Optimum Replacement Time of Productive Animals in Greece

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Abstract

The purpose of this paper is to determine the optimum replacement time (lactation period or litter) of the various kinds of productive animals, which are reared in our country. For this determination three methods are applied, namely the method of the average total cost of production, the method of the average "standardized" sum of the gross profit and the value of the slaughtered animal, and the method of the average "standardized" farm income.

The analysis showed that the optimum replacement time of a productive animal does not differ considerably between the methods of the average total costs of production and the average farm income. On the contrary, the optimum time of replacement is much greater when using the sum of the gross profit and the value of the slaughtered animal method.

Comparing the results of applying the above mentioned methods to various kinds of productive animals, it is concluded that the most appropriate and suitable method is the one which is based on farm income because it determines the exact, and corresponding to actual practice, lactation period or litter as an optimum time of replacement.

Résumé

L'objectif de ce travail est de déterminer la période optimale de replacement (période de lactation ou portée) pour différents types d'animaux productifs, qui sont élevés dans notre pays. Pour cette détermination, trois méthodes ont été appliquées, à savoir la méthode du coût total moyen de la production, la méthode de la somme moyenne "standardisée" du profit brut et de la valeur de l'animal abattu et la méthode du revenu moyen "standardisé" de l'exploitation.

L'analyse a montré que la période optimale de replacement pour un animal productif ne diffère pas considérablement entre les méthodes du coût total moyen de la production et du revenu moyen de l'exploitation. A l'opposé, la période optimale de replacement est de loin plus élevée quand on utilise la méthode de la somme du profit brut et de la valeur de l'animal abattu.

En comparant les résultats obtenus par l'application des trois méthodes aux différents types d'animaux productifs, on en conclut que la méthode la plus appropriée et la plus convenable est celle qui repose sur le revenu de l'exploitation, étant donné qu'elle permet de déterminer, exactement et en ligne avec la pratique courante, la période de lactation ou portée comme période optimale pour le remplacement.

1. Introduction

When we say optimum time of replacement of a perennial crop or livestock enterprise or a farm machinery, we consider the determination of the time when the farm enterprise or the farm machinery achieves accumulatively, directly or indirectly, the maximum average profit or income. This time depends on the kind of farm enterprise or farm machinery and it can be expressed in years of productive life (orchards, vineyards), in hours of work (tractors), in hectares harvested (combines, sugar beet or cotton pickers), in number of lactation periods (cows, ewes, goats), in number of litters (sows) etc.

The problem of determining the optimum replacement time of various perennial farm enterprises and more specifically of various kinds of productive animals has not been sufficiently studied in our country and abroad. As it is known the normal replacement of various kinds of productive animals is based on their age and yield without taking into account certain other physical and economic data which are considered necessary for determining the optimum time of replacing each kind of animal. This fact was the reason why I decided to study the above mentioned problem of livestock production based mainly on my experience for more than 30 years of continual farm management research. In the attempt to study this problem I was based on certain physical and economic data and on a special methodology. These data derive from various Centers of Genetic Improvement of Productive Animals in Greece, from the Ministry of Agricultural Development and from some special investigations undertaken during the period 1991-2003. The various economic data were converted from current to standard prices through the Consumer Price Index.

2. Physical and economic data needed and methodology used

The physical data needed for this work are: the milk yield in Kgs and the number of calves, lambs, kids and piglets weaned according to the number of lactation period or litter, the body weight of cows, ewes, goats and sows replaced and the corresponding one of calves, lambs, kids and piglets weaned, the work in hours per lactation period or litter for each kind of productive animal, the kind and quantity of feed, the building and machinery needed, etc. On the other hand the economic data needed are: the price of milk and live weight of the aforementioned kinds of animals, the market price or the cost of production of the various kinds of feed, the labor wages, the payment for veterinary services, repairs, insurance and interest for livestock and fixed capital.

The methods used for determining the optimum replacement time of various kinds of productive animals are: a) the average total cost of production, b) the average sum of the gross profit and the value of the slaughtered animal, and c)

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the average farm income. The purpose of the first method is to determine the time (lactation period or litter) of minimizing the average total cost of production by using the following equation:

$$S_n(A.T.C.) = \frac{S_n(T.C.)}{S_n(T.P.)} = Minimum$$

where S_n (A.T.C.) = accumulated average total costs of production until n lactation period or litter per Kg. of milk (cows, ewes, goats) or per piglet weaned , S_n (T.C.) = accumulated total costs of production until n lactation period or litter per cow, ewe, goat or sow, and Sn (T.P.) = accumulated total production in kgs of milk or in number of piglets weaned until n lactation period or litter per cow, ewe, goat or sow. Using this method the total costs (labor, feed, annual expenses of animals, buildings, machinery, etc) per lactation period or litter for each kind of productive animal is estimated. These accumulated costs are from the second until the last lactation period or litter. On the other hand, the yield in kgs of milk produced or the number of piglets weaned per lactation period or litter is estimated. These accumulated yields are from the second until the last lactation period or litter. The determination of the accumulated minimum average total costs of production is achieved by dividing the accumulated total cost of production by the accumulated total production per lactation period or litter. It is necessary to elucidate that in the case of cows the value of calf weaned is subtracted from the total cost of each lactation period in order to have the total cost of production for milk production only, while in the case of ewes and goats the difference of live weight of lambs and kids between weaned and born is transformed into milk according to the existing relation between milk quantity consumed and live weight produced. This quantity of milk is added to the milk quantity produced from each ewe and goat and this sum is divided by the total production costs for estimating the accumulated average total cost of production according to the number of lactation period (see Appendix 1a for cows as an example).

The purpose of the second method is to determine the time (lactation period or litter) in which the accumulated average standardized sum of the gross profit and the value of the slaughtered animal is maximized through the following equation:

$$I_n = \left[\sum_{i=1}^{n}\left[D_i\left(GR.PR. + V.S.\right) + R_o\right] \times \left(A.F.\right)_n\right] = \max imum$$

where GR.PR= gross profit, namely the difference between gross return and variable cost, V.S. = value of the slaughtered animal, Ro= value of the productive animal, Di= the discounting factor, Di (GR.PR + V.S.) = the gross profit and the value of the slaughtered animal discounded, A.F.= the annuity factor, I_n= the accumulated average standardized gross profit and value of the slaughtered animal. The gross profit of each lactation period or litter is added to the value of the slaughtered animal, and this sum together with the value of the productive animal are converted into the first lactation period or litter by using the discounting factor. In this case we use the minus sign (-) before the value of the productive animal (because it means payments) and the plus sign (+) before the gross profit and the value of the slaughtered animal (because it means receipts). After that by substracting the sum of the gross profit and the value of the slaughtered animal from the value of the productive animal, we receive the remainder gross profit and the value of the slaughtered animal accumulatively. Finally, by using the annuity factor, the forementioned sum is transformed into a standardized one according to the number of lactation period or litter. The lactation period or the litter with the maximum average standardized sum of the gross profit and the value of the slaughtered animal accumulatively recommends the optimum replacement time (see Appendix 1b for cows as an example).

The purpose of the third method is to determine the time (lactation period or litter) in which the accumulated average standardized farm income is maximized through the following equation:

$$I_n = \left[\sum_{i=1}^{n}\left(D_i\left(G.R - F.E. = F.I.\right) \times \left(A.F.\right)_n\right)\right] = \max imum$$

where G.R = gross return, F.E.= farm expenses except for land rent, labor wages and interest of capital, F.I.= farm income, Di (GR-F.E=F.I) the farm income discounted, and In= the accumulated average standardized farm income. The farm income of each lactation period or litter is converted into the first lactation period or litter by using the discounting factor and after that by adding the farm income from the second until the last lactation period or litter we take the accumulated farm income. Finally, this farm income is transformed into a standardized one through the annuity factor. The lactation period or litter on which the accumulated maximum average standardized farm income corresponds, represents the optimum replacement time (see Appendix 1c for cows as an example).

3. Application of the above mentioned methods to various kinds of productive animals

The above mentioned methods were applied to the physical and economic data of cows (friesian black and white), ewes (various breeds), goats (breed of island Skopelos) and sows (large-white and landrace) (table 1).

For cows the optimum replacement time fluctuates between the 5th and 6th lactation period by using the method of the average total production costs. The 6th lactation period is the optimum replacement time by using the method of farm income. On the contrary, the optimum replacement lactation period is the 10th when we use the method of the sum of the gross profit and the value of the slaughtered cows.

Table1. *Optimum replacement time of various kinds of productive animals according to the method used*

Kinds of productive animals	Optimum replacement number of lactation period or litter		
	Method of production cost	Method of farm income	Method of sum gross profit and value of slaughtered animal
I. Cows (Friesian)	5-6	6	10
II. Ewes (various breeds)	5-7	5-8	9-10
III. Goats (Island Skopelos)	8	8	12
IV. Sows (large-white and landrace)	4-5	4-5	10

For ewes of various breeds, the optimum replacement time fluctuates between the 5th and 7th lactation period by using the method of the average total production costs, while it fluctuates between 5th and 8th lactation period by using the farm income method. On the contrary, the optimum replacement lactation period fluctuates between the 9th and 10th by using the sum of the gross profit and the value of the slaughtered ewes.

For goats the optimum replacement lactation period is the 8th by using the first and the second method, and the 12th by using the third method.

Finally, for sows the optimum replacement time fluctuates between the 4th and 5th litter by using either the production costs method or the farm income method and the 10th litter by using the sum of the gross profit and the value of the slaughtered sows method.

4. Comparison of methods used for determining optimum replacement time of various kinds of productive animals

Based on the results of table 1 we see that the optimum replacement time for all kinds of productive animals is about the same by using either the production cost method or the farm income method. On the contrary, the optimum replacement time for all kinds of productive animals is much greater when using the sum of the gross profit and the value of the slaughtered animal method.

By comparing the above mentioned three methods we consider that the production costs method identifies the minimization of the average total cost of production with the maximization of profit. However, the profit does not depend on the production costs only, but also on the price of the product (milk, piglet, etc). This means that this method does not determine exactly the optimum replacement lactation period or litter in which the maximum average profit is achieved. The farm income method determines exactly the optimum replacement lactation or litter in which the maximum average farm income is achieved. On the contrary, the sum of the gross profit and the value of the slaughtered animal method determines the lactation period or litter as an optimum replacement time which is outside of the usual time of replacement. For this reason, the farm income method is considered as the most appropriate method for determining optimum replacement time for productive animals.

5. Conclusions

For optimum replacement time of productive animals three methods are usually applied, namely the production cost method, the farm income method and the sum of the gross profit and the value of the slaughtered animal method. These methods were applied to milk cows, to milk and meat ewes and goats, and to sows for producing piglets. By comparing the results from the application of the three methods to four kinds of productive animals (cows, ewes, goats, sows) we consider that the most appropriate and suitable method for determining the optimum replacement time is the farm income. This is true taking into account that this method determines on the one hand the lactation period or litter on which the maximum average standardized income corresponds and on the other the lactation period or litter which the farmers follow approximately in actual practice.

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Appendix 1. *Determination of optimum replacement time (lactation period) for cows by using: a) the method of the average total cost of production, b) the method of the average "standardized" sum of the gross profit and the value of the slaughtered cow, and c) the method of the average "standardized" farm income*

Gross profit, value of animal as productive and slaughtered, farm income, etc.	Number of lactation periods										
	0	1	2	3	4	5	6	7	8	9	10
a. Average total production costs											
1. Total expenses of milk (€/cow)	-	1910	1944	1955	1956	1984	1948	1940	1922	1912	1901
2. Accumulated total expenses (")	-	1910	3854	5809	7765	9749	11697	13637	15559	17471	19372
3. Milk yield (kgs/cow)	-	6192	6835	7038	7098	7418	6932	6775	6420	6098	5990
4. Accumulated milk yield (")	-	6192	13027	20065	27163	34581	41513	48288	54708	60806	66796
5. " aver. tot. pr. costs (")	-	0.308	0.296	0.290	0.286	0.282	0.282	0.283	0.285	0.287	0.290
b. Gross profit and value slaughtered											
1. Gross profit (€/cow)	-	948	1073	1112	1126	1178	1093	1062	992	922	907
2. Value slaughtered (")	-	505	505	505	505	505	505	505	505	505	505
3. Sum of No. 1 and No.2 (")	-	1453	1578	1617	1631	1683	1598	1567	1497	1427	1412
4. Discounting factor	-	0.9174	0.8417	0.7782	0.7084	0.6499	0.5963	0.5470	0.5019	0.4604	0.4224
5. Value of prod. cow and No. 3 discounted	-1500	1333	1328	1258	1155	1094	953	857	751	657	596
6. Accumulated No. 5	-	-167	1161	2419	3574	4668	5621	6478	7229	7886	8482
7. Annuity factor	-	1.0900	0.5685	0.3951	0.3087	0.2571	0.2229	0.1987	0.1807	0.1668	0.1558
8. Average standardized of No. 6	-	-182	660	956	1103	1200	1253	1287	1306	1315	1321
c. Farm income											
1. Gross return (€/cow)	-	1641	1801	1852	1869	1951	1827	1787	1697	1616	1588
2. Farm expenses (")	-	1182	1209	1215	1219	1240	1212	1205	1192	1186	1180
3. Farm income (")	-	459	592	637	650	711	615	582	505	430	408
4. Discounting factor	-	0.9174	0.8417	0.7782	0.7080	0.6499	0.5963	0.5470	0.5019	0.4604	0.4224
5. Discounted farm income	-	421	498	496	460	462	367	318	253	198	172
6. Accumulated farm income (")	-	421	919	1415	1875	2337	2704	3022	3275	3473	3645
7. Annuity factor	-	1.0900	0.5685	0.3951	0.3087	0.2571	0.2229	0.1987	0.1807	0.1668	0.1558
8. Average standardized farm income	-	459	522	559	579	601	603	600	592	579	568