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RABBIT PRODUCTION IN LOW-INPUT SYSTEMS IN AFRICA – PROSPECTS, CHALLENGES AND OPPORTUNITIES

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ABSTRACT

High poverty levels continue to plague much of Africa, in spite of several intervention strategies to stem the tide. The role of small livestock like rabbits as a tool in poverty alleviation programmes has been acknowledged for decades and successful national rabbit projects have clearly been demonstrated in Africa. With rising poverty levels across Africa, the need to rejuvenate such national rabbit projects for long-term sustainability becomes apparent. This presentation focuses on the status of rabbit production in Africa, with special attention to smallholder rabbit project development and its connection with poverty alleviation issues in the continent and with an emphasis on the strengths, weaknesses, opportunities and barrriers to the system. A special case is made for the sustainable development of smallholder, low-input rabbit production systems in Africa on account of their popularity, low investment requirements and low economic risks, as well as their contributions to family nutrition, income generation and gender empowerment. Successful rabbit projects in several countries across Africa were identified and the reasons for success, as well as lessons learned, are discussed. In all, several cases standout: the National Rabbit Project of Ghana, the Heifer Project International (HPI) Rabbit Project in Cameroon (HPI-CAM), and CECURI Rabbit Project in Benin Republic. Other fast-paced and moderately developed rabbit industries (e.g., in Egypt, Tunisia and Algeria in particular) are also recognized. Critical constraints to rabbit project developments (political will on the part of the government, non-implementation of sustainable models for low-input and smallholder rabbit units, absence of clientele-focused research and development (R&D) programmes, etc.) are also discussed. Prospects and opportunities for the development of sustainable smallholder rabbit production models include the following goals: (a) a paradigm shift among researchers to focus on innovative research related to the development of sustainable backyard rabbit production systems; (b) special R&D focus on the needs of smallholder rabbit units; (c) sustainable breeding programmes to meet the requirements of smallholder rabbit units; (d) documentation and up-scaling of good practices in smallholder rabbit units across regions; (e) development of local value chains in smallholder rabbit development, and (f) establishment of regional and global networks of smallholder family rabbit projects. The actualization of these goals requires a new line involving a sustainability research agenda that focuses more on backyard rabbit farms as the primary beneficiaries. The World Rabbit Science Association could play a key role in the realization of these goals, as enshrined in its constitution. Overall, the need for a poverty focus and a pro-poor research agenda involving owners of backyard rabbits are emphasized.

Key words: Rabbits, Smallholder units, Low-input systems, Poverty alleviation, Africa.

INTRODUCTION

For several decades, Africa has been plagued by high poverty levels that have portrayed an increasingly worrisome trend over time. According to a World Bank report (World Bank, 2008), between 1993 and 2002, poverty levels in Sub-Saharan Africa (SSA) increased from 200 million to 220 million in rural areas and from 80 to 100 million in urban areas,. This report noted that the number of rural poor has continued to rise and will likely exceed the number of urban poor by 2040. Across the continent, country profiles by the Central Intelligence Agency (CIA) have revealed that over a 12-year period, poverty levels in SSA ranged between 28 and 80% of the entire populace (CIA, 2012).

These reports noted that overall, poverty levels are very high in the continent with differences between regions (e.g., North vs. Sub-Saharan Africa) or by location within countries (e.g., rural *vs.* urban areas, World Bank, 2008).

Small livestock species, including rabbits, have been promoted as tools in poverty alleviation programmes (Dolberg, 2001; Owen *et al*., 2005). For over three decades now, the contribution of smallholder rabbit units to food security in developing countries has been clearly recognized (Owen, 1976; Cheeke, 1986; Lukefahr and Cheeke, 1991a). Rabbits are particularly favoured for poverty reduction programmes on account of their low investment and early benefits, and subsistence on renewable resources for feeding, housing and general management. Thus, small-scale rabbit projects could be used as a vehicle for the poor to help themselves (Lukefahr, 1999a). A projected five-year budget plan for an initial three-doe operation for a typical rabbit farmer in Cameroon illustrated the low investment costs involved in small-scale subsistence rabbit enterprise (Lukefahr and Cheeke, 1991a). The model could later be easily expanded to 5- to 10-doe operations in order to achieve a major favorable impact for the target family. Several reports have established connections between rabbit development projects in terms of: (a) poverty alleviation (Cheeke, 1986; Lukefahr, 2000; Owen *et al*., 2005); (b) rural development (Kpodekon and Coudert, 1993; Kpodekon *et al*., 2000); (c) reducing rural-urban migration (Kamel and Lukefahr, 1990); (d) entrepreneurial skills development (Kaplan-Pasternak, 2011); (e) humanitarian services including recovery efforts from natural disasters (Kaplan-Pasternak and Lukefahr, 2011), and (f) gender empowerment (Lukefahr *et al*., 2000).

The support of global organizations and foundations for rabbit research and development has been on-going for several decades now. Of special interest is the support provided by the FAO of the UN for rabbit projects in several developing countries, including Tunisia (Belli *et al*., 2008). Also noteworthy is the support provided by the International Foundation for Science (IFS, Stockholm, Sweden) for young scientists in the developing world for research and development programmes that support poverty alleviation. In December, 1978, the IFS sponsored an international workshop on rabbit husbandry in Africa. The event was held in Morogoro, Tanzania, in conjunction with the Tanzanian National Scientific Research Council. The proceedings of the conference was documented in a provisional report y the IFS (IFS, 1979). According to the report, presentations at the Conference included classic papers on rabbit production in tropical countries (Owen, 1979), methods of smallholder rabbit production (McNitt,1979), rabbit health, reproduction and housing and country reports from Tanzania, Sudan, Mozambique, Togo, Ghana, Zambia, Mauritius, etc).

However, in spite of these efforts, the extent to which small-scale or backyard rabbit projects can make sustainable, long-term contributions to poverty reduction and gender empowerment remains hazy. This fact is corroborated by the rising poverty level in SSA, in spite of several intervention strategies attempted to stem the tide. Thus, this presentation investigated the status of rabbit production in Africa, with special attention to smallholder rabbit project development and its connection with poverty alleviation.

Characteristics of and opportunities provided by smallholder rabbit units

Rabbits were most probably first introduced to countries in SSA well over 100 years ago by the early European Colonists and/or American and European missionaries, followed probably by a long period of repeated stock introductions (Lukefahr and Cheeke, 1991a; Lukefahr *et al*., 2000). Small family rabbitries averaging four does or less, based on local resources for feeding, housing, and healthcare are the usual pattern in many parts of the less developed world (Lebas *et al*., 1997; Onifade *et al*., 1999; Oseni *et al*., 2008). Present strategies to develop small-scale backyard rabbit enterprises have been described as an 'alternative back to basics' approach (Lukefahr, 1999). The author noted that such down-scaled units could represent a more favourable economy of scale of production based on the use of renewable farm resources. Lukefahr (1999a) noted that most farmers in less developed countries live under limited-resource conditions of land, feed supplies, equipment and capital. Under this context, the promotion of commercial animal production enterprises may not be appropriate for such farms because it can subject them to considerable economic risk (Udo, 1997, cited by Lukefahr, 1999a). According to Finzi (2000), smallholder rabbit units are characterized by the following: (a) few breeding rabbits in backyards; (b) use of local materials for hutches and equipment; (c) feeding of

fresh forages and kitchen wastes; (d) integration of rabbits with other farm components; (e) sharing of family labour, and (f) consumption of rabbits by the household or through sale of excess stocks in the local market. Finzi (2000) further noted that smallholder rabbit units, although lacking in economic resources, have available as assets both family labour and traditional knowledge of raising small livestock. This author recommended the need for research that supports the development of rabbit cottage industries.

Colin and Lebas (1996) reported that rabbit production is relatively important to the economy of some developing countries like Nigeria, Egypt, Ghana, Morocco, and Cape Verde. These authors noted that traditional farms with 8 to 10 does that are oriented towards family consumption and based on renewable resources, constitute 64% of farms in SSA and 58% in North Africa. Further, the percentage of does on traditional farms in North Africa and Sub-Saharan Africa are estimated at 66.97 and 75.45%. These figures are high and provide a further justification of the need for clientele-focused R&D for long-term sustainability of these units. More recent reports from the FAO (FAOSTAT, 2011, as shown in Tables 1 and 2) indicate that between 1990 and 2010, some countries (e.g., Botswana, Burundi, Cameroon, Gabon and Egypt) reported modest increases in national rabbit stocks (breeding females) from 15 to 41%; other countries (e.g., Kenya and Rwanda) showed exponential increases of 128 and 170%, respectively. Stock numbers were static for Algeria and declined in Mauritius.

Table 1: Rabbit breeding females (‘000) for selected countries in sub-Saharan Africa over a 20-year period (Source: FAOSTAT (2011)

	Year			
Country	1990	2000	2005	2010
Algeria	1,400	1,400	1,400	1,400
Botswana	100	100	100	120
Burundi	110	50	100	135
Cameroon	38	47	48	48
Egypt	6,591	9,250	9,250	9,300
Gabon	270	300	300	310
Kenya	214	313	472	490
Madagascar	50	120	110	115
Mauritius	15	15	7	5
Rwanda	292	339	519	790
Sierra-Leone	-	300	1,350	1,520

Table 2: Rabbit meat production quantity (tonnes) for selected countries in sub-Saharan Africa over a 20-year period (Source: FAOSTAT, 2011).

	Year			
Country	1990	2000	2005	2010
Algeria	7,000	7,000	7,000	7,000
Botswana	900	900	900	990
Burundi	436	184	396	516
Cameroon	76	94	96	96
Egypt	49,680	69,600	69,840	69,840
Gabon	1,620	1,992	1,800	1,860
Kenya	1,284	1,860	2,820	3,000
Madagascar	300	720	660	690
Mauritius	81	81	38	25
Rwanda	1,152	1,332	2,034	2,040
Sierra-Leone	-	1,500	6,750	9,100

In Egypt, Kamel and Lukefahr (1990) noted that village rabbit projects that directly involved youth reportedly decreased the rate of youth migration to urban areas. Small-scale rabbit projects can also target the more vulnerable households (e.g., HIV/AIDS, conflict and natural disasters involving for example recovery programmes after the devastating earthquake in Haiti in 2010 (Kaplan-Pasternak,

2011; Kaplan-Pasternak and Lukefahr, 2011)). Lukefahr (1999a) reported that small-scale rabbit production projects provide opportunities as humanitarian projects that assist people who live in poor rural countries.

LIMITATIONS TO RABBIT PRODUCTION IN AFRICA

Key constraints to the development of a viable rabbit industry in Africa range from environmental (e.g., heat stress and/or poor stock adaptation and poor diet quality) to other factors including institutional and policy limitations that hinder the development of sustainable programmes for smallholder rabbit units in the continent. These constraints include the following: (a) adaptation to heat stress and/or slow growth rate as a result of a multitude of factors; (b) dearth of clientele-based research for smallholder rabbit units, and (c) lack of suitable and well-adapted genotypes for low-input systems.

Heat stress poses a serious limitation to rabbit production in the tropics (Lukefahr and Cheeke, 1991b; El-Raffa, 1996). High ambient temperatures can cause infertility in breeding rabbits and 30 ^{o}C is considered the threshold, beyond which infertility may result; Lukefahr and Cheeke, 1991b). Adaptation to heat stress, particularly under hot and humid zones, has been extensively reviewed by El-Raffa (1996) who noted that heat stress is ranked as the most important problem facing the rabbit industry in the tropics and in arid regions, as compared to poor quality diets, diseases and(or) parasites. Heat stress reduces feed intake, impairs growth, decreases fertility and increases kit mortality (El-Raffa, 1996). Finzi *et al*. (1992) reported on the results of experiments that evaluated heat stress under field conditions and noted that animal posture (which varied from 'normal' and 'active' to 'stretched') gives some indication of the degree of heat stress in rabbits. Of course, more precise measures such as core body temperature and respiration rate are useful.

Slow growth rates of rabbits with ADG values ranging from 10 to 20 g/d is typical in tropical regions, compared to 35 to 40 g/d as recorded in temperate countries (Lukefahr and Cheeke, 1991a). Odeyinka *et al*. (2008) reported ADG performance of only 7 g/day. Causes of such low ADG values are primarily related to heat stress and poor diets. This constraint underscores the importance of suitable diets and heat stress mitigation strategies for smallholder units. Onwudike *et al.* (1995) reported some promising results for ADG of 21.2, 13.8, and 18.4 g/d, respectively, for rabbits fed Gliricidia compared to Leucaena and a control diet (pelleted concentrate fed alone without supplemental foliage).

A dearth of clientele-based R&D for smallholder rabbit units or lack of R&D focus on smallholder rabbit units is a key challenge. Part of the problem is that the mobilization of farmer groups is not an easy task due to the following reasons: small colony sizes and the fact that smallholder or backyard rabbit production is seen as a secondary activity. Part of the solution is for farmers to have an integrated rabbit production and management package that is based on nutrient recycling among farm components (Lukefahr, 2004) as opposed to a dependency on off-farm inputs such as commercial feed.

The absence of a tradition of eating rabbit meat also appears to be a constraint in some locations in SSA. This can be countered through promotional strategies like rabbit fairs and field days (Price and Regier, 1982; Oseni, 2010) and through cooperative marketing. Other constraints include poor quality feedstuffs, absence of a selection centre for breeding stock, as well as the absence of a long-term strategy for the development of smallholder rabbit units with a clear poverty alleviation focus.

Success stories of rabbit project research and development (R&D) in Africa

For over four decades, several success stories involving the successful implementation of R&D projects involving large numbers of smallholder backyard rabbit units have been recorded all across Africa. Notable examples of these include: (a) CECURI Rabbit Project of Benin Republic (Lebas *et al.,* 1997; Kpodekon and Coudert, 1993); (b) Cameroon (Lukefahr *et al*., 2000); (c) National Rabbit

Project of Egypt (Kamel and Lukefahr, 1990; Galal & Khalil, 1994), and (d) the National Rabbit Project of Ghana (Mamattah, 1979; Lukefahr, 2000); (e) Kenya (Kamande, 2010; Oseni, 2010); (f) Malawi (McNitt, 1979); (g) Mauritius (Ramchurm, 1979); (h) Mozambique (Gaspari, 1979; Demeterova *et al*., 1991); (i) FAO and CIHEAM support for rabbit project development in Tunisia (Belli *et al*.,2008), and (j)Uganda (Lukefahr, 1998b).

Several of these national projects gained global prominence on account of their remarkable successes. Some of these projects or programmes are discussed briefly with emphasis on lessons learned and present status:

(a) In Benin Republic, the CECURI project was set up to vitalize the rabbit production sector, where the promoters emphasized the need for local solutions to feeding, genetics and housing challenges (Kpodekon and Coudert, 1993; Lebas *et al*., 1997). The goal of the project was to raise awareness and knowledge about rabbit production, breeding, pathology, etc., in order to improve local production and to extend a rational method for its rearing. According to Kpodekon and Coudert (1993), some of the impacts of the project included: (a) increased number of scientists involved in rabbit research for development; (b) increased number of smallholder rabbitries; (c) creation of a rabbit breeding association in Benin Republic, and (d) establishment of a functional R&D centre for providing a clientele service to backyard rabbit units.

(b) The Heifer Project International–Cameroon Rabbit Project (or HPI-CAM). Lukefahr and Goldman (1985) and Lukefahr *et al.* (2000) described the HPI-CAM project for farm families that had the goal of improving family nutrition and income, and also enhancing community development and gender status in villages in Cameroon. The project involved appropriate local technologies and the use of renewable, on-farm local resources. The project has been described as a role model in developing rabbit projects in other LDCs by HPI. The HPI-CAM model was applied to the HPI–Uganda smallholder rabbit project and to other development projects (Lukefahr, 1998b).

(c) From Egypt, several reports of projects are noted. Galal and Khalil (1994) reported on the National Rabbit Project of Egypt, which involved collaboration between Zagazig University in conjunction with the Egyptian Academy of Scientific Research and Technology. The breeding objective involved the distribution of purebred Californian and New Zealand White rabbits, along with an extension package to small-scale farmers. A second farmers' project that was coordinated by USAID and the National Development Agricultural Bank of Egypt was established to promote rabbit production in rural areas through soft loans. Both projects recorded good successes. A third project reported by Kamel and Lukefahr (1990) was a comprehensive and integrated project involving rural development in Egbet Badir. The approach was a participatory, community-based development project managed at the grass roots. The project also recorded some remarkable successes, which according to the authors included stemming the tide of rural-urban migration among the youth and literacy improvement.

(d) The National Rabbit Project (NRP) of Ghana, which according to Anonymous (1979), Mamattah (1979), and Lukefahr (2000) was a highly recognized programme and for decades served as a model for Lesser Developed Countries (LDC) as a means to alleviate national meat shortages and increase farm income. The programme provided breeding stock, training, extension support, etc., to limited-resource farmers. These authors noted that the NRP for many years served as a role model to other developing countries in terms of government's role and duty in feeding its people through sustainable smallholder rabbit production.

(e) The National Rabbit Fair of Kenya (Kamande, 2010; Oseni, 2010) involved some 2,000 smallholder rabbit farmers as well as key stakeholders, including micro-finance and input suppliers and services (e.g., veterinarians and feed millers). The goal was to sensitize the populace about the role of smallholder and integrated rabbit production in terms of employment, income generation and family nutrition.

(f) The Rabbit Research Project at Bunda College of Agriculture, Malawi (McNitt, 1979). This project was established to investigate methods of rabbit production that were suitable for smallholder farmers. The project focused on nutrition, animal care, housing and general management. This author noted further that the Bunda College of Agriculture - Rabbit

Research Project was established specifically to investigate the requirements of smallholder rabbit producers with respect to housing, health-care, nutrition and breeding stock.

(g) FAO and CIHEAM support for rabbit project development in Tunisia (Belli *et al*., 2008). As reported by Belli *et al*. (2008), in the last 20 years, rabbit breeding in Tunisia has developed and continues to do so with the introduction of new technology and government support, international organizations such as the FAO of the United Nations, and with initiatives such as the International Observatory on Rabbit Breeding in Mediterranean countries and the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM).

(h) National programme of rabbit production in Mozambique (Gaspari, 1979; Demeterova *et al*., 1991). These authors reported on the successful implementation of a national programme of rabbit production in Mozambique. The project was implemented - via a national centre and several provisional centres - to provide housing, breeding stock and training facilities for the populace with a strong emphasis on renewable resources (especially forages) for feeding rabbits.

Lessons learned

Some of the major lessons learned from these aforementioned projects include the following:

(1) A functional R&D rabbit centre contributes significantly to project success (Kpodekon and Coudert, 1993);
(2) The projects largely focused on the special needs of smallholder rabbit units;
(3) Gender empowerment could also be achieved through backyard rabbit projects (Lukefahr, 2000, HPI-CAM project);
(4) Small-scale rabbit projects could be used as a tool for the enhancement of family welfare (Mammattah, 1979; Owen, 1979; Cheeke, 1986; Kpodekon and Coudert, 1993);
(5) R&D projects involving multiple stakeholders (e.g., researchers, NGOs, government agencies, farmers) can lead to enhancements involving family welfare with positive impacts on potentially thousands of resource-limited families in the developing world;
(6) The synergy resulting from collaboration among stakeholders has been instrumental in ensuring project success;
(7) In particular, the role of the government is pivotal to the success of such development projects;
(8) All the projects served as models for the use of small livestock as vehicles for family welfare, gender empowerment and poverty reduction, and
(9) Well appreciated in development work, continuing the momentum long after the formal lifespan of a project remains a challenge. In other words, the long-term sustainability of a project remains a challenge.

RESEARCH AND DEVELOPMENT (R&D) MODELS INVOLVING RABBITS

Research and Development (R&D) models serve as the basis for linking research output in rabbit science and production to sustainable development, including programmes related to poverty reduction and gender equity. Several R&D models used in the development of smallholder rabbit projects include the Heifer Model (Aaker, 2007) and the Small-Scale Rabbit Production Model (or SSRPM, Lukefahr, 2004), among others. These models serve to link livestock projects as tools for community development, poverty alleviation and gender equality. In particular, the Heifer Model is described as a values-based cornerstone development tool to help rural community-based organizations assess, plan, manage and monitor smallholder livestock project development.

The SSRPM proposed by Lukefahr (2004) represents an alternative and self-supporting system based on renewable farm resources for the development of small-scale rabbit projects as the basis for poverty reduction. According to this author, the SSRPM is a development planning tool that rests on three tiers:
(a) external factors (e.g., ecological, economical and sociological aspects); (b) intermediate factors (e.g., project feasibility, design, implementation, monitoring and evaluation), and (c) internal factors (including genetics, housing and equipment, diet and health management). Thus, the SSRPM

addresses critical requirements for the successful initiation and sustainability of small-scale rabbit projects especially designed for limited-resource farm families in the developing world. Lukefahr (2004) has also called for a novel line of "sustainability research" to evaluate the SSRPM factors (internal, intermediate and external) under local situations.

Research and development (R&D) strategies for smallholder rabbit units

The goals of R&D programmes involving rabbits are to boost knowledge, recognition and awareness of smallholder rabbit production as a key strategy in poverty alleviation, household food security and empowerment of women. It is widely recognized that R&D programmes could play a pivotal role in actualizing these lofty goals (Lebas *et al*., 1997; Bang, 1999; Lukefahr, 1999b; Finzi, 2000; Conroy *et al*., 2002; Lamboley and Morand-Fehr, 2002). Finzi (2000) noted that research has been directed exclusively to improve industrial systems that are largely unsustainable in LDCs. Thus, the need for research relating to alternative and sustainable systems is apparent.

The role of researchers and their contributions to the development of sustainable small-scale rabbit projects is emphasized by Lukefahr (2007b). This author noted that a dynamic and viable rabbit breeding industry depends on a cadre of rabbit scientists who engage in research activities that directly solve farmers' problems. Similarly, Bang (1999) argued that researchers must focus attention on the needs of poor farmers and recommended re-training opportunities for researchers on participatory *on farm* research design and implementation. In this regard, a paradigm shift on the part of rabbit scientists and other stakeholders is evident. In line with this observation, Lukefahr (1999b) called on rabbit scientists to "retune their research priorities to develop local rabbit production systems that yield higher outputs at lower inputs involving no off-farm purchases that would supply inexpensive meat for the family, improve farm productivity and supplement income through the sale of surplus stock". This author called on rabbit specialists to provide their valuable expertise to offer opportunities for small-scale rabbit farming and to share project experiences through publications. Even the WRSA constitution (Article 3, Object 28(ii)) emphasizes the dissemination of knowledge pertaining to all branches of the rabbit industry. Lukefahr (1999b) provided specific examples of research projects for small-scale rabbit production where specific expertise is needed to include the following: (a) suitable farm diets that could replace commercial pellets and guarantee farm feed security; (b) local remedies for treating diseases including mange, sore hocks, coccidiosis, diarrhoea, etc., and (c) Selection of local genetic stocks for novel traits related to adaptation or traits that have real merit under smallholder, low-input systems (e.g., forage intake capacity, thermo-tolerance & low nutrient requirements

The need to focus R&D efforts on resource-poor farmers was further echoed by Conroy *et al.* (2002) who noted that the accountability of scientists to such target groups has been almost non-existent. These authors observed that most research are discipline–based rather system-based, with researchers focusing on components rather than on systems. This was further corroborated by Oseni (2008) who reported that 80% of the publications from SSA were basic research output, uni-disciplinary in nature and conducted largely under *on–station* conditions. This author further reported that over two-thirds of the papers needed further trials to adapt the technologies to existing conditions of backyard rabbit units. As a solution, Conroy *et al* (2002) suggested the creation of incentives for researchers who conduct innovative *in situ* research that are system-based and with a poverty alleviation focus. These authors noted that the conditions which influence the relevance of research to poor livestock keepers include the following: (a) encouragement of *in situ* research and rewards researchers whose work results in benefits to the poor; (b) researchers receive training on how to conduct pro-poor, participatory research and/or forge partnerships with NGOs, and (c) research has a gender bias – researchers work with women if they have main responsibility for livestock.

The need to evaluate research in terms of its potential application to smallholder livestock production units has been suggested. According to Lamboley and Morand-Fehr (2002), there is the need to evaluate the applicability of research results to these target groups based on a scale of 0 to 3, where: "0" implies "research with no possible application"; "1" denotes "research outcome with eventual application after carrying out other trials"; "2" implies research with possible applications, and "3" implies research with direct application to conditions in smallholder units. In line with this suggestion,

Oseni (2008) noted that over two-thirds of research output in SSA belonged to categories "0" and "1" above (Table 3), which represents a very worrisome trend, on account of the high poverty levels in the region.

Table 3: Distribution of research papers by the index of potential applicability of research (from Oseni, 2008) .

Index of applicability	Number of papers	Frequency (%)
0 (No possible application)	6	5.22
1 (More tests required)	78	67.83
2 (Possible application)	21	18.26
3 (Direct application)	10	8.69
All	115	100.00

Some critical R&D questions in relation to smallholder rabbit project development include the following: (i) How are such projects designed to benefit resource-poor farmers? (ii) what is the current status of smallholder rabbit units in SSA? (iii) what are their strengths & weaknesses? (iv) what are the challenges for smallholder rabbit units? (iv) what are the R&D requirements for such units? (v) What are the R&D options for background rabbit project development?

Requirements for the development of the SSRPM

(a) Nutrition

Rabbit nutrition and the assurance of farm feed security is crucial for the sustainability of smallholder rabbit units. Rabbit nutrition represents one of the internal factors for the development of SSRPM based on renewable farm resources (Lukefahr, 2004). Many parts of Africa are characterized by the abundance of biomass which can be exploited for use by backyard rabbit systems. Lukefahr (2011) emphasized the need for *on farm* feed security in backyard systems. Lukefahr (2004) reported that a forage security plan (within a farm) helps to ensure year-round availability of feeds. The author noted that the composition of the diet invariably changes over seasons as certain ingredients become more or less abundant and recommended that training of farmers on methods to prepare a forage security plan is paramount. Other efforts have involved unconventional feeding techniques for rabbits in developing countries (Finzi and Amici, 1996). These authors described the manufacture and use of molasses and blocks and crumbles of feeds for rabbits with particular attention to the developing world.

Samkol and Lukefahr (2008) reported that plants like water spinach, mulberry, cassava leaves and sweet potato vines are nutritious and can be grown by farmers. Other resources including the use of palm kernel cake, which is relatively cheap and available across seasons in some parts of SSA has been evaluated. Orunmuyi *et al.* (2006) reported that palm kernel cake can be used up to 30% in a maize–soybean meal-based diet for weaner rabbits. Further, Finzi (2008) reported that for a forage-based diet, appropriate and specific management must be studied and applied. This author observed that for rabbit nutrition, out of some 170 vegetal feedstuffs or by-products that are well–known for their nutritional qualities for rabbits that are available in developing countries, only 17 (16%) are used by feed mills.

(b) Genetics

The provision of suitable breeding stocks that are well adapted to backyard systems is a key requirement to the sustainability of such systems. Genetics was identified as one of the internal factors in the SSRPM (Lukefahr, 2004). The challenge for smallholder rabbit units is the desired genotypes that can perform under low-input systems characterized mostly by sub-optimal management. With respect to the desired genotypes for backyard systems, the following questions have been raised: (a) what are the desirable genetic stock(s) for low-input rabbit production systems in hot and humid climates? and (b) what available genotype(s) are adapted to such conditions (*e.g.*, low-input, backyard systems)? Attempts to produce adapted genotypes that can perform under the conditions in smallholder units have not received much attention and do not appear to be a priority (Lukefahr, 1998a). Further, several reports have shown that most of the studies in SSA related to genetics are mainly crossbreeding studies involving two- or three-way crosses of the commercial rabbit breeds as indicated in Table 4 (Somade and Adesina, 1990; Oseni (2008). Oseni *et al*. (2008) observed that

clientele service to smallholder rabbits units (*e.g*., provision of breeding stocks and other inputs required by such units) is basically non-existent.

Table 4: Distribution of research papers by the areas of specialization (from Oseni, 2008).

Area of specialization	Number of papers	Frequency (%)
Rabbit Nutrition	61	53.05
Breeding & Genetics	78	67.83
Others	41	35.65
All	115	100.00

As a potential solution, local breeds of rabbits, as well as heterogeneous stocks described as "non-standard breeds" have received increasing attention (Lukefahr et al., 1992; Lakabi *et al*., 2004; Zerrouki *et al*., 2004, 2007; Oseni and Ajayi, 2010). Zerrouki *et al*. (2004) noted that the utilization of local genetic resources first requires characterization of the population existing in the country. In line with this, the characterization of a local Algerian rabbit breed (the Kabylian) was presented in reports by Lakabi *et al*., (2004) and Zerrouki *et al*. (2004, 2007), . Other reports by Gacem *et al*. (2008) noted that in the frame of a cooperative venture between INRA (France) and ITEV (Algeria), a new synthetic strain was developed from the insemination of females of Kabylian by fresh semen of males from the INRA2666 strain, to exploit heterosis and breed complementarity. More sophisticated breeding, including the development of multi-purpose synthetic lines and selection programmes for the development of synthetic paternal lines in Egypt and Saudi Arabia were reviewed by Khalil and Al-Saef (2008).

Heterogeneous stocks represent the product of crosses of pure breeds of commercial rabbits and/or local rabbit breeds (Lukefahr, 1998a). Heterogeneous stocks are predominant in many backyard systems in Africa. Lukefahr (1998a) argued that the maintenance of heterogeneous populations that are locally adapted may have real merit in adverse environments. This author, citing Falconer and Mackay (1996), noted that a high degree of genetic variation and/or heterosis might be important for fitness-related characters (e.g., fertility and survival) as a means for eventual local adaptation. The author observed that local rabbits showed anatomical and physiological soundness, including small-to-moderate mature size (possibly to minimize nutrition stress), large ears in proportion to body size, thermo tolerance, etc. Physiological soundness (Lukefahr, 1998a) included the following: (a) adaptability to the climate (e.g., normal pulse rate, respiratory rate and body temperature); (b) adaptability to sub-optimal diets (e.g., high forage intake capacity); (c) small-to-moderate litter size, and (d) body condition maintenance. This author further noted that qualities relating to anatomical and physiology soundness as exhibited by heterogeneous rabbits may have real merits as potential selection criteria under low-input systems.

Heterogeneous stocks have displayed some degree of adaptation to backyard systems and seem very promising when compared to importedor exotic breeds (e.g., cost, logistics and risks of disease transmission). A major concern with heterogeneous stocks is the problem of inbreeding, which has been identified as a constraint to production, especially in locations where the same breeding animals are circulated among rabbit farmers. A solution to this is a process of buck exchange by farmers across different locations (Lukefahr, 2011). Thus, heterogeneous stocks present ample opportunity for improvement of smallholder and low-input systems on account of the following: (a) availability in many backyard systems in SSA; (b) adaptable to sub-optimal conditions in such units; (c) although output is low (20 fryers per doe per year (Lukefahr and Cheeke, 1991a) there is opportunity for improvement through sustainable efforts as demonstrated by the CECURI in Benin Republic (Kpodekon *et al.,* 1999) and the National Rabbit Project of Ghana (Lukefahr et al., 1992; Lukefahr, 2000). Thus, heterogeneous stocks represent an under-exploited genetic resource for smallholder units that will require further attention with respect to sustainable breeding programmes as the basis for providing clientele service in form of reliable breeding stocks to smallholder rabbit units.

In summary, the provision of suitable and well-adapted rabbit genotypes to smallholder rabbit production units is seen a key aspect of clientele service delivery and will most probably, contribute to the success of any rabbit project development. This step can be coordinated from a research and development institute as is the case with CECURI (Kpodekon and Coudert, 1993) or from an international NGO (e.g., HPI rabbit project of Cameroon, Lukefahr *et al*., 2000). The challenge is the

long-term organizational structure needed to implement such a programme in to secure sustainable smallholder rabbit project development.

(c) Micro-credit

Successful implementation of smallholder rabbit production can be facilitated through the provision of micro-credit and soft loans by banks and micro-credit institutions. Galal and Khalil (1994) reported on the implementation of a smallholder rabbit project in coordination with USAID and the National Development Agricultural Bank of Egypt that promoted rabbit production in rural areas through soft loans. Dolberg (2001) reported that micro-credit played an important role in the success of the Bangladeshi model for the use of poultry as a poverty alleviation strategy among rural women. According to Owen (1979), governments have a role to play in initiating programmes of instruction and the supply of inputs, including micro-finance and soft loans. These have been demonstrated in Ghana and Mexico (Lebas *et al*., 1997). Of course, it is also critical that strong markets for rabbit meat and breeding stock be established so that loans can be repaid.

(d) Training

Training of backyard rabbit farmers on basic husbandry techniques contributes to the sustainability of such production systems. Lukefahr (1999c) observed that rabbit farmers may not have access to proper rabbit training and supervision and attributed many past rabbit project failures. Further, Lukefahr (2007b) reported that formal farmer training, although usually taking place at a R&D training centre, may be more appropriate when held on demonstration farms in the region. Thus, training of farmers on basic rabbit management techniques, especially under smallholder units is seen as a priority step in sustainable R&D programmes. Several major publications (e.g., Finzi, 2000; Djago et al., 2007; Lukefahr, 2010;) have laid out very comprehensive steps in rabbit management under small-scale or backyard systems. Such materials can be used as general guides for training for owners of backyard or smallholder rabbit units. The success of such training programmes can be further enhanced by a training "needs assessment" especially of backyard rabbit systems. Lukefahr (2007b) further suggested that farmers be trained on self-sufficiency rather than depend on off-farm inputs such as imported breeding stock, commercial diets, wire for cages.

Training of farmers could take different forms and dimensions. One form of training is coordinated within the framework of a rabbit R&D project (*e.g.,* CECURI rabbit project, Kpodekon and Coudert, 1993). A second approach is the training organized as part of a rabbit project development by an NGO in collaboration with multiple stakeholders (*e.g.,* HPI-CAM programme, Lukefahr and Goldman, 1985; Lukefahr *et al*., 2000). A third approach to training is the farmer-to-farmer volunteer programme as reported from Haiti (Kaplan-Pasternak and Lukefahr, 2011), which involves local rabbit farmers extending the knowledge of basic rabbit husbandry practices after formal training at a rabbit R &D unit. These approaches are not mutually exclusive, implying that several of these forms can be combined. In general, topics covered during training typically involves vital aspects of small-scale rabbit production, for example, low investment cost, farm-based feeding, production targets, housing, breeding practices, healthcare, promotional strategies and marketing (Kaplan–Pasternak and Lukefahr, 2011).

(e) Role of Networking in Developing the Sustainable Small-Scale Rabbit Production Model

There is the need to create a network of stakeholders involved with sustainable small-scale rabbit project development. Networking provides an opportunity for sharing experiences across a large spectrum of stakeholders, with a shared vision about the boosting the role of backyard rabbit systems in family nutrition and welfare, gender empowerment and poverty reduction. The goal of networking among key stakeholders (e.g., rabbit scientists/researchers, NGOs, farmer groups, government institutions) involved in small-scale backyard systems is to build the sustainable capacity for smallholder rabbit production aimed at benefiting poor families, including women. Through networking, experiences that can be scaled-up or replicated in other locations are identified. The network can also serve to identify and promote suitable R&D agenda and priorities, source funding and facilitate multi-locational cooperation activities. In a nutshell, a functional networking system will enable the following: (a) documenting and up-scaling good practices in backyard rabbit production systems, and (b) sharing of information and updates on applied rabbit research, monitoring and evaluation, with a focus on the use of rabbit as a tool for poverty reduction food security and the empowerment of women.

CONCLUSIONS

This presentation addressed the status of the rabbit industry and/or production in Africa with a special focus on the popular smallholder rabbit production system. Previous successes involving national rabbit project development and implementation activities across the continent have been highlighted, as well as major lessons learned. Such rabbit project successes need to be widely replicated across the continent so that smallholders can benefit, mostly by enhancing food security and income generation. Constraints to the development of sustainable rabbit production systems were also discussed. Critical R&D programmes were also identified where prospects and opportunities for the development of sustainable smallholder rabbit production models were outlined to include the following: (a) a paradigm shift among researchers to focus on innovative *in situ* research related to the development of sustainable backyard rabbit systems; (b) a special R&D focus on the needs of smallholder rabbit units; (c) extension of sustainable breeding programmes to meet the requirements of smallholder rabbit units; (d) documentation and up-scaling of good practices in smallholder rabbit units across regions; (e) development of local value chains in smallholder rabbit development, and (f) establishment of regional and global networks of smallholder family rabbit projects. The realization of these goals requires a new line of medium- and long-term sustainability research agenda with backyard rabbit farms as the primary beneficiaries. Overall, the need for a poverty focus and a pro-poor research agenda involving backyard rabbits are emphasized.

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REFERENCES

Aaker J. 2007. *Heifer Model. Cornerstones Values-based Development. Heifer International, 160 pp.*

Anonymous. 1979. Ghana's rabbit project. Africa Report, Jan-Feb, 1979. Story adapted by S.D. Lukefahr. Rabbit Production in Developing Countries.

Bang J.K. 1999. Participatory research with farmers: Lessons gained from postgraduate training courses in Vietnam. *Livestock Research for Rural Development,* 11(2), 1999. Accessed September 15, 2007 at http://www.cipav.org.co/lrrd/lrrd11 /2/bang112.htm.

Belli P., Fontana E., Sommariva M., Scarpelli L., Rucci C., Luzi F., Haddad B. 2008. The Tunisian traditional rabbit system versus. The commercial system: an epidemiological perspective. *World Rabbit Sci., 16: 221 – 228.*

Cheeke P.R. 1986. Potentials of rabbit production in tropical and sub-tropical agricultural systems. *J. Anim. Sci., 63: 1581-1586.*

CIA. 2012. Central Intelligence Agency. Country Reports. Accessed at https://www.cia.gov/library/publications/the-world-factbook/fields/print_2046.html

Colin M., Lebas F. 1996. Rabbit meat production in the world. A proposal for every country. *In: Proc. 6th World Rabbit Congress, Toulouse, France. July, 1996. Vol. 3, 323 – 330.*

Conroy C., Thakur Y., Vadher M. 2002. The efficacy of participatory development of technologies: experiences with resource-poor goat-keepers in India. *Livestock Research for Rural Development, 14(3). Accessed on the 10th of October, 200 at: http://cipav.org.co/lrrd/lrrd14/3/conr143.htm.*

Demeterova M., Pereira C.I., Dade A.C. 1991. Rabbit production under tropical conditions in Mozambique. World Animal Review, 69(4): 36 – 43.

Djago Y.A., Kpodekon M., Lebas F. 2007. Le Guide pratique de l'éleveur de lapins en Afrique de l'Ouest (Practical manual for rabbit breeding in Western Africa. - Manual in French). 2e édition révisée. Accessed at: http://www.cuniculture.info/Docs/Elevage/Tropic-01.htm.

Dolberg F. 2001. A livestock development approach that contributes to poverty alleviation and widespread improvement nutrition among the poor. Lives. Res. For Rural Dev., 13/5:

El-Raffa A.M. 2004. Rabbit production in hot climates. *In: Proc., 8th World Rabbit Congress, Sept. 7-10, 2004. Mexico.*

Falconer D.S., Mackay T.F.C. 1996. *Introduction to Quantitative Genetics. 4th Edition, pp 235 – 239.*

Finzi A. 2000. Integrated Backyard Systems. FAO, Publications Division. Accessed at (http://www.fao.org/ag/AGAinfo/themes/documents/ibys/)

Finzi A. 2008. Rabbit production development, new strategies to avoid conflict between use of natural resources for food and feed. ole of organic rabbit farming for poverty alleviation. Proceedings MEKARN Rabbit Conference: Organic Rabbit Production from Forages. R. Preston and Nguyen Van Thu (eds.). Cantho University, Vietnam, 25-27 Nov., 2008. Accessed at http://www.mekarn.org/prorab/Finzi.htm.

Finzi A., Amici A. 1996. Unconventional feeding techniques for rabbits in developing countries. *In: Proc. 6th World Rabbit Congress, Toulouse, France. July, 1996.*

Finzi A., Nyvold, S., El Agroudi M. 1992. Evaluation of heat stress in rabbits under field conditions. *J. Applied Rabbit Res. 15: 739-744.*

Gacem M, Zerrouki, N., Lebas, F., Bolet, G. 2008. Strategy for developing rabbit meat production in Algeria: creation and selection of a synthetic strain. *In Proceedings, 9th World Rabbit Congress,Verona, Italy, pp 85 – 91.*

Galal E.S.E., Khalil M.H. 1994. Development of rabbit industry in Egypt. CIHEAM – Options Mediterraneennes, 43 - 53.

Gaspari D. 1979. Rabbit breeding production in Mozambique. IFS Provisional Report No. 4, Rabbit Husbandry, Morogoro, Tanzania, Dec., 1978, pp 43 – 48.

IFS 1979. Provisional Report Number 4. Rabbit Husbandry, Morogoro, Tanzania, Dec. 1978.

Kamande W. 2010. Where rabbit meat competes with 'Githeri'. The Standard, February 3, 2010, Page 18.

Kamel L., Lukefahr S.D. 1990. A note on the social impact of village scale rabbit project development in rural Egypt. *J. of Applied Res.*, 12:259-262.

Kaplan-Pasternak M. 2011. Promoting entrepreneurial opportunities through rabbit production in Haiti. Rabbit Production in Developing Countries. 4pp. WRSA. Accessed at: http://world-rabbit-science.com/

Kaplan-Pasternak M., Lukefahr S.D. 2011. WRSA project: Rabbit production development in response to the earth quake disaster in Haiti. Interim Report to the WRSA. Accessed at: http://world-rabbit-science.com/

Kpodekon M., Coudert P. 1993. Impact of a rabbit research and information centre on research activity and development of rabbit production in Benin. *World Rabbit Sci., 1(1) 25-30*

Khalil M.H., Al-Saef A.M. 2008. Methods, criteria, techniques and genetic responses for rabbit selection: a review. *In: Proceedings, 9th World Rabbit Congress, Verona, Italy. Pp 1 - 22.*

Kpodekon M., Gnimadi A., Djago Y., Bhouin S. Faorugou S. 2000. Rabbit production and network in Benin in 1998. *In Proc. 7th World Rabbit Congress, Puebla, Mexico. 7 – 10 September, 2004.*

Lakabi D., Zerrouki N., Lebas F., Berchiche M. 2004. Growth performance and slaughter traits of a local Kabylian population of rabbits reared in Algeria: effects of sex and rearing season. *In: Proceedings of the 8th WRC, Puebla, Mexico, pp 1396 – 1402.*

Lebas F., Coudert, P. Rochambeau, H. De., Thebault, R.G. 1997. *The Rabbit: Husbandry, Health and Production. 2nd Edition. FAO Rome.*

Lukefahr S.D. 1998a. Review of global rabbit genetic resources: special emphasis on breeding programmes and practices in lesser developed countries. *Animal Genetic Resources Information, 23: 49 – 67.*

Lukefahr S.D. 1998b. Rabbit production in Uganda: Potential vs. opportunity. World Rabbit Sci., (3-4): 331-340

Lukefahr S.D. 1999a. Teaching international animal agriculture. *J. Anim. Sci., 77: 3106–3113.*

Lukefahr S.D. 1999b. Opportunities for rabbit research and human development in the western hemisphere: a rabbit revolution: *World Rabbit Sci., 10(3): 111 – 115.*

Lukefahr S.D. 1999c. Small-scale rabbit production in the Western Hemisphere: Back to basics? *World Rabbit Sci., 7(2): 87 –94.*

Lukefahr S.D. 2000. National Rabbit Project of Ghana: a genetic case study. *ICAR Technical Series 3, pp 307–317*

Lukefahr S.D. 2004. Sustainable and alternative systems of rabbit production. *In Proc. 7th World Rabbit Congress, Puebla, Mexico. 7 – 10 September, 2004. Accessed at: http://www.dcam.upv.es/8wrc.*

Lukefahr S.D. 2007a.The small-scale rabbit production model: intermediate factors. *Livestock Res. for Rural Dev.,19, Article Number 69. Accessed September 21, 2007 at http://www.cipav.org.co/lrrd/lrrd19/5/luke19069.htm.*

Lukefahr S.D. 2010. Developing Sustainable Rabbit Projects. (2nd edition). Heifer International Publishers. Little Rock, AR. USA, 165 pp.

Lukefahr, S.D. 2011. Partners of the Americas / Farmer to Farmer Programme Report, 20 pp. WRSA. Accessed at: http://users.tamuk.edu/kfsdl00/TRIP%20REPORT%20BY%20LUKEFAHR.pdf

Lukefahr, S.D., Cheeke, P. R. 1991a. Rabbit project development strategies in subsistence farming systems. 1. Practical considerations. *Wld Anim. Rev., 69: 26 – 35.*

Lukefahr,S. D., Cheeke P.R. 1991b. Rabbit project development strategies in subsistence farming systems. 2. Research applications. *Wld Anim. Rev., 69: 60 - 70.*

Lukefahr S.D., Goldman M. 1985. A technical assessment of production and economic aspects of small-scale rabbit farming in Cameroon. J. Appl. Rabbit Res. 8: 126 - 135.

Lukefahr S.D., Atakora J.K.A., Opoku E.M. 1992. Heritability of 90-day body weight in domestic rabbits from tropical Ghana, West Africa. *J. Heredity,* 83: 105 - 108.

Lukefahr S.D., Nkwocha, H.I., Njakoh, H., Tawah, E., Akob, J.M., Kongyu, F.A., Njwe, R.M., Gudahl, D. 2000. Present status of the Heifer Project International – Cameroon Rabbit Program: Back to the future. World Rabbit Sci., 8(2): 75 - 83.

Mamattah N. 1979. Sociological aspects of introducing rabbits into farm practices. IFS Provisional Report No. 4, Rabbit Husbandry, Morogoro, Tanzania, Dec., 1978, pp 93 – 99.

McNitt J.I. 1979. Methods of smallholder rabbit production. IFS Provisional Report No. 4, Rabbit Husbandry, Morogoro, Tanzania, Dec., 1978, pp 100 – 112.

Morand-Fehr P., Boutonnet, J.I., Devendra, C., Dubeuf, J.P., Haenlein, G.F.W., Holst, P., Mowlem, L., Capote, J. 2004. Strategy for goat farming in the 21st century. *Small Ruminant Research, 51: 175 – 183.*

Onifade A.A., Abu O.A., Obiyan R.I., Abanikannda, O.T.F. 1999. Rabbit production in Nigeria: Some aspects of the current status and promotional strategies. World Rabbit Sci., 7(2): 51 - 58.

Opoku E.M., Lukefahr S.D. 1990. Rabbit production and development in Ghana: The National Rabbit Project experience. *Journal of Applied Rabbit Research, 13: 189 – 192.*

Orunmuyi M., Bawa G.S., Adeyinka F.D., Daudu O.M., Adeyinka I.A. 2006. Effects of graded levels of palm-kernel cake on performance of grower rabbits. *Pakistan Journal of Nutrition, 5(1): 71 – 74.*

Oseni S.O. 2008. Research output and publications in rabbit science and production from sub-Saharan Africa – implications for future research and development efforts. *9th World Rabbit Congress, Verona, Italy. Pp 1591-1596.*

Oseni S.O., Ajayi B.A. Komolafe S.O. Siyanbola D., Ishola M. Madamidola G. 2008. Smallholder rabbit production in southwestern Nigeria: current status, emerging issues and ways forward. *9th World Rabbit Congress, Verona, Italy. Pp 1597-1601.*

Oseni S.O. 2010. Report of an exhibition by the Rabbit Breeders Association of Kenya - January 2010. Project Stories from the Field. Rabbit production in developing countries. Accessed at: http://world-rabbit-science.com/

Owen J. E. 1976. Rabbit production in tropical developing countries: a review. *Trop. Sci., 18 (4): 203 – 210.*

Owen J,E. 1979. Rabbit production in tropical countries. IFS Provisional Report No. 4, Rabbit Husbandry, Morogoro, Tanzania, Dec., 1978, pp 73-92.

Owen E., Kitalyi, A., Jayasuriya, N. and Smith, T. 2005. *Livestock and Wealth Creation. DFID, LPP. Nottingham University Press.*

Price M.L., Regeir F. 1982. Rabbit production in the tropics. *Echo Technical Note. Accessed on the 8th of Febraury, 2012, at http://www.echonet.org*

Ramchurm R. 1979. New feed resources for rabbits in Mauritius. IFS Provisional Report No. 4, Rabbit Husbandry, Morogoro, Tanzania, Dec., 1978, pp 49 -55.

Samkol P., Lukefahr S.D. 2008. A challenging role of organic rabbit production towards poverty alleviation in South East Asia. *In: Proc., 9thWorld Rabbit Congress, Verona, Italy. Pp 1479 – 1497.*

Somade B., Adesina A. 1990. Influence of the breed of doe and season on the growth rate of rabbits. *Beitr. Trop. Vet. Med., 28(2): 175 – 183.*

World Bank 2008. World Development Report, 2008. Agriculture for Development, The World Bank, Washington, DC. 386 pp accessed at: http://www.ukfg.org.uk/docs/wdr2008.pdf

Zerrouki N., Bolet G., Berchiche M. Lebas F. 2004. Breeding performance of a local Kabylian rabbit does in Algeria. *In: Proceedings of the 8th WRC, Puebla, Mexico, pp 371 – 377.*

Zerrouki N., Kadi S.A., Lebas F., Bolet G. 2007. Characterization of a Kabylian population of rabbits in Algeria. *World Rabbit Sci., 15: 111 - 114*.