes) or grass more some concentrate, mainly bran. Grass is freely collected or cultivated. In the latter case alfalfa is most frequently administered.

Grasses fed to rabbits depends strongly on tradition. Generally only few species are utilised, for instance leaves of sweet potatoes or elephant grass, and many available grasses or leaves are not administered. To avoid this cultural limiting factor, an inventory of edible vegetal sources should be prepared for each homogeneous area. Moreover the period when they are available and the amount should be registered. In this way the maximum number of animals to be raised can be previously determined on the base of the amount of forage that can be daily collected in the dry season. In case, when the dry season begins, it is better to reduce the

number of the animals raised instead of having them undernourished. Alternatively some feeding resource must be found.
The problem has been studied with relationship to alfalfa and the utilisation of hay has been considered. Unluckily this plant, that can allow rabbit production even without integration if administered fresh, gives a lot of problems when fed as hay. In fact, as soon as dried, the leaflets detach very easily from the stems and are lost under the cages to a total amount of 73%, in the different phases of collecting, storing, administering and utilisation by rabbits (FINZI, 1999). If stems are considered, 50% of the total weight of the hay is lost, but the stems are scarcely utilised.
To avoid this enormous loss of the most digestible and protein-rich part of the hay appears of main importance when alfalfa hay has to be fed to rabbits in the dry period. The strategy has thus developed of beating the hay and collecting separately the leaflets and the stems. The latter can be used to feed ruminants while the leaflets can be directly administered in a feeder or included in composed feed in form of molasses blocks or crumbles (fig. 16).
Preparing molasses blocks or crumbles at local level looks as the only chance of producing balanced feed for rabbits when mills, mixers and pelletizers are not available. Some solutions are possible, but many problems remain because molasses represent an excessive amount of fermentable carbohydrates (45-50% to form blocks); alfalfa hay and other ingredients need to be milled to avoid breakable blocks.
Blocks have many positive traits: they are easily prepared, wrapping up in a piece of paper any available quantity of the mass. In this way molasses stick to the paper and there are not losses by melting out. After drying in the air, which is favoured by a cylindrical shape, blocks are easily stocked and transported, if necessary. They do not produce powder and give no losses because, when the block nibbled by rabbits is reduced to a small dimension, it can be recovered and included in a new block before falling down under the wooden cage. Another advantage is that no feeder is necessary.
Blocks appear suitable only if fresh forages are also fed to the animals. In this case they eat enough roughage and less block, so that the overall amount of molasses ingested is tolerable. Satisfactory growth performances up to 31 g/d can be obtained (VELASCO et al., 1994; FINZI and AMICI, 1996). But if hay is administered, too much block is consumed, having a better palatability, and diarrhoea is induced. In case there are no available fresh grasses for a long period, it is possible to produce crumbles, which contain only 10-14% of molasses. Crumbles, differently from blocks, can also be formulated as complete feed and, as shown in figure 17, efficiency can be sensibly improved in comparison to feeding alfalfa alone (FINZI et al., 1997). A daily growth of 30 g/d was obtained.
Crumbles, as blocks, do not produce powder, thanks to the sticky molasses component, but crumbles are not homogeneous and they need a feeder. Moreover preparation is more complicated though not difficult. The mass must be wetted until becoming pasty and flattened to a thickness of 2-4 cm; then, after drying in the air, it can be crumbled.

MANAGEMENT

Intensive management, as adopted in the industrial systems, is not appropriated to rural reality, though frequently it is taught as a mean to development. When rabbits are kept in free colonies, the only possible managerial improvements refer to hygiene, feeding and keeping low the density of the animals to reduce the risks of spreading sicknesses. The control of pregnancy by palpation can be taught to avoid maintaining does that are no longer able to reproduce. But it must be remembered that women that normally take care of the animals in the villages are able to control the reproductive function of does by other means when the nest

is dug underground and cannot be controlled. For instance they observe the swelling of udders or the plucking of fur.
The most common mistake is to believe that reproduction rate must be relatively high. Even mating immediately after parturition has been unfortunately proposed in the past time. If environmental conditions are not good and grass is administered, does must be mated after weaning and weaning has to be delayed to 35-40 days. In the hot season, when rabbits reduce feed ingestion and grass is dry, the tradition to slow down the frequency of mating or even to stop it must be considered correct. In fact, also if some pregnancy is obtained, does will be exhausted and undernourished and litters will be later lost anyway.
Project makers must always consider this factor since most of developing countries are situated in the tropical area. In North Africa, where rabbit keeping is traditional, when animals are kept in cages, reproduction stops for nearly four months in the hot season (FINZI, 1987). The animals are not even mated because, stressed by heath, they are not able to eat enough to sustain pregnancy and milking.
When ambient temperature raises over 35°C for several hours, rabbits could begin to die. In these conditions the only efficient emergency intervention is to immerse completely the animals in a bucket of water at ambient temperature. The recovery is immediate and also animals near to die can be saved (FINZI et al., 1992c).
Some improvement can be obtained taking care of reposition rate. This factor is often neglected also by field technicians which forget to teach to new breeders that if they do not care to substitute properly the stock, at the end it will grow old and production fall to zero.
Sick animals should be immediately sacrificed and eaten if possible. Traditional medicine only sometimes is effective. To keep sick animals generally only helps sickness diffusion and, after death, also the food is lost.
To teach keeping records of does is recommended, though, in practice, it is useful more to generate mental order and ability to write than to improve management and selection.
A most original management to defend new-borns by mice has been observed while analysing local keeping systems in an African Country. The housekeeper knew that does milk the litter once a day, thus, immediately after parturition, she took the nest with the litter and put it in a box. Each morning she took care of bringing the doe to the box and put it again in the cage after milking. She had cleverly adopted the same technology of programmed milking in the industrial farms, with the slight difference of moving the doe instead of opening and closing the nest-box.

In comparison to the costly technical (bafflers or traps) or chemical (poison) strategies of defence by mice, that are only relatively efficient, it is astonishing the absolutely sure, simple

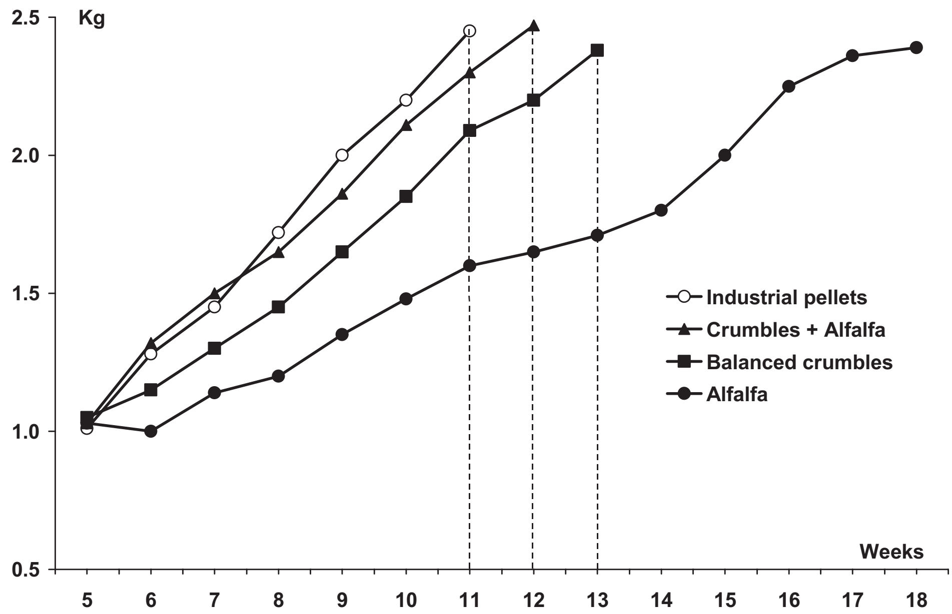

Fig. 17 - Efficiency of crumbles in comparison with alfalfa and industrial pellets.

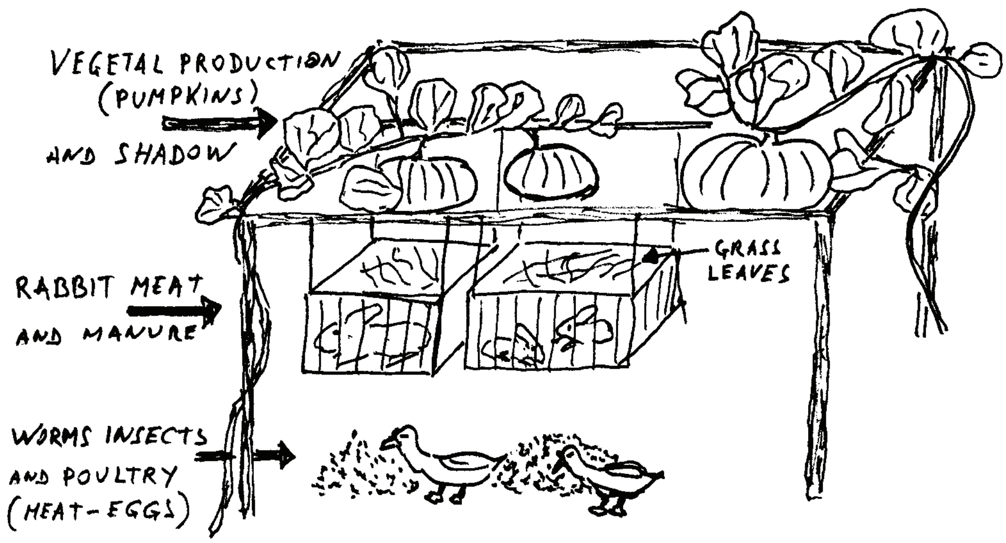

Fig. 18 – Scheme of three-layer integrated cropping.

and cheap mean invented by an African woman. It is worthwhile to mention here that to study and divulge local sound technologies is a necessary duty of field technicians.

CONTROL OF PATHOLOGIES

Bacterial or viral diseases have practically no prophylactic or therapeutic control in rural conditions. Vaccines and drugs or antibiotics are may be used in peri-urban areas but problems of distribution, conservation, need of only few doses and cost are decisive limiting factors in rural areas. Moreover it is not reasonable to think that people can be induced to do

something to protect backyard animals when they have not even means to nourish or cure or dress their own children.
But it must be remembered that rabbits have been raised for centuries before the development of modern medicine. Conditioned pathologies ware not existing. Density of animals was low and diffusion of sicknesses was difficult because rabbit raising units were relatively isolated and animals were not moved over great distances. Anyhow the small open-air unit of the Centre in Viterbo is going on since 19 years without any therapy or even vaccination. Microbial dispersion in the air, no possible direct contact among the animals except during mating, a careful hygiene and immediate elimination of the animals at first symptoms are probably sufficient to keep a healthy stock and to avoid heavy losses.
To slaughter the rabbits at first symptoms must be highly recommended in Developing Countries. In this way a source of infection is immediately eliminated and it is important to eat the meat before thinning and death waste it.
This is not possible with reference to gale that is a too diffused parasitic disease, unless it appears for the first time in a healthy breeding after the introduction of a bought subject. Gale is traditionally controlled by treatment with oil that probably impairs respiration of parasites when they are completely covered with. More recently the use of wasted machine oil has widespread. This technique has to be preferred because corresponds to the criterion of recycling materials and a repellent action is probably also contributing to the effect of the therapy. These systems allow controlling the sickness but the stock will be never cured definitely.
If some project is going on, an initial stock can be cured with ivermectine (Ivomec 0.1 ml subcutaneous injection per subject per three days and eventually repeated after some week). The sickness does not appears again if healthy animals are distributed to new breeders and exchanges are very careful and reduced to a minimum. In case, old or new infected keepings can start again with healthy rabbits and new cages after complete elimination of the old stock.
Cresol is very active against coccidia. Oocysts are killed by a concentration 0.1% of the chemical (MARGARIT *et al*, 1996). Cresol is very cheap and it is relatively easily found, but it is necessary to pay attention because phenols are frequently sold as cresol. They have a good bactericide action but they are nearly inactive against coccidia. Also bleach is active, cheap and easily found, but chlorine must reach at least a 0.5% concentration to kill the coccidia. Anyhow in dry hot climates apparently coccidiosis is not a problem, probably because environmental conditions are not favourable to maturation of oocysts.
An odd habit with relationship to rabbits and pathologies was observed in Central Africa. Rabbit urine is collected and sold. It is added to drinking water of poultry to protect them from respiratory diseases. It is an extra income from rabbit keeping even if a therapeutic effect of urine is very doubtful.

DIFFERENTIATION AND INTEGRATION

The small animals raised in the backyard pertain to two main groups: fowls that, though omnivorous, are mainly grain feeding species, and mammals (guinea pigs, rabbits and some local species). The latter have received less attention till now, but, being herbivorous, they can well contribute in utilising even small amounts of forage.
Peculiarities of small backyards are seldom considered as elements of a system and projects try frequently to improve some element of it (for instance, poultry keeping), without considering the interference internal to the system (for instance, destination of grains to human vs. animal nutrition), nor external to it (for instance, marketing problems). But it is possible to consider the backyard as a whole, both in the phase of analysis and in the phase of planning its improvement.

It must be learned that intervention needs to harmonise with the local situation and not conflict with it. And instead of starting with an idea, trying to actuate it, according to a program thought in advance, it is much better to develop a program as suggested by the real situation properly analysed. Programs developed *in situ* may become very different from the original idea. They should be differentiated and flexible, according to situation, being thus more susceptible of success.

Production systems can partly overlap or develop in sequence in order to balance vantages and disadvantages of each single activity or to exploit wastes of a previous activity as a positive input for a next one. Of course it is not necessary that two activities are in a temporal sequence, normally they can well develop contemporary. The sequence is only functional as when polluting duck drops (negative trait) become useful to fertilise fishponds (positive trait) or horticulture wastes (negative) are utilised to feed rabbits (positive).

A variety of possible combinations of animal rearing and vegetal production have already shown to be useful and are commonly practised. Neither all of them are well known, nor they have been properly analysed to optimise the proportion of the components of integrated systems. Forms of integration can be generated spontaneously. They remain generally unnoticed while they are of extreme interest because they indicate in advance the way to pursue to improve efficiency and sustainability of backyard systems as a whole.

With reference to rabbits it is quite common to observe, in Developing Countries, that muskovy ducks (very rarely ducks of the genus *Anas*) sit or wander and scavenge most of their time under the cages where rabbit are raised. Also when they cannot profit of the fallen rabbit feed, avoiding it to be wasted, they can found there any kind of insects, eggs and worms which represent a rich source of protein very difficult to be found otherwise. Integration of muskovy ducks to rabbit keeping has been experimentally tested (GUALTERIO et al., 1988). Moreover ducks utilise very well any kind of animal slaughtering wastes, for instance the offal of rabbits (FINZI et al., 1989), and this is another reason to keep them as a part of integrated systems. Sitting under the cages ducks do not compete with rabbits for space. In the backyard space is limited, and it is very important to obtain more different integrated productions from the same area, as in the example above reported.

A three-layer integrated cropping permits to utilise the space still better (fig. 18). An arbour was projected to make pumpkins to grow on the top to produce fruits and shadow the rabbits. Rabbits were kept under the arbour to produce meat and faeces. Ducks could feed on fallen pellets, if administered, or on insects attracted by faeces. Faeces are manure to pumpkins and pumpkins stems and leaves are used to feed rabbits.

When a trial was performed, on a surface of m 6x2.5 were raised 5 rabbit does and 1 buck in an underground cell system. Rabbits received pelleted feed and each doe produced 43 weaned rabbits as a mean in one year. When no concentrated mash was administered to ducks a surface corresponding to 6 does was necessary to permit 1 duck to nourish on insects and fallen rabbit feeding, if also grass was administered or pasture was available. Each 12 weeks a 2.5 kg body weight muskovy duck was fattened as a mean. From the shadowing arbour 45 kg of pumpkins were produced. Also a few strawberries were collected from the area around the underground part of the rabbit housing (FINZI, 1999). The possibility to get such different valuable productions only from a surface of 15 m^2, in a backyard well protected from predators and thieves, should be always well considered by field technicians and project makers.

The integration scheme, though technically simple, is very complex from a conceptual point of view. Pumpkins give shadow that is a main rabbit production factor in tropical countries. Leaves, stalks and the external part of pumpkins are protein rich fodder for rabbits. They can also be easily dried and maintained as a very palatable feedstuff to be used when vegetables are scarce. Pumpkin is a tasty fruit to nourish the family and the seeds, dried and salted, are

loved by children, to whom a vitamin, protein and energy rich food is provided. It can be also remembered that pumpkin seeds are a traditional medicine, which is active against intestinal worms. There is no need of manuring pumpkin plants when they are planted nearby the rabbit cages.
Other climbing plants can be used, as beans or grapes. From a 5x15m kiwi arbour, shadowing 24 rabbit does cages, 320 kg of fruits were obtained. No chemical manure was utilised. Leaves, stems and not ripe fruits were a very palatable feed for rabbits. All the system represents a very attractive job for the housekeeper, which can take care of the animals without leaving her home. It is important to notice that rabbits are the core and the pivot of these multi-layer rural integrated systems.
Also guinea pigs generally do no compete with rabbits for space, since they are normally kept free in the kitchen. But they compete for food wastes and collected grasses. In fact never happened to see both species raised together. Normally rabbits prevail in the peri-urban area, while guinea pigs prevail in the rural medium. This is true also in Africa, where guinea pigs were imported in the seventieth century, diffusing then spontaneously. Though it is scarcely known, they are nowadays rather popular in rural areas of Africa as in South and Centre America. They represent an impairment to rabbit diffusion since they are comparatively much easier to be raised in free colonies and they do not give problems with cages and nests.
But a surprising possibility of integrating feed utilisation was observed when rabbits and grass-cutters were comparatively observed. Grass-cutters are a very popular food in West Africa. These big rats begin to be raised to furnish the market in addition to hunting. Both mammal species are commonly fed with guinea grass or elephant grass, but it is easy to observe that grass-cutters eat only the stems discarding the leaves, while rabbits eat the leaves and, if fed *ad libitum*, leave the stems. Local technicians agree that the two species can very well integrate to get the complete utilisation of local grasses.
The proposed best scheme is to feed rabbits first. Then it is easy to collect the stems and administer them to grass-cutters; the inverse is less easy because leaves are more and they get quickly dirtied and trod by the animals. A negative trait is that the two species compete for space, while interacting positively for feed utilisation.
The over mentioned examples could give an idea of what can be done with reference to differentiation and integration.

CONCLUSION

A long experience on diffusion and improvement of rabbit keeping, as a contribution to food security, has shown that in poor rural areas only simple, appropriate, mainly self-made, no cost technologies are sustainable. Specific know-how is nowadays lacking because research aiming to develop rural breeding systems has completely stopped when industrial production began to develop.
Nevertheless it is possible to start again. The many examples reported should give confidence to field technicians and project makers that sound ways to development do exist. But they are not in the passive transferring of exotic breeds or complex technologies from industrialized Countries. It is only necessary to find out the many simple technologies that have been spontaneously developed by breeders, to study them and to divulge them. A good input could also come from research, specifically devoted and oriented to improve rural backyard systems. These should be developed as multi-species integrated systems, which should aim to maximize the overall output throughout an appropriate complete and, in case, recycled utilization of local resources.

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