# A typology of camel farming systems in Bikaner and Jaisalmer districts of Rajasthan, India

G. Laval [1] N.D. Khanna [2] B. Faye [1*]

*Key words*

Camel - Dromedary - Animal husbandry method - Classification - Rajasthan - India.

*Summary*

One hundred ninety-six camel owners of Bikaner and Jaisalmer districts in Rajasthan were investigated in 23 villages connected by metalled roads from July to September 1997. Questions about camel management and utilization were asked. Discriminatory parameters and methods were identified while running multivariate analysis with SPAD 3® software. They were assigned to defined classes to carry out a typology of camel farming systems. Five classes related to camel owners' activities and revenues were identified: 1) wealthy farmers (47%); 2) modest farmers (25%); 3) rearing activities predominating (19%); 4) very large families (6%); 5) poor landless breeders (3%). Four classes related to herd structure were defined: 1) medium-size camel herds (40%); 2) large herds of various species (28%); 3) single male camel herds (27%); 4) she-camel herds (5%). Six classes related to camel rearing objectives were revealed: 1) cart used for both business and farm (32%); 2) cart used for farm only (19%); 3) camel trade (19%); 4) ploughing and/or under-used camels (13%); 5) multipurpose camels (11%); 6) income from trade first and cart second (6%). Four classes related to nutritional management and health status were identified: 1) grazing around a village associated to stall feeding (39%); 2) stall feeding only (38%); 3) poor animal health status associated to migration (15%); 4) good health status associated to migration (8%). An overall typology was then defined from the previous four typologies. Nine classes were depicted, four of which represented 75% of camel owners and six were related to specific districts and/or areas.

## ■ INTRODUCTION

The camel uses various adaptive mechanisms for life in the desert. In the dry land ecosystem camel rearing is regarded as a fairly constant resource for sustenance. The camel has a great importance in the local, social culture of the societies inhabiting the dry lands. Marketing of camels is an important trade in India where it is also used as a draft animal. Consequently, Khanna and Rai suggested that camels used as draft animals be encouraged in arid regions (6). Camel power for farming use is more economical than a pair of bullocks, and the burden camel energy is not only cost effective but also profitable.

With about 6.8% of the world camel population, India ranks third after Somalia and Sudan (2). The Indian camel population was 1.078 million in 1982 (7) and is mostly confined to the northwestern parts of the country. Rajasthan State has the highest camel population (70.13% of the Indian camel population in 1982) followed by Haryana, Gujarat and Punjab. In 1982 a total of 59,000 and 52,000 camels were recorded in Bikaner and Jaisalmer districts of Rajasthan, respectively (7).

Aspects of camel pastoral systems have been studied by NRCC (National Research Centre on Camel, Bikaner, India) for many years regarding utilization patterns, traditional management, organization of pastoral societies and indigenous camel health knowledge (5). Köhler-Rollefson focused on Raikas breeders of Rajasthan (8). This article presents a typology of camel farming systems in Rajasthan. Similar methodology and survey were conducted on camel breeders of Laayoune district in Morocco by Michel *et al.* (11). This typology analysis completes a first basic analysis undertaken with the same data (9).

1. Cirad-emvt, Campus international de Baillarguet, BP 5035, 34032 Montpellier Cedex 1, France

2. Director, National Research Centre on Camel, Bikaner, Rajasthan 334 001, India

* Corresponding author

Tel.: +33 (0)4 67 59 37 03; Fax: +33 (0)4 67 59 37 96
Email: faye@cirad.f

## ■ MATERIALS AND METHODS

### *Data collection*

A bench mark survey of camel keeping was conducted in Bikaner and Jaisalmer districts of Rajasthan from July to September 1997. A total of 196 camel owners was interviewed, 132 and 54 from Bikaner and Jaisalmer districts, respectively. Seventeen villages were investigated in Bikaner district, an additional six in Jaisalmer district. Eleven villages of both districts were in an irrigated area and 12 villages in a non-irrigated area. The location of the investigated villages is shown in figure 1. The villages were connected by metalled road. Data about camel management were collected from 1427 and 1021 camels in Bikaner and Jaisalmer districts, respectively.

An eight-page data form was filled out for each camel owner. The interview length was approximately 20 min per farmer, ranging from 15 to 90 min. Each form was divided into five main parts. The first part inquired into the camel owner: his social status, agricultural activities and revenues. The shepherd's pattern was also questioned. The second part was concerned with camel herd composition and also other domestic herbivores. The third part investigated into camel production, taking into consideration questions on trade, carting and draft use. The fourth part was concerned with nutrition and grazing management, the last part with camel health status. NRCC provided technical and vehicle facilities.

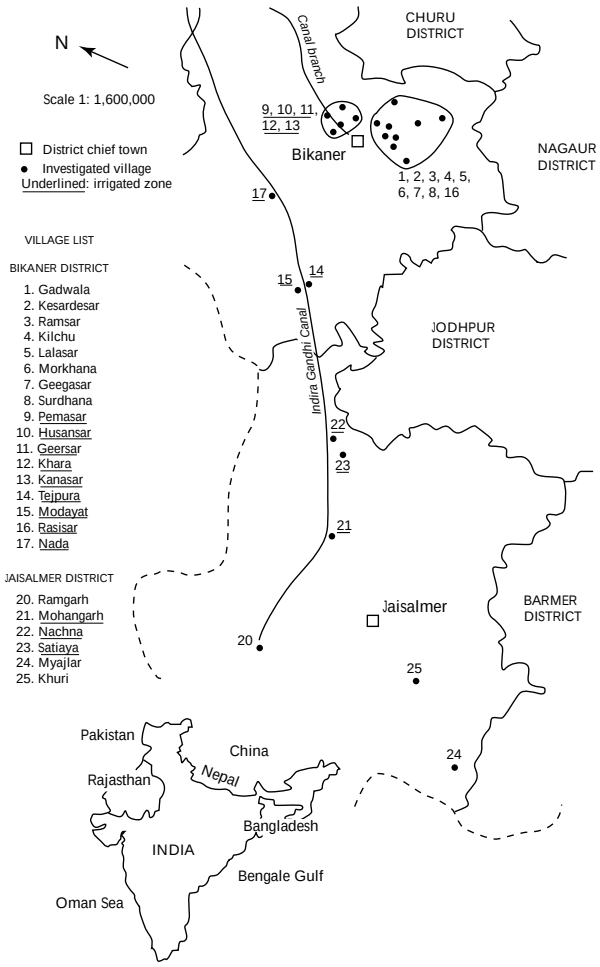


***Figure 1**: Location of investigated villages in Bikaner and Jaisalmer districts of Rajasthan.*

### *Data analysis*

A typology of camel farming systems was set up from the collected data. It took into account the three elements of a farming system, i.e., the farmer (social status, activities, income), the herd (composition, performance) and the resources/environmental conditions (3, 10). The analysis was run with the multivariate analysis software package SPAD 3® (1). A total of 85 parameters was identified. Most of them were converted into many data (also called modality), so that MCA (multiple correspondence analysis) could be run, followed by a cluster analysis, when similar farming systems could be assembled in the same group. To make the overall evaluation easier four analyses corresponding to four specified topics were conducted separately. The first one was concerned with farmers' activities and revenues, the second with camel and other animals herd composition, the third with camel rearing objectives and the last with camel nutrition and health. Eventually the four analyses were combined to identify the types of farming systems.

Several parameters were selected to run the analysis for each topic. SPAD 3® could identify the most discriminatory among the parameters and to assign camel owners to specific types. Modalities of the discriminatory parameters were then used to characterize each type. In table I are presented the discriminatory parameters (= variables) in order of significance after analysis of each of the four typologies. The parameters are presented with their various related modalities and the number of farmers concerned for each of them.

Other parameters (= variables) were analyzed but were of lesser significance.

## ■ RESULTS

### *Four typologies corresponding to four specified topics*

Figure 2 shows the results of the cluster analysis for four homogeneous groups of data taken separately. Within each typology several types were identified and named. Their distribution among the farmers is represented with percentages. Their characteristics were described using the most discriminant modalities that were classified in order of relative contribution within each type.

The cluster analysis allows to identify five groups of farmers (or types) for the typology of camel owners' activities and revenues, four groups for the typology of herd structure, six groups for the typology of camel rearing objectives and four groups for the typology of nutritional management and health status as described in figure 2.

### *Overall typology*

To carry out an overall analysis the four previous typologies were combined. Each of them was considered as one parameter with several modalities corresponding to the types. "Camel rearing objectives" was found to be the most discriminatory parameter followed by "owners' activities and revenues," "herd structure" and finally "nutritional management and health status." Nine types of similar farming systems were drawn from the analysis (table II).

**Table I**

Discriminatory parameters and their modalities

| Typology | Parameters | Modalities with number of farmers concerned (out of 196 farmers interviewed) |
|---|---|---|
| Activities and revenues | 1. Irrigation of the land | No land: 6; irrigated: 32; non-irrigated: 124; mixed land: 34 |
| | 2. Tool used for ploughing | No ploughing: 5; camel only: 34; camel first and tractor second: 25; tractor first and camel second: 122; tractor only: 10 |
| | 3. Land area | No land: 6; small: 84; medium-size: 82; large: 24 |
| | 4. Family size | Small family: 44; medium-size: 106; large: 34; very large: 12 |
| | 5. Second revenue | Agriculture: 29; camels: 59; other animals: 97; none or not known: 11 |
| Herd structure | 1. Sex of camels | Only male(s): 52; only female(s): 16; more (or equal number of) males: 42; more females: 86 |
| | 2. Proportion of mature females | Less than 30%: 83; 30 to 39%: 24; 40 to 49%: 18; 50 to 59%: 42; 60 to 69%: 14; more than 70%: 15 |
| | 3. Number of camels | Single camel: 53; 2 to 4 camels: 49; 5 to 9 camels: 37; 10 to 30 camels: 31; more than 31 camels: 26 |
| | 4. Number of small ruminants | None: 34; 1 to 10: 31; 11 to 50: 59; 51 to 200: 46; more than 201: 26 |
| | 5. Number of cattle | Less than 2 cattle: 53; 3 to 9: 82; 10 to 20: 40; more than 21: 21 |
| Rearing objectives | 1. First benefit from camels | Trade: 59; cart: 86; ploughing service: 16; other: 0; safari: 0; none: 35 |
| | 2. Second benefit from camels | Trade: 20; cart: 16; ploughing service: 65; other: 3; safari: 2; none: 90 |
| | 3. First objective of camel rearing | Trade: 50; cart: 110; ploughing: 24; pack loading: 5; ride: 2; none: 3; not known: 2 |
| | 4. Cart utilization | No cart: 57; cart for business only: 3; business first and farm work second: 38; farm work first and business second: 50; farm only: 37; not known: 11 |
| | 5. Second objective of camel rearing | Trade: 17; cart: 21; ploughing: 111; pack loading: 16; ride: 2; none: 23; not known: 6 |
| Nutrition and health | 1. Grazing distance from village | Stay at farm: 69; < 20 km: 94; seasonal migration (< 100 km): 7; seas. migr. (> 100 km): 5; prolonged migr. (< 100 km): 16; prol. migr. (> 100 km): 5 |
| | 2. Feeding | Pasturelands only: 13; crop byproducts only: 69; additional crop byproducts to working camels: 61; add. crop by-prod. to all camels: 22; to working and weak camels: 9; other than to working camels: 10 |
| | 3. Water frequency | Daily: 164; irregularly: 32 |
| | 4. Annual mortality (% in a herd over the last year) | None: 137; low (< 10%): 15; average (10-19%): 17; high (20-50%): 8; not known: 9 |
| | 5. Mange occurrence | None: 107; high (< 50%): 24; very high (< 50-100%): 50; not known: 15 |

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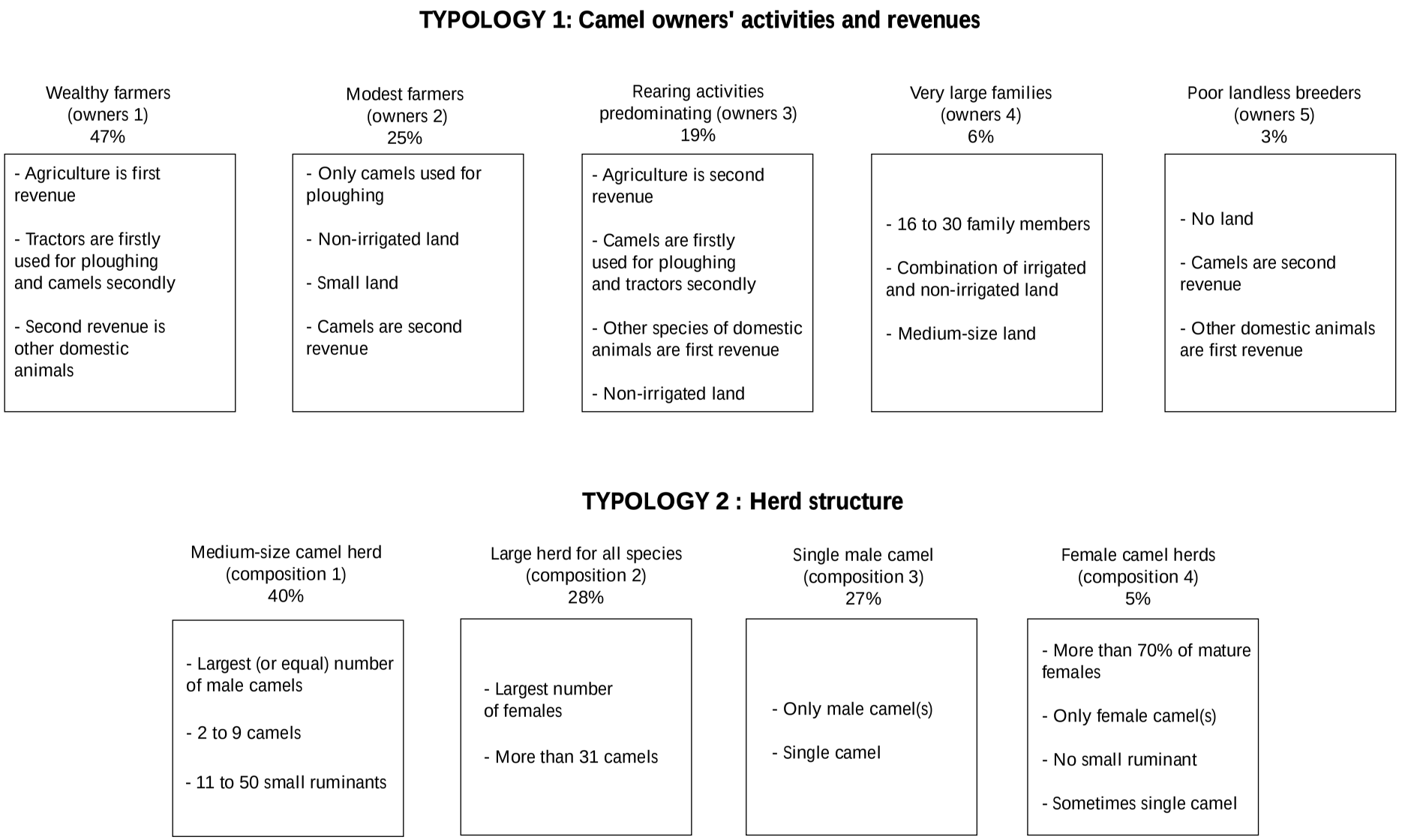


***Figure 2**: Description of four specified typologies concerning camel farming systems (part I).*

## TYPOLOGY 3: Camel rearing objectives

| Cart used for business and farm (objective 1) 32% | Cart used for farm only (objective 2) 19% | Camel trade (objective 3) 19% | Ploughing and/or under-used camels (objective 4) 13% | Multipurpose camels (objective 5) 11% | Income from trade first and cart secondly (objective 6) 6% |
|---|---|---|---|---|---|
| - First objective and benefit of camels are cart<br>- Second benefit comes from ploughing (rent)<br>- Second objective of camels is ploughing<br>- Utilization of cart is for farm and business | - Utilization of cart is for farm only<br>- No benefit from camels<br>- First objective of camels is carting | - First objective and benefit of camels are trade<br>- No cart utilization Camel(s) never purchased<br>- Milk is consumed<br>- Hair collected | - First objective and benefit of camels are ploughing<br>- No cart utilization<br>- No second objective<br>- No second benefit | - Second benefit is trade<br>- Milk is consumed<br>- First benefit is carting | - Second objective and benefit are carting<br>- Cart utilization is farm 1 and business 2<br>- First objective and benefit are trade |

## TYPOLOGY 4: Nutritional management and health status

| Grazing around village combined with stall feeding (management 1) 39% | Only stall feeding (management 2) 38% | Poor health status associated to migration (management 3) 15% | Good health status associated to migration (management 4) 8% |
|---|---|---|---|
| - Grazing around the village (< 20 km)<br>- Additional crop by-products for working camels<br>- Daily water supply | - Camels only kept at farm<br>- Only crop by-products<br>- Daily water supply<br>- No mortality<br>- Concentrates to working camels | - 50 to 100% mange<br>- Prolonged migration (< 100 km)<br>- Irregular water supply | - Additional crop by-products to working and weak (lactating females, diseased) animals<br>- Seasonal or prolonged migration<br>- Irregular water supply |

***Figure 2**: Description of four specified typologies concerning camel farming systems (part II).*

**Table II**

Overall typology

| Types | Distribution (%) | Characteristics * | Proportion of the modality in each cluster, i.e., type (%) |
|---|---|---|---|
| Type 1 | 29.1 | **Cart used for business and farm (obj1)[1]** | 98 |
| | | Only stall feeding (mgt2)[2] | 65 |
| | | Wealthy farmers (own1)[3] | 72 |
| | | Single male camel (com3)[4] | 50 |
| | | Middle-size camel herds (com1) | 50 |
| Type 2 | 21.9 | **Camel trade (obj3)** | 61 |
| | | **Multipurpose camels (obj5)** | 33 |
| | | Large herds of various species (com2) | 58 |
| | | Poor health status associated to migration (mgt3) | 36 |
| | | Rearing activity predominating (own3) | 42 |
| | | Grazing around village combined with stall feeding (mgt1) | 64 |
| Type 3 | 13.3 | **Cart used for farm only (obj2)** | 100 |
| | | Only stall feeding (mgt2) | 69 |
| | | Wealthy farmers (own1) | 73 |
| | | Single male camel (com3) | 50 |
| Type 4 | 11.2 | **Camel used for ploughing or under-utilized (obj4)** | 100 |
| | | Modest farmers (own2) | 55 |
| | | Grazing around village combined with stall feeding (own1) | 65 |
| | | Medium-size camel herds (com1) | 55 |
| Type 5 | 6.6 | **Good health status associated to migration (mgt4)** | 100 |
| | | Large herds of various species (com2) | 90 |
| | | Rearing activities predominating (own3) | 70 |
| | | Camel trade (obj3) | 40 |
| | | Multipurpose camels (obj5) | 30 |
| Type 6 | 6.1 | **Income from trade first and cart second (obj6)** | 100 |
| | | Large herds of various species (com2) | 80 |
| | | Poor health status associated to migration (mgt3) | 70 |
| | | Very large families (own4) | 30 |
| Type 7 | 4.6 | **Female camel herds (com4)** | 100 |
| | | Wealthy farmers (own1) | 78 |
| | | Cart used for farm only (obj2) | 44 |
| | | Ploughing and/or under-utilized camels | 33 |
| Type 8 | 4.1 | **Very large families (own4)** | 100 |
| | | Single male camel (com3) | 50 |
| Type 9 | 3.1 | **Poor landless breeders (own5)** | 100 |
| | | Camel trade (obj3) | 67 |
| | | Poor health status associated to migration (mgt3) | 50 |

* The most discriminant characteristics are written in bold characters

1. Objective; 2. Management; 3. Owner; 4. Composition

## ■ DISCUSSION

If a farming system is usually described as the interactions between a farmer, a herd and its resources and environmental conditions (10), it appears that in the multivariate analysis using MCA the most structural data are predominant in the typology analysis. So it is better to proceed with two steps and analyze separately the homogeneous groups of variables before overall analysis to balance the role of each group (11).

The present investigation was undertaken in the rural villages connected by metalled roads near the canal and bigger cities of the Thar desert. This study will reflect the future fate of camel keeping when almost all areas of the dry land are served with all-weather roads, and enjoy the effects of socioeconomic development plans of the Government of India. The role of the camel as a domestic animal is undergoing fundamental changes as subsistence pastoralism shifts toward sedentary market oriented systems (9). Thus, many farmers keep single or few camels for farm work such as ploughing and cart pulling, whereas large herds are declining due to the use of grazing lands for cultivation (8).

One must be aware of the unfair sampling strategy of the survey. Type proportions within the various typologies do not reflect the reality. Indeed, a great number of large herd breeders were deliberately interviewed to involve a large sample of each type in the survey. It became apparent in the field that large herd owners were not as many as described in this paper. Accordingly, the results of the present study do not respect the actual distribution of the various types especially concerning herd composition typology.

The focus should be on the typology of camel rearing objectives which is relevant to the situation of camel husbandry in that Rajasthan area. However, the type distribution should not be considered because of the sampling issue. The three other typologies can bring further information, whereas the overall typology can identify clearly four types (1-4), including 75% of the farmers and five secondary types, under-represented and difficult to analyze. Further investigation will be necessary to better identify and characterize these subtypes in order for instance to propose target-oriented development strategies.

Types 1, 3 and 7 were more common in Bikaner than in Jaisalmer district. Types 2 and 9 were more common in Jaisalmer district, whereas type 5 was highly related to Jaisalmer district. Types 1 and 3 were also mostly found in irrigated areas, whereas type 2 was highly related to non-irrigated areas. Type 4 was more common in Bikaner district and in non-irrigated areas. All these results agreed with the preliminary analysis (9), which favors a pertinent typology analysis.

The typology of nutritional management and health status can bring information of interest. Breeders conducting migrations were divided into two distinct types (types 3 and 4): One type showed a poor health status and the other a better one. Different nutrition management could be the reason. Indeed, it appears that a large proportion of type 4 breeders (good health status associated to migration) gave crop byproducts to working and also to weak animals (i.e., lactating females, young and diseased animals). Moreover, several herds collectively supervised by the same shepherd, possibly because of time and budget constraints, could be related to animal care deficiency and poor health status (type 3).

Higher mange morbidity was found in migrating herds, which were also the larger ones. This could be explained by poor nutrition and weakness associated with a multitude of contacts between animals. If migration patterns are kept, the mange issue becomes essential: improvement and spread of treatment become necessary. Better calf care associated with better nutritional management could help as well. For development perspectives the elimination of migration and extensive rearing could improve many issues directly related to them. The encroachment of irrigated and cultivated zones on pastureland zones is a good reason to investigate into alternate methods of large scale rearing for trade. Therefore, research into improvement of reproductive parameters as conducted at the National Research Centre on Camel of Bikaner (Rajasthan) is necessary. Modern facilities like artificial insemination and embryotransfer technology must be considered seriously, as well as selection of breeds with good reproductive performances. Prophylactic methods must be set up for parasitic diseases. Intensive nutrition management with an optimal use of crop byproducts and concentrates should also take the step on the traditional one. Special care should be given to calves and adults during early lactation and the mating season so that fertility parameters might be improved. The large herd owners, whose main activity was breeding and who lived for the most part in non-irrigated zones, should be handled first since they are more concerned about camel issues through trade and should be more motivated. Then they could show the way to others. Camel breeding is still the only means to use the driest and non-irrigated zones of Rajasthan. It should be properly considered by development decision-makers.

## ■ CONCLUSION

The main objective of camel rearing in Rajasthan is obviously animal power for pulling a cart or ploughing (12). Various types of draft objectives appeared in the survey. The area where farmers dwell needs to be recognized. In non-irrigated zones camels were widely used for ploughing, but were frequently under-used. In irrigated zones camels were used for carting and for ploughing but as a second choice after tractors. Many farmers used camels for business and earned revenues from cart services. For development perspectives various aspects can be drawn from the survey results:

- In the poor and non-irrigated areas camel owning equals subsistence rearing. Development strategies should focus on bringing the optimal output from the animals;

- In irrigated zones the future of the camel is uncertain. Some farmers fully use their animals for farm work and for business, whereas others use them for farm work only. Most of them prefer tractors for ploughing. The use of animal power may decrease and mechanization may become preponderant like in more developed states in India such as Punjab, where development has already deeply taken place. If animal power is to be preserved draft performance and nutrition management should be improved since stall-feeding is the usual practice for working animals.

The camel market should be organized keeping in mind that some breeders will supply the farmers' demand for draft animals.

Compared to camel farming systems in other geographical zones such as Morocco (11), Indian camel husbandry is deeply characterized by the use of animal power and small-size herds. Agricultural activities are very relevant in Rajasthan, especially in the newly irrigated zones. Nobody can forecast the future of camel husbandry in a socio-economically developing State such as Rajasthan.

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## *Résumé*

**Laval G., Khanna N.D., Faye B.** Une typologie des systèmes d'élevage camelin dans les districts de Bikaner et de Jaisalmer au Rajasthan, Inde

Cent quatre-vingt-seize chameliers ont été interrogés dans 23 villages accessibles par route dans les districts de Bikaner et de Jaisalmer au Rajasthan de juillet à septembre 1997. Les questions ont concerné la gestion de l'élevage camelin et l'utilisation des animaux. Les méthodes et les paramètres discriminants ont été identifiés par des analyses multivariées classiques utilisant le logiciel SPAD 3® et assignés à des classes déterminées en vue de réaliser une typologie des systèmes d'élevage. Cinq classes d'activités et de revenus des propriétaires de dromadaire ont été identifiées : fermiers riches (47 p. 100), fermiers modestes (25 p. 100), activités d'élevage prépondérante (19 p. 100), grandes familles (6 p. 100) et éleveurs pauvres sans terre (3 p. 100). Quatre classes de structure des troupeaux on été déterminées : troupeaux de taille moyenne (40 p. 100), grands troupeaux pluri-espèces (28 p. 100), troupeaux mâles uniquement (27 p. 100) et troupeaux femelles uniquement (5 p. 100). Six classes d'objectifs ont été observées : charrette pour la ferme et la location (32 p. 100), charrette à usage fermier uniquement (19 p. 100), commerce des chameaux (19 p. 100), chameaux destinés aux travaux de labour et/ou sous-utilisés (13 p. 100), chameaux pour multi-usage (11 p. 100), revenus provenant d'abord du commerce des chameaux et secondairement de la charrette (6 p. 100). Quatre classes de niveau nutritionnel et de statut sanitaire ont été identifiées : pâturage autour du village associé à l'alimentation en stabulation (39 p. 100), alimentation en stabulation uniquement (38 p. 100), mauvais statut sanitaire associé à une migration (15 p. 100) et bon statut sanitaire associé à une migration (8 p. 100). Une typologie globale a été définie à partir de ces quatre typologies de base. Neuf classes ont été décrites dont quatre représentaient 75 p. 100 des chameliers et six étaient spécifiques de certains districts ou de certaines zones.

***Mots-clés*** : Chameau - Dromadaire - Méthode d'élevage - Classification - Rajasthan - Inde.

## *Resumen*

**Laval G., Khanna N.D., Faye B.** Tipología de los sistemas de crianza de camélidos en los distritos de Bikaner y Jaisalmer en Rajastán, India

Se investigaron 196 dueños de camellos en los distritos de Bikaner y Jaisalmer, en 23 pueblos comunicados por ferrocarriles, entre julio y setiembre 1997. Se hicieron preguntas sobre el manejo y la utilización de los camélidos. Se identificaron métodos y parámetros discriminatorios, al tiempo que se corrió un análisis multivariado con el programa SPAD 3®. Se definieron clases para llevar a cabo la tipología de los sistemas de crianza de los camellos. Se identificaron cinco clases relacionadas con las actividades y los ingresos de los dueños de camellos: 1) finqueros ricos (47%); 2) finqueros modestos (25%); 3) predominio de actividades de crianza (19%); 4) familias numerosas (6%); 5) criadores pobres sin tierra (3%). Se definieron cuatro clases en relación con la estructura del hato: 1) hatos medianos de camellos (40%); 2) hatos grandes de varias especies (28%); 3) hatos únicamente de camellos machos (27%); 4) hatos únicamente de camellos hembras (5%). Se designaron seis clases relacionadas con los objetivos de crianza del camello: 1) tiro utilizado tanto para negocio como para la finca (32%); 2) tiro utilizado únicamente para la finca (19%); 3) venta de camellos (19%); 4) camellos sub-utilizados y/o utilizados para arado (13%); 5) camellos de uso múltiple (11%); 6) ingresos principales a partir de la venta y luego de tiro (6%). Se identificaron cuatro clases de acuerdo al manejo nutricional y al estado de salud: 1) pastoreo alrededor de un pueblo en asociación con alimentación en establo (39%); 2) alimentación en establo únicamente (38%); 3) pobre estado de salud animal asociado con migración (15%); 4) buen estado de salud asociado con migración (8%). Seguidamente se definió una tipología a partir de las cuatro tipologías previas. Se desglosaron nueve clases, cuatro de las cuales representaron 75% de los dueños de camellos y seis fueron relacionadas a distritos y/o áreas específicos.

***Palabras clave***: Camello - Dromedario - Método de crianza - Clasificación - Rajastán - India.