

DEVELOPING RABBIT LINES FOR MEAT PRODUCTION IN EGYPT AND SAUDI ARABIA: OVERVIEW, SYNTHESIZING PLAN, DESCRIPTIVE PERFORMANCE AND FUTURE PROSPECTS

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SUMMARY- A programme of selection for meat rabbits was carried out in Egypt and Saudi Arabia where three Egyptian and one Saudi Arabian research centres are involved, each of them having the task to develop two lines of rabbits. The set of lines in the programme are a control V line, four replicated Spanish V line and three synthetics between the V line and a local breed. The local breeds used in synthetics were Baladi Red and Sinai Gabali in Egypt and Saudi Gabali in Saudi Arabia. Line V was replicated in four different locations, three in Egypt (Alexandria, Animal Production Research Institute, and Moshtohor) and one in Saudi Arabia (King Saud University). The procedure used to form the synthetics was to cross bucks of the local breed with does of V line to get the F₁ cross and does and bucks of F₁ cross were mated to get F₂, then inter-se mating was practiced to get F₃. The lines are being selected by a BLUP methodology, under different local conditions, following different criteria of selection, depending on the Centres, aiming in all cases to develop maternal lines, giving special consideration to milk production, and growth after weaning, in addition to litter size. Data of the last year of the project in each location were only used for describing the performances obtained.

The current performances of the synthesized lines in different locations are given, in order to get a general idea for their expected productivity and the importance of factors, other than the genetic ones, affecting the productivity. These performances verified that the most stable and convenient trait in all lines is referring to the prolificacy, which have been around 8.5 total born and around 8 born alive per litter. Post-weaning daily gains were also convenient and ranged from 19 to 29.4 g/d in the locations studied. This is the largest programme with the most comprehensive efforts executed in countries of hot climate to develop new lines of meat rabbits where heat stress is considered as one of the most important limiting factors to raise meat rabbits. Finally, consolidation of the programme to develop an organisation to diffuse pure and crossbred animals for the farmers are important targets to be discussed.

Keywords: Selection programme; rabbit lines; co-operative project.

INTRODUCTION

Egypt is a country that produces rabbit meat in family farms; tries to develop industrialised rabbit production and has a very important research structure related to rabbit science and technology. Recently in Saudi Arabia, a national project was established for developing rabbit production and to detect the possibilities of producing meat rabbits under industrialised conditions.

The genetic researches in Egypt concerning rabbits had concentrated mainly in studies describing the local and exotic breeds, in the crosses among them and in the genetic analysis of many traits related to production, but recently fewer efforts have been devoted to establish and select, in local conditions, new lines that are promising to have good production and adaptation under the Egyptian conditions. Some years ago, an effort was done creating the breeds Giza White and the Red, White and Black Baladies (Khalil, 2002 a and b), but a permanent programme of selection of them was not established. One of the conclusions of the First International Conference of Rabbit Production in Hot Climates held in Cairo in 1994 pointed out this lack and gave attention for the researchers to start selection programmes to improve productivity in local conditions. In Saudi

Arabia, the situation is different because rabbit production is recently developed and the targets of research were directed from the beginning to identify which the breeds or lines are convenient for this country. For this reason, special emphases were paid to construct a genetic improvement programme convenient for this hot climate country (Khalil *et al.*, 2002). The crucial aspects to be considered in this point are the initial production and the adaptability of the populations involved in this programme of selection. This is because the improvement rate accumulates over the beginning level, and for this reason it is very important to start with rabbits at a high level of production as possible. The productivity of the Egyptian local breeds are well known to be low and the majority of the exotic populations which are being introduced in Egypt belongs to lines of cosmopolite breeds, no highly selected or may be selected in temperate areas where the heat is not a problem (Afifi, 2002; El-Raffa and Kosba, 2002 a & b; Khalil, 2002 a& b)

The governmental programmes for developing and selecting rabbit lines in Spain have been carried out in two places located on the coast of Mediterranean Sea (Barcelona and Valencia). Valencia is in the south east of this coast and has a climate similar to the one of some Mediterranean areas in Egypt, as Alexandria. In Valencia, humidity and temperatures in summer are commonly high from the middle of July to the middle of September where the daily temperature ranges from 23-24 °C to 32-34 °C and this means that the rabbits are exposing to a heat stress environment. Under this environment, some lines have been developed in Valencia following different objectives and methods of selection. The lines specialised as maternal lines have been selected for litter size at weaning or at birth, and in two of these lines more than 30 generations of selection have been carried out. One of these lines, line V has been studied in places of hot climates such as Adana in Turkey or Zagazig in Egypt and this line has revealed more productivity than other exotic breeds, as was reported in the First International Conference of Rabbit Production in Hot Climates, held in Cairo (Yamani, 1994) and in the 6th World Rabbit Congress, held in Toulouse (Testik, 1996). The essential elements of a programme of selection in rabbits were reviewed by Baselga (2004) who dealt with the responses obtained per generation within the selected lines and the corresponding crossbreds.

The objective of this paper is to describe a joint project running in Egypt and Saudi Arabia to develop new lines of meat rabbits in these hot climates countries through programmes of crossbreeding and/or selection. The paper will focus on (1) Base lines and breeds to be involved in the project, (2) Synthesizing plans to develop these new lines, (3) Criteria and methods of selection to be followed in different locations, (4) Some results of the performances obtained and the current situation as well, and (5) Some recommendations and proposals for the future.

MATERIALS AND METHODS

A joint research project between Spain, Egypt and Saudi Arabia was constructed to develop new lines of meat rabbits in these hot climates countries. The project involves different research centres in Egypt and Saudi Arabia represented by two Faculties of Agriculture in Alexandria and Moshtohor and Ministry of Agriculture (Animal Production Research Institute, APRI) in Egypt, College of Agriculture and Veterinary Medicine (King Saud University) in Saudi Arabia, and Faculty of Agriculture of Valencia (UPV) in Spain.

Overview for the lines and breeds to be involved at the beginning of the project:

Firstly, we intend to analyse the genetic material available at the start of the project to determine or decide which breeds or lines to be used in the programme of selection. The most common practice in the past was to rely on the existing breeds and to get samples of one or several to establish a new population of small size, then two or three generations of inter-se mating give rise to a new line. In this case, the final size of the line can range between 100-200 does and 20-40 bucks. This procedure is not difficult to be carried out but a care must be taken because some problems can arise. One of these problems comes from the enormous diversity that can exist within a breed. This means that you can get the sample of the founder stock for the new line from the populations of the breed that are genetically poor in traits of interest and consequently the starting point for the new line will be low and possibly non-competitive. Another setback is that healthy problems could be appeared when all the founders are put together in the same herd and they were come from a relatively large number of different farms. This latter problem can be overcome by using hysterectomy or other techniques such as freezing and transfer of embryos to obtain animals from the farms (García-Ximénez *et al.*, 1996).

According to the conditions of selection of line V mentioned before, and results of the comparative experiments carried out previously in Egypt and Turkey, it is advisable to use line V

itself, peculiarly in the Delta where the environments for rabbit production is not extremely hot. The last results obtained also for V line raised in Saudi Arabia have confirmed the fact that adaptability of Line V in heat stress conditions is good (Khalil *et al.*, 2002). Moreover, genotype-environment interaction for maternal traits was absent and this was evidenced from the data of V line collected for rabbits raised in Alexandria and Valencia that was pooled and analysed to detect such interaction (El-Raffa *et al.*, 2005). However, the local breeds in Egypt and Saudi Arabia are considered to be another important source of animals that could contribute considerably since these breeds are more adaptable to hot areas, but the reproductive performances they have may be relatively low. Lines synthesized from crossing line V with local breeds could be used to compromise between animals for the productive capability and the adaptability to the heat. In this sense, breeds like Baladi Red, Sinai Gabali and Saudi Gabali were crossed with Line V to develop three different synthetic lines in Egypt and Saudi Arabia.

Lines actually involved and synthesizing plan:

The most essential component in a programme of rabbits selection is the development of maternal and paternal lines, that is the crucial activity.

Survey of lines synthesized all-over the World: All-over the world, the oldest programme is the French programme that was started in 1969 when the organisation to produce paternal and maternal lines was decided upon (Rouvier, 1981). The work to develop lines in Spain was started since 1976 in Valencia University (UPV) and IRTA. The French and Spanish programmes have kept their work uninterrupted until now and all the lines created at the beginning of the programmes have undergone more than thirty generations of selection. There are other public institutions, in other countries, involved in programmes to develop new rabbits lines to be used in production. In USA for example, a selection programme was began in 1988 in Alabama A&M University to develop a paternal line (line Altex) and since 1994 this program was shifted to be continued in Texas A&M University (Department of Animal and Wildlife Sciences). In Hungary, White Pannon breed has been developed since 1991 in Faculty of Animal Science (Pannon University of Agriculture) through selection for growth rate (Garreau *et al.*, 2000). In Uruguay, the INIA (Las Brujas, Canelones) has had a programme since 1999 involving two maternal lines and a paternal one (Capra *et al.*, 2000). There are also more examples of selection programmes carried out in Mexico and Brazil to develop new lines of meat rabbits.

Synthesizing plan of the present project:

As we said in the previous section, line V was chosen as one of the lines to be included in the project. Line V was replicated in four different locations, three in Egypt and one in Saudi Arabia. The first replication was established in Alexandria at the end of 1998 with rabbits imported from Valencia. Such replicate in Alexandria was the base to establish one replicate in APRI, since 2001 and another replicate in Moshtohor, two years later. The replicate in Saudi Arabia was originated at the end of 2000 with rabbits imported from Valencia. There are some reasons advising us to keep several replicates of the same line in different locations, as in the case of Line V. The first reason for such replication is the security respectful to the healthy troubles or accidents that could affect the animals in a certain location and could cause their extinction, e.g. the disappearance of V line sent to Zagazig in Egypt several years ago as a result of contamination of feed with aflatoxins. The second reason is that in this way the stage of multiplication of a programme of selection is actually an stage of true selection and the farmers are served better (Baselga, 2004).

In the present project, there are three new synthetics to be developed in different stages. The procedure used to form these synthetics was to cross bucks of the local breed with does of V line to get the F₁, then does and bucks of F₁ were mated to get F₂ and then inter-se mating of F₂ was practiced to get F₃. F₃ can be considered as the foundation of the synthetic line, no matter the programme of selection can begin in F₂. The synthetic line based on Baladi Red rabbits located in Sakha Station of APRI in Egypt have reached progeny of F₃, while the synthetic based on Saudi Gabali rabbits located in King Saud University in Saudi Arabia have reached progeny of F₄. But, the synthetic line based on Sinai Gabali rabbits in Moshtohor in Egypt is now in the primary stage. The allowance of several synthetics is important for the same reasons exposed above for the replicates of line V. Additionally they will be the base to produce crossbred does that could perform better than the purebreds. In Saudi Arabia has been developed another synthetic line, also between Saudi Gabali and V line, but in this case the participation is 3/4 V line and 1/4 Saudi Gabali. Here, Gabali bucks were mated to V line does to get the F₁, then does of F₁ were backcrossed with bucks of V line and

then the progeny of the backcross was inter-se mated to get the new synthetics that is being selected for litter weight at weaning and individual weight at 84 d.

It is common to use crossbred does in industrial production of rabbits, crossing bucks of a maternal line to does of other maternal line. The aim of the cross between the maternal lines is to take advantage of the expected positive heterosis in reproductive traits, the eventual complementarity among the lines and the dissipation of the inbreeding accumulated within the lines. Because the usual methods of improving the lines are based on within-line selection, as it will be explained in the next section, it is expected that the initial heterosis expressed in the cross will be maintained along the generations of selection and that the genetic progress obtained selecting the maternal lines will be capitalised on top of the heterosis and expressed in the crossbred does.

Criteria and methods of selection to be followed in the project:

Selection criteria: The set of lines that is being developed will try to cover very different targets of production: family farms, industrialized farms, pure line does, crossbred does, use or not use of specialised paternal lines or use of different heat stress areas. In all these targets, it was advisable to keep the specialisation in the lines to be used as maternal lines, including in some of them objectives related with growth.

In the present project, criteria used to select Line V were litter size at weaning in Alexandria, litter weight at weaning in APRI, litter weight at weaning and individual weight at 56 d in Moshtohor and litter weight at weaning and individual weight at 84 d in Saudi Arabia. But, the criteria used to select the synthetic lines were litter weight at weaning in APRI, litter weight at weaning and individual weight at 56 d in Moshtohor, and litter weight at weaning and individual weight at 84 d in Saudi Arabia. Litter weight at weaning has been included as criteria of selection in the majority of cases because there is a belief saying that capability of the does for milk production is not quite enough when the litter size increases. In literature, the most common criteria of selection used in establishing the maternal lines were related with litter size at birth or at weaning (Estany *et al.*, 1989; Rochambeau *et al.*, 1994; Gómez *et al.*, 1998). In one of these cases, the selection criteria included litter size at birth and individual weight at nine weeks to prevent negative responses in adult weight (Bolet and Saleil, 2002). There are other proposals for the selection of these lines including traits related with the ability of the doe to nourish the lactating progeny, such as weight at weaning (Garreau and Rochambeau, 2003), litter weight at weaning or total milk production (Khalil *et al.*, 2004). A review article dealing with the current situation and perspectives of selection to get maternal lines was written by Garreau *et al.* (2004).

Selection methods: Selection methods in maternal lines are complex and this complexity is due to the fact that litter size traits do not express themselves in the males and to that values of heritabilities for reproductive traits are low. So, it is necessary to consider as many own and relative records, as possible, in the genetic evaluation of does and bucks. Family indexes included the own information and the information of the relatives were proposed to carry out such genetic evaluation (Matheron and Rouvier, 1977; Baselga *et al.*, 1984). This methodology is still applied for selection in line A (UPV, Spain), reaching the 32nd generation of selection. In this case, evaluation of does or bucks was based on family index that has four items: average litter sizes at weaning of the individual to be evaluated if it is a doe, of its dam, full sisters and half sisters (paternal or maternal). Currently, mixed model methodology (BLUP) is the most common procedure used in evaluation. One of the biggest differences with the family index is that some environmental and physiological effects are considered in the model. The selection of all the lines of the project is being done or will be done, depending of the lines, by BLUP.

RESULTS AND CURRENT SITUATION

The objective of this section is to show some non-comparative data collected in the last year of the project for the main reproductive and growth traits of replicated V-line and the synthetics obtained in different locations. The data are non-comparative because the conditions were different for each line, but such descriptive data could be used as useful indicators to know the performances of these lines and to identify as well the importance of non-genetic factors affecting these performances in different locations.

Performances of purebred V-line rabbits:

Table 1 shows the reproductive and growth performances in the four replicates of line V. These four replicates have the same genetic level and the differences observed among them are considered as environmental variations. In this context, environmental variations are related to differences in housing,

Table 1: Observed performances⁺ of Line V in different locations of the project

Location	Litters	TB	BA	NW	KI	Young	WW	DG	AGE
Alexandria	290	8.7	8.0	4.9	49	1450	524	20.9	64
APRI	394	8.4	8.0	6.0	67	1867	479	18.9	84
Moshtohor	249	-	7.8	5.9	45	838	429	24.9	84
Sau. Arabia	137	-	7.9	7.3	61	137	619	29.7	84

⁺TB= Total born; BA= Number born alive; NW= Number weaned; KI= Kindling interval; WW= Weaning weight (g); DG= Daily gain (g/d) from weaning (28d) to AGE (d).

temperatures, cages, management, quality of feed, disease incidence, etc.... Anyway, figures observed in the four replicated locations were relatively constant in terms of total litter size at birth (around 8.5) and number born alive per litter (around 7.9). These figures show that prolificacy of this line raised in hot climate countries is good. The other variable studied such as litter size at weaning and post-weaning daily gains were more sensitive to the environment in the sense expressed before (Table 1). Based on levels of rabbit production in hot climate countries, these values gave us an impression to be much favourable and ranging from medium level to high level of performances and they are indicators of the effort needed to control the factors such as feed quality, diseases, temperatures and others. Accordingly, much efforts of research are needed to cover these items to keep production of rabbits in these countries safely.

Performances of crossbred rabbits:

Despite the synthetics are not considered to be completely formed, data obtained in the last year of the project in Saudi Arabia and Egypt are very promising, exhibiting a trend for prolificacy and capability for growth to be similar or higher than the V line (Tables 2&3). The results obtained are necessary to be confirmed in the next future since the reproductive data available now is only for F₂ and F₃; consequently we have to wait to get more generations. At the present situation, these results would allow us to use these synthetics in production as pure lines and to cross them with V line to get crossbred does to be distributed for the farmers in Delta and reclaimed areas and Upper Egypt (where the temperatures are higher than that in the Delta) and in different areas in Saudi Arabia as well.

Table 2: Actual reproductive performances⁺ of crossbreds obtained from crossing local breeds with Line V in different locations of the project.

Location	Breed	Crossbred	Litters	TB	BA	NW	KI
APRI	Red Baladi	F ₂	217	8.3	8.1	6.7	72
Moshtohor	Sinai Gabali	F ₁	38	-	8.2	6.6	43
Sau. Arabia	Saudi Gabali	F ₃	104	-	8.1	7.3	61

⁺ TB= Total born; BA= Number born alive; NW= Number weaned; KI= Kindling interval.

Table 3: Actual growth performances⁺ of crossbreds obtained from crossing local breeds with Line V in different locations of the project.

Location	Crossbred	No. of young	WW(g)	DG1(g/d)	DG2(g/d)
APRI	F ₃	799	462	16.4	20.0
Moshtohor	F ₂	260	547	23.8	23.0
Saudi Arabia	F ₄	751	640	31.9	29.4

⁺WW= Weaning weight(g); DG1(2)= Daily gain (g/d) from weaning (28d) to 56 (84) d.

Recommendations and proposals for the future:

Consolidation: The first important point to recommend is to consolidate the project as a true programme of genetic improvement. In this sense, a long term policy is necessary to compromise between the Universities and Institutes involved as partners in the project in terms of: (1) Allocation of enough spaces for housing the rabbits of lines synthesized, (2) Supplying the farms with good equipments, and (3) Saving sufficient number of qualified labours in the farms. Here, we have to remember that the minimum size of each line is 120 does and 20 bucks to be used in long term selection programme. Additionally, a control line in Alexandria of 60 does and 15 bucks is necessary to be available in the future to evaluate the genetic responses obtained as the programme of selection progresses.

Adaptability: The next point after consolidation is to identify the adaptation aspects for does of pure line and does of simple cross in different areas and systems of production. The case in which the use of crossbred does reveals to be the best, it would be necessary for this case to diffuse the animals by an economic way (simple, efficient, and safe way).

Development of paternal line in hot climate countries: Until now, the development of paternal lines specialised in high rates of growth has not been considered in many areas of hot climate. However, this aspect of developing paternal lines should be tackled at the same time that the development of an organisation, commented in the previous paragraph, necessary to produce and diffuse crossbred does in the areas where the use of double cross scheme is convenient and enough advanced in their systems of rabbit production.

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