Extended Abstract
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Poster Title	Modeling animal performance under infectious and non-infectious challenges: The case of Chios sheep

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Abstract	***200 words max***
A linear programming model is developed to estimate the impact of new traits making animals resistant to diseases on the structure and economic performance of sheep and goat farms. The idea is to simulate farm operation by maximizing its economic performance (gross margin). The model enables assessment of a wide variety of scenarios/challenges related to animal traits that prevent infectious and non-infectious diseases as well as the assessment of socioeconomic effects of these new traits. For a demo version of the model we used technical and economic data from Chios sheep farms in Greece to assess different scenarios of mastitis and parasites prevalence in flocks. Comparison of optimal modelled solutions suggest that profitability and sustainability of examined sheep farms are significantly improved when relative diseases are limited. However, this does not affect the production and management plan of the farmer and does not alter the structural profile of the farm.	

Keywords	Sheep farming, Optimization model, Linear Programming, Infectious and non-infectious diseases
JEL Code	Q12 Micro Analysis of Farm Firms, Farm Households, and Farm Input Markets see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

Small ruminant farms operate in a challenging and competitive environment and efforts towards intensification of production threatens their multidimensional nature which is a key characteristic to maintain their resilience. The latter is subject of debate when considering genetic trade-offs between traits such as growth, milk production or fertility with resistance or tolerance to diseases. The notion is that the development of new genetic traits that increase resistance to infectious and non-infectious diseases improves resilience and sustainability of sheep and goat farms and allows a more efficient management of such farming systems. Here, we propose a farm-scale mathematical programming model for sheep and goat farms to simulate economic performance under new resilient and efficient traits that counteract presence of infectious and non-infectious diseases. The model provides simulating scenarios of how changes towards optimizing one farm component (e.g. genetics at animal level) could affect other components of the farm or the overall system (e.g. gross margin, labour, land use, grazing, profit etc), in terms of sustainability. The idea is that the

model can be a useful tool for policymakers to identify problems and propose innovative strategies to re-design small ruminant farming systems. The model is applied using technical and economic data from a typical Chios dairy sheep farm in Greece operating under a semi-intensive system. The impact of mastitis and gastro-intestinal nematode (GIN) parasites on farm profitability was assessed. The outcome indicated the optimal structure of the farm and provided suggestions for adjustments required in the farming system to valorise fully its potential.

Methodology ***100 – 250 words***

A mathematical linear programming model has been developed aiming at the maximization of an objective function that calculates gross margin, under a set of constraints related to land use and grazing, human labour, feed and capital requirements, nutritional content of feedstuff etc. In the development of the model a set of constraints associated with infectious and/or non-infectious diseases (i.e. mastitis and GIN), has also been included to account for the likely impact on: (i) expected disease prevalence in the flock, (ii) milk yield, (iii) veterinary expenses and (iv) labour requirements. Two scenarios were investigated with the SMARTER model. First, the model simulates farm's performance under the presence of GIN and mastitis. In the case of Chios sheep, where mastitis prevalence accounts for 15% of milking ewes, their annual milk production is lower due to discarded amounts of milk during treatment. Moreover, veterinary expenses are higher by 4€/year/ewe and labor requirements are increased by 1h/year/ewe. In the case of GIN infection with 35% prevalence in milking ewes, annual milk production fall up to 22% and meat yield is lower by 15%. In the second scenario (future plan) the solution demonstrates the optimal organization of the farm under perfect conditions where no diseases occur. The results produced under the 2 scenarios are then compared and the economic and structural adjustments are discussed.

Results ***100 – 250 words***

In the first scenario, where both diseases are present, the farm utilizes 3.76 ha of irrigated land to produce maize and 41.4 ha for grazing. Apart from grazing the diet of ewes is supplemented with forage and concentrates; the former includes silage and the latter purchased cotton cake and wheat, apart from own-produced maize. The results also indicate that three workers are employed full-time to assist the family of two members fully committed to farm work. The main product of the farm is milk; most of it sold to dairy industry and the rest is used for inhouse cheese production that is sold directly to consumers. Moreover, in the optimal plan of the farm, lamb and ewe meat account for 28.7% of gross revenues, which are 376.5€/ewe. Variable costs such as expenses for purchased feeds, seeds and agrochemicals, veterinary expenses, fuel etc, are 72.5€/ewe, while the gross margin is 304€/ewe. The future plan that is without presence of diseases, shown remarkable similarity with the optimal plan of the current situation in terms of farm structure. However, the farm differs substantially in terms of financial outputs. More specifically, although the farm has the same number of animals and same human labor with only marginal changes in ration formulations, the gross

margin per ewe is increased by 8.2%, indicating an improvement in the economic performance of the farm.

Discussion and Conclusion	***100 – 250 words***

The aim was to develop a mathematical model accounting for parameters that could shape new farm profiles for different environmental, technical, and economic challenges. The model operates at farm level and can be adapted to different breeds and farm types. In this exemplary case of a Chios sheep farm the results indicate that the structure of the farm does not change significantly if new resilient and efficient animal traits are developed to prevent diseases. This finding is interesting, because it shows that although the occurrence of diseases at given percentage changes economic performance, the impact is not considered important to impose the farmer change the management plan. It appears that the development of resilient animals is not considered a groundbreaking issue for the farmers. Although the gross margin of the farm is increased in the disease-free scenario, does not affect the managerial decisions of the farmer. Results also show that the improvement of the economic performance of the farm the increase of gross output, not the reduction in the production cost. Moreover, although Chios sheep farms are predominantly focused on milk production, the optimal solution indicates that meat production could also be an important income. Meat sales can contribute to the financial stability of farms, which is necessary when negotiating for better milk prices or considering alternative paths for expansion.

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