ESTIMATION AND IMPACT OF MEASUREMENT ERRORS FOR SMALL RUMINANTS DEMOGRAPHIC DATA COLLECTED DURING RETROSPECTIVE INTERVIEWS OF FARMERS IN SENEGAL

Lesnoff M.[1], Lancelot R.[2]

Les enquêtes rétrospectives sont souvent présentées comme une alternative aux enquêtes longitudinales (suivi individuel des animaux) pour estimer les paramètres démographiques d'une population de troupeaux et pour étudier sa dynamique temporelle. Cependant, elles ne rendent pas compte des phénomènes complexes décrits lors des suivis individuels et sont entachées d'erreurs de mesure liées à la mémoire de l'éleveur. Les auteurs décrivent les erreurs mesurées lors d'une enquête rétrospective effectuée sur un ensemble d'éleveurs traditionnels de petits ruminants au Sénégal et suivis par enquête prospective depuis 13 ans. Les pourcentages de réponses en accord avec les données longitudinales s'avèrent faibles pour l'origine des animaux (< 40% pour les animaux donnés, confiés ou troqués), leur âge (< 50% pour les animaux de plus d'1 an) et la parité des femelles (< 50% pour les femelles multipares). L'estimation des paramètres démographiques obtenus d'après les données rétrospectives sur un échantillon de brebis (zone de Louga) donnent des résultats cohérents avec les données longitudinales du même échantillon (considéré comme population référence), excepté pour la fécondité 0-1 an (0.25 contre 0.02). Sous l'hypothèse que ces paramètres restent constants et d'après un modèle de Leslie « femelle-dominant », les taux de multiplication de la population estimés d'après l'enquête rétrospective et l'enquête longitudinale sont respectivement de 0.71 et 0.64 indiquant une décroissance de la population (résultat cohérent avec nos observations de terrain). Malgré les erreurs de mesure individuelles, l'enquête rétrospective permet ici de décrire de manière robuste la tendance dynamique de la population étudiée. Ce résultat reste à valider sur d'autres populations animales et d'autres systèmes d'élevage.

INTRODUCTION

Demographic analysis is an important tool for planning livestock research and development programmes. It can be used to estimate productivity, assess constraints and project trends. Demographic parameters are best estimated from longitudinal data following individual animals. However, longitudinal studies are costly, time consuming and often restricted to small, purposely-sampled geographic areas which limit their generalizability. Thus, surveys asking farmers or herders to reconstruct retrospective life histories of their animals are conducted. These life histories can be used to estimate parameters for demographic models. However, the degree of recall and other errors of these data can only be guessed at, since there is no follow-up data for comparison. Few comparisons of this type are available (Deen *et al.*, 1994) and to our knowledge, none in tropical countries.

In this study, the follow-up data come from a 13-year longitudinal survey of several hundreds of small ruminants herds totalling 3-5,000 animals, in Senegal. This follow-up called « Pathologie et Productivité des Petits Ruminants » (PPR) was conducted by ISRA and CIRAD to obtain consistent and accurate information on settled traditional farming systems. All animals were ear-tagged and surveyed within the selected herds and detailed data including demography, reproduction and growth, were collected bimonthly by trained surveyors. The longitudinal study protocol was defined and data entered using the PANURGE information system (Faugère and Faugère, 1993) and the data were stored and handled in a specific relational database called BAOBAB (Lancelot *et al.*, 1997).

To assess the extent and impact of measurement errors from retrospectively collected survey data, we compared demographic estimates using the PPR data to retrospective data collected during a single visit in the same herds.

MATERIAL AND METHODS

When the retrospective study was conducted, 200 herds in 2 distinct areas (Louga a Sahelian region and Kolda a Guinean region) were enrolled in the PPR programme. Since the farming systems, ethnic groups and animal breeds differed in these areas, sampling was stratified by geographical site and ethnic group. The sample size of 80 herds was selected according to the available human and material resources.

Each selected farmer was interviewed once by a surveyor. In order to minimize surveyor bias, the surveyor who collected the retrospective data had not followed that herd previously. The interview was conducted early in the morning before the animals had gone for browsing. Each interview consisted of two parts. First, each animal was counted by the surveyor and its ear-tag number recorded. Individual-animal information was asked: sex, age (month and year of birth), origin (birth, purchase, lending, gift,...) and parity for the females. Second, 1 to 5 females (according to the herd size) born in the herd were randomly selected and their life histories recorded, including breeding career and survival (vs death or utilization) of their offspring. Missing data were allowed for in both the first and second part of the interview and no answers were forced.

[1] Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (CIRAD-EMVT), BP 5035, 34032 Montpellier Cedex 1, France

[2] Institut Sénégalais de la Recherche Agricole (ISRA-URA PA), BP 2057 Dakar-Hann Sénégal

The 80 herds were surveyed over 1 month (May 15th to June 15th, 1996). Descriptive statistics and comparisons were computed. A Bhapkar test (Agresti, 1990, p. 359) was used to compare marginal distributions of actual (longitudinal) and estimated (retrospective) age group and parity. Age structure and age-specific demographic parameters (mortality, utilization and fecundity rates) were estimated and life tables built. For the purpose of most analyses, age was categorized into age groups of one year length. Dynamic population (Leslie) models were run to estimate the asymptotic population growth rate (Leslie, 1945). We made 2 assumptions: (1) that demographic parameters remained constant and (2) that the population dynamic only depended on females (female dominant model). The life table parameters were adjusted by the procedure of Caswell (1989, p.9-11) and used as the entries of several population projection matrices (one per site and per species). For each Leslie model, the asymptotic population multiplication rate was the dominant eigen value of the projection population matrix. When this eigen value is higher than 1, the population size increases.

RESULTS AND DISCUSSION

Eighty herds were surveyed.Median herd size was 14 sheep and goats (range 2-101). There were 1,300 small ruminants in the sample (70% sheep). Seven hundred and forty animals were found in both the retrospective and follow-up databases. Career data was collected for 220 females (71% ewes), 171 of which had no missing data. The average survey time per animal was highly variable between herds: 2.0 min (range 0.4-4.9 min) for descriptions of individual animals and 11.2 min (range 1.2-40.2) for career data. For the biggest herds, the total survey time reached more than 4 hours. This is very long, considering that these farmers were used to being surveyed and were fast in answering questions. Thus, when detailed information is required on many animals a long period of time will be needed. Alternatively, animals could be randomly subsampled within herds. However, this procedure is difficult to set up in most traditional tropical farming systems and is time consuming too. The best combination of techniques will depend on the objectives of the study and the circumstances in the field.

Measurement errors on individual features

The results (table I) are given in agreement rates (% of retrospective responses which agreed with longitudinal data). The origin of animals was correctly given for animals born in the herd (99%) or bought (81%), but animals obtained as loans or gifts were poorly recalled (40%). Thus, retrospective information on the origin of animals obtained outside the flock appear difficult to obtain. There was also errors in classifying animal age, particularly for animals older than 1 year. The farmers tended to overestimate the age of young animals (groups 0-1, 1-2, 2-3 and 3-4) and to underestimate the age of older ones. The difference between the actual and estimated age group marginal distributions was highly significant ($p < 0.001$), but because of compensating errors, the two distributions had similar patterns (decreasing class size from age groups 0-1 to 7+). The parity agreement rate was also poor with high agreement only in classifying nulliparous females (91.5 %). Generally, parity was underestimated, usually by one class for younger female (parity 1 to 3) and by more for older ones. As with the age, the Bhapkar test for the two marginal distributions showed a significant difference ($p = 0.006$) but distributions had the same pattern.

Table I

Percentage agreement of age group estimated by farmers in a cross-sectional survey versus actual age group as recorded in the PPR follow-up

Age group	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7 +	Actual total
0-1	0.89	0.10	0.01	0.01	0.00	0.00	0.00	0.00	375
1-2	0.07	0.64	0.18	0.06	0.06	0.00	0.00	0.00	137
2-3	0.00	0.19	0.42	0.24	0.11	0.03	0.00	0.00	90
3-4	0.00	0.00	0.18	0.43	0.25	0.13	0.00	0.03	40
4-5	0.00	0.00	0.11	0.17	0.44	0.17	0.06	0.06	18
5-6	0.00	0.00	0.07	0.17	0.43	0.23	0.10	0.00	30
6-7	0.00	0.00	0.00	0.25	0.25	0.25	0.13	0.13	8
7+	0.00	0.00	0.00	0.00	0.40	0.00	0.40	0.20	5
Reported total	342	141	75	61	53	20	7	4	703

Bahapkar test of marginal homogeneity: $p < 0.001$

Life tables and demographic analysis

How do these differences in parameter estimates influence demographic predictions? Age-specific fecundity estimates for the Louga sheep are presented in table II as an example. Fecundity was poorly estimated in the retrospective study for the 0-1 and 1-2 age groups, but this difference disappeared when these 2 groups were pooled (0.8). Fecundity estimates for older females were similar.

Table II
Comparison of age group fecundity estimates

Age group	Nb female careers compared	Fecundity estimate retrospective	Fecundity estimate longitudinal
0-1	84	0.25	0.02 **
1-2	68	0.57	0.80 *
2-3	49	0.82	0.79
3-4	27	1.11	0.94
4-5	16	1.00	0.82
5 +	15	0.73	0.84

* p < 0.05, ** p < 0.001, matched t-test

The life table parameter estimates are presented in table III. Survival estimates were compared across 3 age groups (0-1, 1-2, 2+). Rates for survival, mortality and utilization were similar for females. For males, the retrospective data overestimated mortality from 0-1 years of age and underestimated utilization rates from 1-2 years (64% vs. 100%). The estimated population multiplication rates using the 3 age groups were similar, 0.71 for the retrospective data and 0.64 for the follow-up, and was expected since female demographic estimates were the same and the model is female dominant. A comparable decrease in population size was estimated using the entire PPR database and reflects the effects of 2 dry years.

Table III
Comparison of life table parameter estimates

		Number of offspring		Survival		Mortality		Utilization	
	Age group	retr.	long.	retr.	Long.	retr.	long.	retr.	long.
Female	0-1	50	60	0.49	0.44	0.18	0.19	0.33	0.37
	1-2	14	14	0.71	0.71	0.00	0.00	0.29	0.29
	2+	9	10	1.00	0.80	0.00	0.10	0.00	0.10
Male	0-1	86	64	0.40	0.48	0.20	0.11	0.40	0.41
	1+	23	14	0.21	0.00 *	0.14	0.00	0.65	1.00 *

* p < 0.05, ** p < 0.001, X^2 test

Under the assumption of constant demographic parameters for the reference population, the retrospective and prospective data lead to the same overall conclusion. This indicates that the retrospective studies may be useful in roughly estimating demographic trends. We think this result needs to be replicated in other farming system and animal species. This comparison may be limited in other ways as well. It has been shown (Vincent *et al.*, 1994) that estimates of population multiplication rates computed from life tables without individual information are biased and that this bias is accentuated by age-grouping (Houiller *et al.*, 1989). Also, the retrospective data do not allow us to account for the seasonal or annual variability of demographic parameters. For these objectives, individual prospective data are needed for the dynamic modeling of such complex systems.

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