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Selection indexes for improved weaning and marketing body weights of the Burundi local rabbits

Summary

Estimates of genetic and phenotypic parameters for growth-related traits involving body weights at 4, 6 (weaning), 8 and 10 (marketing) weeks of age and average daily gains from 4- to 6- and 6- to 10-weeks of age (postweaning daily gain) were computed on 193 males of the Burundian local rabbits . Estimates were then used for constructing thirteen selection indexes, involved body weights at 4, 6 and 10 weeks of age and daily gains, to improve body weights of rabbits at weaning and marketing.

The use of weaning weight in an index combined with body weight at 4 weeks of age (W_4) and postweaning average daily gain ($index_{I1}$) or postweaning daily gain solely ($index_{I2}$) resulted in a relative efficiency of about 100% as using weaning weight combined with body weights at 4 and 10 weeks of age ($index_1$) or with marketing body weight ($index_2$) or W_4 ($index_3$). The accuracy of selection (r_{TI}) using these indexes ranged between 0.890 and 0.906. They lead to a progress in weaning weight from 77–79g and in marketing weight from 54–56g. However, from a practical stand point, selection on index 3, including W_4 and weaning weight, or on index 5, including weaning weight alone, could be recommended for improving both weaning and marketing weights of Burundian local rabbits.

Key Words: body weight, genetic improvement, selection index, rabbits

Zusammenfassung

Titel der Arbeit: **Selektionsindizes zur Verbesserung der Absetz- und Vermarktungsgewichte bei Lokalkaninchenrassen in Burundi**

Es wurden genetische und phänotypische Parameter von Wachstumsmerkmalen wie die 4-, 6, 8 und 10 Wochengewichte sowie die täglichen Gewichtszunahmen von der 4. - 6. sowie der 6. - 10. Woche an 193 Kaninchenböcken der Burundischen Lokalrasse geschätzt. Diese Parameter fanden Eingang in die Konstruktion von 13 Selektionsindizes um eine Verbesserung der Vermarktungsgewichte zu erzielen. Es werden die verschiedenen Indizes beschrieben und deren Effizienz diskutiert. Aus praktischer Sicht erreichten Indizes, die das 4 Wochen- und 10 Wochengewicht oder ausschließlich das 10 Wochengewicht einbezogen, die größte Effizienz.

Schlüsselwörter: Körpergewicht, genetische Verbesserung, Selektionsindizes, Kaninchen

Introduction

Small scale rabbit production involving minimal inputs, could make a substantial contribution to the supply of animal protein in developing countries. In Burundi, the objective of encouraging production of rabbit meat requires improvement of the productivity of its local breed, a one that is being kept mainly by farmers. To the author's knowledge, the unique attempt was made by the author himself (ANOUS, 2000) to improve meatiness of this breed using selection index. He reported that selection for the full index involving body weights at 4, 6 and 12 weeks of age (i.e. initial, weaning and marketing body weight, respectively) is expected to lead to increase lean weight (+34.8g) through acheving extra marketing body weight (+56.1g) and higher percentage of lean (+0.62% unit) with maximum accuracy of selection

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equal 0.87. However, the effect of this method of selection on growth-related traits (i.e. body weights and average daily gains) till marketing is still needed.
Therefore, the purposes of the present study are to quantify the genetic and phenotypic variation and covariation of growth-related traits in the local rabbits of Burundi, and to calculate the direct and correlated responses expected from selection for both weaning and marketing body weights, considered to be of prime interest to meat rabbit breeders in Burundi, using selection index.

Material and methods

Source of data. The data used in this study were collected during the period from February to June 1995 on 193 male Burundian local rabbits, progeny of 18 unrelated bucks and 46 unrelated does. They were raised at the experimental farm of the *Institut Supérieur d'Agriculture* (I.S.A.), Gitega (located approximately 1680m above sea level), Burundi. Local rabbits are of small size and adult males and females weight about 1.7kg. Each doe was contributed 3 to 4 liters with unrepeated mating with the same buck.
Management and traits considered. Rabbits were identified at 3 weeks of age and weaned at the age of 6 weeks. From weaning up to marketing at 10 weeks of age, all animals were fed *ad libitum* on a 16 % crude protein commercial pelleted ration containing 2600 Kcal digestible energy/kg diet. Roughages and green grass were also provided. The body weights in grams at 4 (W_4), 6 (W_6), 8 (W_8) and 10 (W_{10}) weeks of age were recorded for each rabbit. Average daily gain from 4- to 6-weeks of age (DG_{4-6}) and postweaning average daily gain from 6- to 10–weeks of age (DG_{6-10}) were calculated (g/d).
Statistical analysis. Heritabilities and genetic and phenotypic correlations were estimated from the sire components of variance and covariance by the Least Squares and Maximum Likelihood program (HARVEY, 1990) according to the following model:

$$Y_{ijK} = \mu + S_i + D_{ij} + E_{ijK},$$

where:

- Y_{ijk} = the weight or average daily gain measured on the k^{th} animal of the j^{th} dam nested within the i^{th} sire;
- μ = the population mean for the trait Y;
- S_i = the random effect of the i^{th} sire ($i = 1,2, \ldots,18$);
- D_{ij} = the random effect of the j^{th} dam nested within the i^{th} sire ($j = 1,2, \ldots, 46$);
- E_{ijK} = the random error assumed NID~$(0, \sigma^2 E)$.

Estimates of heritability from the maternal half-sib correlations were less than zero for some traits. Therefore, only estimates calculated by paternal half-sib analysis were considered in the present study. As parity and litter size were not significant in a preliminary analysis ($P>0.10$), they were ignored in the final one .
Both weaning and marketing body weights were retained in the aggregate genotype with equal economic value (assumed to be 1). Body weights at 4 , 6 (weaning) and 10 (marketing) weeks of age together with daily gains from 4– to 6- and from 6- to 10-weeks of age were used in different combinations to compute thirteen selection indexes (CUNNINGHAM et al., 1970) to select for increased body weights at weaning and marketing.

Results and discussion

Heritability estimates. The value of heritability estimates (h^2) for growth–related traits together with their standard errors (S.E.) are shown in Table 1.

Table 1
Mean (X), phenotypic standard deviation (σ_P) and heritability (h^2) with its standard error (±S.E.) for live performance traits (Mittelwert, Standardabweichung und h^2-Werte der untersuchten Merkmale)

Traits	X	σ_P	h^2±S.E.
Body weight (g) at:			
4-week (W_4)	303	84.1	0.67±0.52
6-week; weaning body weight (W_6)	544	94.4	0.81±0.56
8-week (W_8)	732	89.8	0.98±0.60
10-week; marketing body weight (W_{10})	867	78.6	0.67±0.52
Average daily gain (g/d) between:			
4- and 6-week (DG_{4-6})	17.2	4.0	0.47±0.46
6- and 10-week; postweaning daily gain (DG_{6-10})	10.7	1.2	0.53±0.48

The value of h^2 estimate for body weight increased with increasing age from 0.67 at 4-week of age up to 0.98 at 8-week of age, then it decreased. In agreement with the conclusion of previous reports reviewed by KHALIL et al. (1986), estimates of heritability for body weight were highest at younger ages, declining to the lowest values after weaning and increasing again at the older ages.

The h^2-value for body weight was higher at weaning than marketing (0.81 vs 0.67). This agrees with the findings of MOSTAGEER et al. (1970) on Giza White rabbits (0.185 vs 0.150) and KHALIL (1986) on Bouscat (0.46 vs 0.24) and Giza White (0.65 vs 0.39) breeds. The estimates of sire–component h^2 show that selection for body weight at earlier ages may be useful method for improving early rabbit growth.

Generally, the h^2 values obtained in the present study for the body weight at 4, 6, 8 and 10 weeks of age were higher than those reported in the literature (0.10 to 0.55 at 4 weeks; MOSTAGEER et al., 1970; OUHAYOUN et al., 1973; EL–AMIN, 1974; CHEVALET, 1976; VRILLON et al., 1979; 0.185 to 0.650 at 6 weeks; MOSTAGEER et al., 1970; ALVAREZ et al., 1974; KHALIL, 1986; FERRAZ et al., 1991; 0.20 to 0.72 at 8 weeks; MOSTAGEER et al., 1970; EL–AMIN, 1974; KHALIL, 1986; 0.15 to 0.56 at 10 weeks; MOSTAGEER et al., 1970; OUHAYOUN et al., 1973; VRILLON et al., 1979; KHALIL, 1986; FERRAZ et al., 1991). This reflects the high contribution of the genetic additive variance to the total variance for body weights in this breed of rabbit compared to the other breeds.

The heritability estimates for the average daily body weight gain were moderate to high, but lower than those of body weight. They were higher between weaning and marketing than between4- week of age and weaning (0.53 vs 0.47). However, the range of h^2 values reported in the literature for these traits (0.13 to 0.31; MOURA et al., 1991 and KROGMEIER et al., 1994, respectively) indicates low to moderate contribution of the genetic additive variance to the total variance. Thus, using body

weights for constructing selection indexes to increase both weaning and marketing body weights of rabbits in the present study will lead to more gain than using daily gains.

Genetic and phenotypic correlations. Estimates of genetic and phenotypic correlations among various growth-related traits are given in Table 2.

Table 2
Genetic (above diagonal) and phenotypic (below diagonal) correlations among the live performance traits* (Genetische (oberhalb der Diagonalen) und phänotypische (unterhalb der Diagonalen) Beziehungen zwischen untersuchten Merkmalen)

Traits	W_4	W_6	W_8	W_{10}	DG_{4-6}	DG_{6-10}
W_4	-	0.90	0.94	0.79	0.20^{NS}	-0.96
W_6	0.81	-	0.98	0.94	0.61	-0.98
W_8	0.67	0.88	-	0.99	0.49	-0.89
W_{10}	0.63	0.82	0.95	-	0.67	-0.77
DG_{4-6}	-0.13^{NS}	0.48	0.49	0.45	-	-0.50
DG_{6-10}	-0.51	-0.59	-0.31	-0.15^{NS}	-0.23	-

*NS: not significant (P>0.05).

The genetic correlations among body weights were generally higher than the phenotypic correlations. They were all positive, so that rabbits more heavy at given age tended also to be more heavy at any later age. The lowest values obtained were between body weight at 4–week of age and marketing body weight ($r_G = 0.79$ and $r_P = 0.63$). This agrees with the conclusion reported by KHALIL et al. (1986). Thus, rabbit body weight at earlier ages can be used for selection to improve its body weight at later ages.

The genetic correlations between body weights and average daily gains were also higher than the phenotypic correlations. Genetically and phenotypically, the relation was positive among body weights and average daily gain from 4– to 6-weeks of age, while negative with average daily gain from weaning to marketing. This opposition in sign may indicate that, in rabbits, body weight before weaning is subjected to a large maternal influence, while it was influenced after weaning by the environmental factors (ex. ration, climat, etc).

Body weight at 6 weeks of age was highly correlated both genetically and phenotypically to body weight at 4 ($r_G = 0.90$ and $r_P = 0.81$) and 10 ($r_G = 0.94$ and $r_P = 0.82$) weeks of age, indicating that weaning weight could replace alone the two other body weights (W_4 and W_{10}) as an index trait.

The basic traits in the aggregate genotype (W_6 and W_{10}) showed large and positive genetic relationships with the other growth-related traits; the relationship was negative with postweaning average daily gain ($r_G = -0.98$ and -0.77, respectively). This indicates that selection for increasing body weights at weaning and marketing should affect positively body weights at other ages and negatively postweaning daily gain.

Selection indexes. Thirteen selection indexes arranged in three strategies (i, ii and iii), according to the use of one or a combination of body weights and average daily gains, were constructed. The weighing factors (b-values) and correlations of the indexes with the total aggregate genotype (r_{TI}– values) are given in Table 3.

Table 3
Weighing factors (b-values) and accuracy of selection in absolute (R_{TI}) and relative (RE) values in indexes used to improve both weaning and marketing body weights (Wichtungsfaktoren (b-Werte), absolute (R_{TI}) und relative (RE) Werte bei unterschiedlichen Strategien in den verschiedenen Indizes)

Strategy*	Index No.	Source of information	b-values					r_{TI}	RE %
			W_4	W_6	W_{10}	DG_{4-6}	DG_{6-10}		
i	1	W_4, W_6, W_{10}	-0.02	1.12	0.41	-	-	0.899	100.00
	2	W_6, W_{10}	-	1.10	0.42	-	-	0.899	100.00
	3	W_4, W_6	-0.06	1.43	-	-	-	0.890	99.00
	4	W_4, W_{10}	0.59	-	1.11	-	-	0.844	93.88
	5	W_6	-	1.38	-	-	-	0.880	97.89
	6	W_{10}	-	-	1.51	-	-	0.802	89.21
	7	W_4	1.24	-	-	-	-	0.709	78.87
ii	8	DG_{4-6}, DG_{6-10}	-	-	-	26.74	-62.35	0.868	96.55
	9	DG_{4-6}	-	-	-	30.88	-	0.842	93.66
	10	DG_{6-10}	-	-	-	-	-83.67	0.658	73.19
iii	11	W_4, W_6, DG_{6-10}	-0.10	1.26	-	-	-26.30	0.906	100.78
	12	W_6, DG_{6-10}	-	1.20	-	-	-25.96	0.905	100.67
	13	W_4, DG_{6-10}	0.88	-	-	-	51.01	0.788	87.65

*i: Using body weights alone; ii: Using daily gains alone; iii: Using daily gains combined with body weights.

Using body weights alone in an index (strategy i) showed that selection on index 1, including W_4 ,W_6 and W_{10} is theoretically capable of predicting the aggregate genetic value of an animal 0.90 as accurately as a perfect index (r_{TI} = 0.899). Assuming the efficiency of index 1 to be 100 %, the omission of W_4 or W_{10} from index 1 (indexes 2 and 3, respectively) resulted in practically the same value of r_{TI} as index 1 (r_{TI} = 0.899 and 0.890, respectively).The relative efficiency of the reduced indexes including W_6, W_{10} or W_4 alone (indexes 5, 6 and 7) were 97.89, 89.21 and 78.87 %, respectively. Using index 5, including W_6 solely, leads practically to the same value of r_{TI} as with indexes 1,2 and 3 (r_{TI} = 0.880).

In terms of selection efficiency , the use of average daily gains solely in an index (strategy ii) would not be as promising as the use of body weights alone (strategy i) or body weights combined with daily gains (strategy iii). Using W_6 combined with W_4 and postweaning daily gain (index 11) or with postweaning daily gain (index 12) resulted in a relative efficiency of about 100 % as using indexes 1, 2 and 3.

From a practical standpoint, selection on index 3 including W_4 and W_6 or on index 5 including W_6 alone could be considered as the best for improving both weaning and marketing body weights of Burundian local rabbits since their application is earlier compared to the use of indexes 1 and 2 (involving W_{10} measured at later stage of the animal life), and easier compared to the use of indexes 11 and 12 (involving postweaning daily gain).

The effect of the different indexes was calculated as the expected improvement in both weaning and marketing body weights as well as correlated response in the other growth–related traits when selection on indexes 1 to 13 and the results are given in Table 4.

Generally, selection using body weights alone (indexes 1 to 7) or combined with postweaning daily gain (indexes 11 to 13) gave the greatest progress in marketing body weight, especially when W_6 was involved (from 42 to 56g), while selection using daily gains alone (indexes 8 to 10) gave the lowest improvement (from 30 to 40g). On the other hand, selection using daily gains gave the greatest progress in weaning weight (from 61 to 102g), especially when DG_{4-6} was involved , however selection

using body weights alone or combined with daily gains gave the same improvement in weaning weight (from 63 to 79g).

Table 4
Expected genetic changes in growth-related traits when using indexes to improve both weaning and marketing body weights (intensity of selection = 1.00) (Erwarteter genetischer Gewinn in den Wachstumsmerkmalen bei unterschiedlichen Strategien in den verschiedenen Indices)

Strategy*	Index no.	Source of information	Expected genetic change for :					
			the traits in aggregate genotype		the related traits			
			W_6	W_{10}	W_4	W_8	DG_{4-6}	DG_{6-10}
i	1	W_4, W_6, W_{10}	76.7	55.9	54.8	100.0	1.5	-0.7
	2	W_6, W_{10}	76.7	55.8	54.9	100.2	1.6	-0.7
	3	W_4, W_6	76.8	54.5	55.3	99.4	1.4	-0.8
	4	W_4, W_{10}	71.0	53.4	53.6	99.3	2.9	-0.6
	5	W_6	76.8	54.4	55.8	100.1	1.5	-0.8
	6	W_{10}	65.7	52.6	44.5	86.6	1.5	-0.5
	7	W_4	62.9	41.6	56.4	97.1	4.5	-0.7
ii	8	DG_{4-6}, DG_{6-10}	102.3	40.4	95.5	78.0	1.9	-0.5
	9	DG_{4-6}	94.6	29.6	94.6	65.1	1.9	-0.3
	10	DG_{6-10}	61.2	35.9	47.9	57.1	1.0	-0.6
iii	11	W_4, W_6, DG_{6-10}	79.1	54.5	57.5	96.9	1.3	-0.8
	12	W_6, DG_{6-10}	79.1	54.3	58.2	98.0	1.5	-0.8
	13	W_4, DG_{6-10}	71.4	44.8	60.4	91.2	3.4	-0.7

* i: Using body weights alone; ii: Using daily gains alone; iii: Using daily gains combined with body weights.

The decreasing in post weaning average daily gain of rabbits is much less when daily gains alone in an index (from – 0.3 to – 0.6 g/d) compared to the use of body weights alone (from– 0.5 to – 0.8 g/d) or body weights combined with daily gains (from – 0.7 to – 0.8 g/d). Selection on all indexes is expected to increase all the other growth–related traits differently.

The index incorporating body weights at 4, 6 and 10 weeks of age (index 1) gave the greatest progress in marketing body weight (+56 g) as well as the reduced index involving body weights at weaning and marketing (index 2), however a moderate progress in weaning weight (+77 g) was observed with their use. On the other hand, the index incorporating DG_{4-6} alone (index 9) or together with postweaning daily gain (index 11) gave the greatest progress in weaning weight (+95 and +102 g, respectively) with a small progress in marketing body weight (+30 and +40 g, respectively). The indexes 3, 5, 11 and 12 gave about the same improvement in both weaning and marketing weights , and also the same improvement in the other growth–related traits. The magnitude of the amount of progress in growth–related traits is comparable with this obtained using index 1 or 2. Therefore, using one or more than one of the above mentioned indexes would lead to the same progress in growth–related traits.

Taking into consideration the expected genetic changes in growth–related traits as well as in weaning and marketing body weights, it appears more practical to the Burundian farmer to use the index including weaning weight alone (index 5) or combined with body weight at 4- week of age (index 3) for improving efficiently both weaning and marketing body weights of rabbits since their application is earlier. The use of these

indexes should result in a genetic increase in weaning and marketing body weights of 77 and 54 g, respectively after one round of selection.

In conclusion, this study points out that selection index is a useful tool to improve growth performance of Burundian local rabbits without imposing more charge on production costs.

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Buchbesprechung

Veterinärmedizinische Neurologie

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In den zurückliegenden Jahren hat sich die Disziplin Neurologie in der Veterinärmedizin von einem Randgebiet zu einem bedeutsamen Spezialgebiet entwickelt. Diesem Trend und dem Bedürfnis nach immer besseren Dienstleistungen in der Praxis Rechnung tragend haben die Herausgeber der Veterinärmedizinischen Neurologie nunmehr die zweite, neubearbeitet und erweiterte Auflage der Monographie auf den Markt gebracht. Das Buch ist in erster Linie an Praktiker und Studierende der Veterinärmedizin gerichtet. Im Teil 1 wird der Leser vertraut gemacht mit dem neurologischen Untersuchungsgang, der speziesübergreifend beschrieben wird. Es schließt sich eine Übersicht zur Klassifikation neurologischer Erkrankungen an. Den Abschluss dieses allgemeinen Teils bildet ein Kapitel über spezielle Untersuchungsmethoden. Dabei liegt der Schwerpunkt bei den bildgebenden Verfahren. Die Teile II bis V behandeln, geordnet nach Lokalisationen, neurologische Erkrankungen bei Kleintieren, Pferden, Wiederkäuern und Schweinen. Aussagefähige Abbildungen, Schemata und Tabellen ergänzen in geeigneter Weise den Text. Ein Literaturverzeichnis ausgewählter Fundstellen am Ende eines jeden Kapitels erlaubt es interessierten Lesern, tiefer und detaillierter in bestimmte Sachgebiete einzudringen. Insgesamt stellt das Buch die Diagnose und Therapie neurologischer Erkrankungen bei Haus- und Nutztieren unter Praxisbedingungen übersichtlich dar. Der Tierarzt wird in die Lage versetzt, die Neurologie als Bestandteil der tierärztlichen Tätigkeit entsprechend den Notwendigkeiten und Bedürfnissen erfolgreich zu praktizieren.

WILHELM KANITZ, Dummerstorf