ANNUAL PRODUCTIVITY INDEX: A SYNTHETIC INDEX OF RABBIT GENETIC VALUES FOR IMPROVING FARM EFFICIENCY

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ABSTRACT

To face the problem of selecting for increased production, or at least to maintain an acceptable level of reproduction rate, in backyard or small rabbit keeping units, a simple total selection index was developed in the mid 1980's. This index, named Annual Productivity Index (IPa, according to the Italian language), was based on the estimation of the annual, cumulative number of kits weaned per doe. The practical application of the IPa has worked well for many years, allowing for the selection of does in a simple manner and while maintaining an acceptable level of production on a farm by identifying and culling animals with a lower reproductive performance index. In order to test the predictive value of this index (for the selection of better does that weaned more kits versus culling of the worst does), an analysis was performed utilising the carefully recorded doe cards of an industrial farm located in the Viterbo province (Italy). The mean IPa value of the farm was 48.5 weaned rabbits per doe per year. Index values rose sharply from the first weaning, but increased more slowly from the third to the 14th weanings (parity), while remaining at high values for does weaning 50 rabbits per year. A randomly selected sample consisting of a third of the breeding stock was necessary to validate estimates of IPa values for the entire breeding herd that involved all weaning records between the 1st and the 14th weanings. Present index values could be reliably predicted ($P<0.001$) based on the IPa value of a certain weaning order as a function of the value of another previous weaning beyond the 3rd weaning. Therefore, the IPa index has been confirmed as a useful tool for selecting does and as a tool to easily measure the overall productivity level of a farm.

Key words: Rabbit, management, annual productivity index, culling, selection.

INTRODUCTION

Due to the development of modern genetics and the increasing diffusion of hybrid lines, rabbit pure breeds have lost importance. The exception is in backyard production systems or as sport or fancy animals being cared more for show perfection rather than for production traits. Backyard producers have had to face the problem of selecting for production to at least maintain an acceptable level of reproduction rate. To address this problem, a simple total selection index was developed in the mid 1980's (Finzi *et al*., 1997) to produce a new breed specifically reared in an open air environment. The breed name is the "Leprino" of Viterbo (ANCI-AIA, 2006) that is presently raised by a cooperative of specialised farmers (Consorzio Coniglio Verde, 2011). The Index (Annual Production Index), called IPa according to the Italian language, was based on the estimation of the annual, cumulative number of kits weaned per doe, starting from the total number of weaned kits at the 3rd parity or weaning. The application of the IPa was easily adopted at farm level, which allowed for the selection of better does that weaned more kits in relationship with time and to cull quickly the worst ones. In this way, it was possible to maintain an acceptable farm mean reproduction level that was considered good but widely varying around 40 weaned kits/doe/year (González-Redondo *et al*., 2008), according to the technical capability of the farmer. To study the predictive value of the IPa (based on calculations involving the first and latter weanings), the aim of this paper was to carefully utilise the recorded doe cards from an industrial farm to conduct analyses to examine correlations of the IPa index for consecutive weanings (parities).

MATERIALS AND METHODS

Experimental farm and animals

The study was carried out using data from an industrial farm located in the Viterbo province (Italy). The farm that produced hybrid meat rabbits had 600 doe cages and industrial facilities consisting in a standard building, with a dynamic ventilation system and control of environmental microclimatic conditions. The management was characterised by: a three-week cycle; artificial insemination 11 days after parturition; standardization of the litter size after births; weaning at 35 days; and slaughtering at 11 weeks at a live weight of about 2.5 kg. Industrial pellets containing 17% crude protein and 16% crude fibre for breeding does were utilized. Feed and water were administered *ad libitum*.

Data recorded and experimental design

Reproduction data involved 591 doe record cards from the farm that were carefully processed in order to calculate for each weaning (litter or parity record) from each doe an Annual Productivity Index (IPa) according to (Finzi *et al*., 1997):

$$\text{IPa} = \frac{\text{Number of weaned rabbits from first mating to } n \text{ weanings}}{\text{Time from first mating to } n \text{ weaning (days)}} \times 365$$

Due to the fact that the litters were standardised after birth throughout fostering, corrections to this formula were introduced: a) when a doe produced surplus kits to be adopted by other does, the half of the number of fostered kits was added to the number of the weaned kits to the donor doe; b) when a doe received kits by adoption, then half of the difference between the weaned and live born kits was added to the live born kits, but only when the number of weaned kits was higher than the number of live born kits. In fact, kits only delivered or only weaned by the doe were considered equivalent for practical reasons and estimated as half of both the gestation or milking biological effort.

A total of 4,002 IPa values was calculated (Table 1), including those from the 1st to 14th weaning of does. After the 14th weaning (parity), the number of data values was no longer considered sufficient and were not included in the study.

Statistical analysis

Correlations were considered as measures of the predictive value of the IPa at each weaning point with reference to the future reproductive ability of each doe. Student's t tests were calculated to analyse the adequate sample size to permit the estimation of the IPa's values of the entire farm. To this aim, the aggregated IPa's were calculated based on random sub-samples of does. The statistical analyses were performed according to the SPSS 15.0 program (SPSS, Inc., 2006).

RESULTS AND DISCUSSION

The mean (±SD) current IPa values for the entire farm was 48.5±12.6 rabbits per doe per year. Values ranged from 5.4 to 73.9, including up to the 24th weanings of the oldest does. The mean IPa rose sharply from 37.1 rabbits/doe/year at the 1st weaning to 50.4 at the 3rd weaning (Table 1). Thereafter, IPa values increased more gradually up to 60.4 rabbits per doe per year to the 14th weaning (Figure 1). This rate of increase, as shown by a decreasing number of does, depended obviously on the progressive culling of the less productive ones. The observed values agree with the annual productivity values in terms of rabbits produced per doe per year, as used in both intensive (Ramon *et al*., 2003; Xiccato and Trocino, 2007; Serrano *et al*., 2011) and alternative systems (González-Redondo *et al*., 2008).

The higher variability of the IPa values up to the 3rd weaning (Table 1) is due to the fact that the younger does have lower but more highly variable reproductive performance (Rommers *et al*., 1999; Rommers *et al*., 2006), more reproductive problems, and(or) undergo a higher culling rate (Rommers

et al., 2006). For this reason, reproductive performance increases with parity order (Xiccato *et al*., 2004), and therefore IPa values were considered reliable to analyse for farm productivity starting from the 3rd weaning records.

Table 1: Difference between IPa's of the entire breeding stock (n=591 does) and IPa's of samples consisting of a variable number of does (mean±SD).

Weaning order	N	Breeding stock IPa	Sample N=50 does		Sample N=100 does		Sample N=150 does		Sample N=200 does		Sample N=250 does		Sample N=300 does	
			IPa	P	IPa	P	IPa	P	IPa	P	IPa	P	IPa	P
1	591	37.1±10.6	36.3	0.083	36.7	0.413	38.3	0.005	37.7	0.141	37.6	0.214	37.2	0.744
2	511	45.6±9.4	46.3	0.117	45.5	0.731	46.5	0.041	46.2	0.184	46.1	0.275	46.2	0.184
3	447	50.4±8.4	50.4	0.950	50.8	0.284	51.5	0.005	50.6	0.571	50.9	0.186	50.7	0.413
4	396	54.0±8.6	53.7	0.551	54.4	0.304	54.9	0.029	54.3	0.426	54.4	0.304	54.2	0.573
5	352	56.1±8.2	55.0	0.017	55.6	0.301	56.3	0.574	56.2	0.738	56.3	0.574	56.3	0.574
6	317	57.1±7.7	56.2	0.035	57.3	0.672	57.6	0.264	57.4	0.513	57.5	0.376	57.4	0.513
7	270	58.3±7.3	57.7	0.210	59.6	0.003	59.5	0.005	58.9	0.148	58.7	0.318	58.5	0.584
8	243	59.0±7.0	57.8	0.009	60.2	0.007	60.2	0.007	59.9	0.043	59.6	0.171	59.5	0.252
9	211	58.6±6.5	57.9	0.104	59.5	0.051	59.5	0.051	59.3	0.131	59.2	0.198	59.1	0.288
10	179	59.1±6.3	57.5	0.001	59.1	0.947	59.3	0.623	59.2	0.781	59.2	0.781	59.3	0.623
11	147	59.4±6.5	57.7	0.002	60.3	0.099	60.1	0.201	59.7	0.594	59.7	0.594	59.6	0.729
12	132	59.6±6.5	57.3	0.001	60.2	0.305	59.9	0.616	59.5	0.842	59.5	0.842	59.6	0.981
13	116	60.2±6.0	58.7	0.009	61.1	0.107	60.8	0.278	60.8	0.278	60.6	0.464	60.6	0.464
14	90	60.6±5.3	57.8	0.001	60.8	0.758	60.8	0.758	61.4	0.169	61.0	0.505	61.2	0.307

Table 1 also shows, for the 1st to the 14th weanings, the predictive value of samples consisting of different numbers of randomly selected does in comparison to the entire breeding herd. Samples consisting of only 50, 100, or 150 does were not sufficient for reliably IPa estimation of the entire breeding herd. In fact, for several weaning orders, we found significant differences between the IPa values of the sample and that of the entire breeding herd. The sample consisting of 200 does only showed a slight difference for the 8th weaning IPa value, and larger samples showed no difference. Therefore, it can be deduced that it is necessary to sample a relevant number of does in order to reliably estimate the IPa's values of the breeding herd for an industrial farm. We suggest that a random sample consisting of one-third of the breeding herd may be enough.

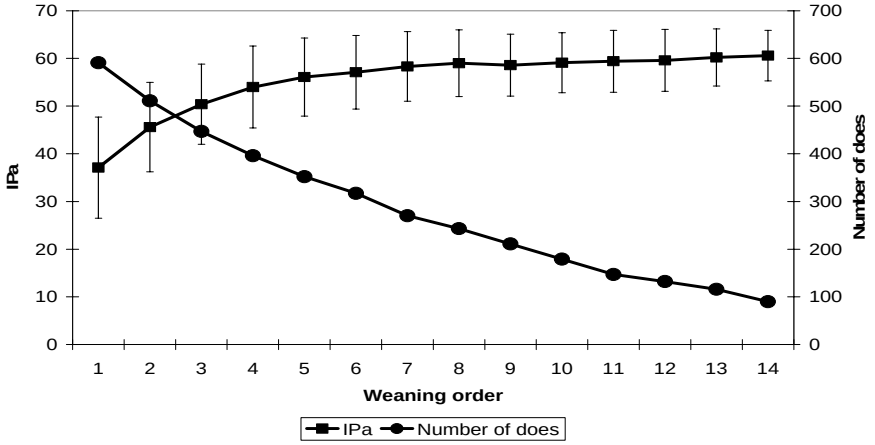

Figure 1: Development of IPa values of the entire breeding herd (n=591 does) based on the weaning (parity) order (mean±SD), and the number of does involved.

Table 2 presents the Pearson's correlation coefficients of the relationships among the IPa's for the 1st to the 14th weanings. It was found that all the correlations that were predicted between the IPa value of a certain weaning order (as a function of the value of another previous weaning order) were positive ($P<0.001$). However, the strength of the correlations was variable. For example, correlations of IPa values of lower weaning orders were less strong than those of higher orders. As discussed previously, this was due to the fact that does at the beginning of their reproductive career show a higher variability in their reproductive performances. Moreover, for all the weaning orders, correlations decreased with the distance between the weaning orders involved in the prediction. Therefore, the IPa index was

confirmed to be a useful tool for selecting for more productive does, and was revealed to be an efficient tool to easily measure the overall productivity level of a farm.

Table 2: Correlations among IPa's of weaning orders 1 to 14 for the entire breeding stock[1].

		IPa2	IPa3	IPa4	IPa5	IPa6	IPa7	IPa8	IPa9	IPa10	IPa11	IPa12	IPa13	IPa14
IPa1	r	0.655	0.506	0.472	0.472	0.429	0.413	0.399	0.426	0.397	0.431	0.436	0.501	0.407
	N	511	447	396	352	317	270	243	211	179	147	132	116	91
IPa2	r		0.776	0.710	0.642	0.619	0.556	0.544	0.504	0.506	0.495	0.471	0.459	0.366
	N		447	396	352	317	270	243	211	179	147	132	116	91
IPa3	r			0.887	0.824	0.784	0.744	0.703	0.642	0.660	0.647	0.631	0.586	0.478
	N			396	352	317	270	243	211	179	147	132	116	91
IPa4	r				0.914	0.834	0.806	0.764	0.731	0.713	0.706	0.681	0.657	0.574
	N				352	317	270	243	211	179	147	132	116	91
IPa5	r					0.926	0.884	0.834	0.792	0.788	0.774	0.758	0.726	0.631
	N					317	270	243	211	179	147	132	116	91
IPa6	r						0.947	0.904	0.865	0.840	0.823	0.795	0.762	0.677
	N						270	243	211	179	147	132	116	91
IPa7	r							0.947	0.888	0.861	0.838	0.796	0.780	0.673
	N							243	211	179	147	132	116	91
IPa8	r								0.929	0.899	0.888	0.856	0.823	0.754
	N								211	179	147	132	116	91
IPa9	r									0.949	0.935	0.903	0.874	0.829
	N									179	147	132	116	91
IPa10	r										0.969	0.935	0.913	0.884
	N										147	132	116	91
IPa11	r											0.956	0.938	0.906
	N											132	116	91
IPa12	r												0.969	0.923
	N												116	91
IPa13	r													0.964
	N													91

[1]All correlations significant at the P<0.001 level.

CONCLUSIONS

A randomly selected sample consisting of one-third of the breeding herd is necessary to reliably estimate IPa's values of the entire breeding doe herd. The index value of a certain weaning order can be reliably predicted as a function of values from a previous weaning order. The IPa index has been revealed to be a useful tool to easily measure the overall productivity level of a farm. The results of this study explain the positive results obtained by farmers who adopted the use of the selection index. Because to the limited information required for recording and its simplicity of calculation, it could be potentially useful in the management of small alternative farms in developing or developed countries, although more research is needed to confirm this application across divergent environments.

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