Economic competitiveness gap related to the application of the GAEC standards of cross-compliance on farms: evaluation methodology

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Abstract

This paper describes the methods used in the monitoring carried out in the farms of the MO.NA.CO. project, to calculate the economic competitiveness gap faced by agricultural holdings that accede to the commitments imposed by the standards included in the project. The monitoring works were performed in agricultural holdings in relation to the particular reference condition of each standard. The processing of the information acquired allowed us to define the working times of each cultivation operation by means of the indications in the recommendations of the *Associazione Italiana di Genio Rurale* - Italian Rural Engineering Association, that considers the official methodology of the International Commission of the *Organisation Scientifique du Travail en Agriculture* (C.I.O.S.T.A.). The overall costs and revenues in case of compliance or non-compliance with the commitments of the standard were calculated by using Biondi's methodology and other norms that indicate the technical and economic coefficients to be used in the calculations (EP 496.2 and D 497.4 ASAE standards). With the data related to the unit cost of ploughing a model Partial Least Squares (PLS) has been achieved and validated, and it makes possible to predict the unit cost of this agricultural operation. Finally, the values of the variation of the economic competitiveness gap are reported for each standard.

Introduction

The adherence to the commitments contained in the standards-compliance requires the adoption of specific agronomic practices, performing special processing of the land or of specific interventions by mechanical means. The cost of such actions has a direct impact on the farm and it may cause a loss of competitiveness.

The MO.NA.CO. project through the monitoring of numerous case studies and the application of official methods, has estimated the costs of such actions, determining the value of the competitiveness gap imposed on farms that adhere to commitments imposed by some standards.

Materials and methods

Processing with mechanical means

During the course of the MO.NA.CO. project, the data relating to the agricultural operations in the period from 2011 to 2014 were collected from field surveys conducted by the various operating units while the processing was being carried out. Information was acquired from the plots of land of the various operating units regarding the features of the specific plot (slope, surface, etc.), the type of crop grown (species, seeding/planting density, etc.), the necessary labour involved (number of workers and tasks), and the data for the economic analysis inherent to the farm machinery and tractors, and the purchase cost of the production factors, etc. Most of the agricultural operations carried out during the monitoring of the project were realised via use of the means (tractors and operating machinery) supplied to the respective agricultural holdings relating to the operating units, while in some cases, mainly due to unavailability of specific machinery (e.g. combine harvesters), it was necessary to resort to labour services supplied by third parties and the tariffs applied locally were used in the economic calculations. The processing of the information acquired allowed to define the work times of each cultivation operation by means of the indications in the recommendations of the *Associazione Italiana di Genio Rurale* - Italian Rural Engineering Association (A.I.G.R.) III[a] R.1 (Manfredi, 1971), that considers the official methodology of the International Commission of the *Organisation Scientifique du Travail en Agriculture* (C.I.O.S.T.A.). The plots of land of the agricultural holdings examined differ in shape and size, geomorphology, soil composition and geographic location, as well as agronomical and administrative management. In order to significantly reduce the influence induced by this vast variability of agricultural holding characteristics, only several items of the C.I.O.S.T.A. method were taken into account. Since all the plots monitored had a limited surface area (generally 0.5 ha), among the various types of work times (as defined in the aforementioned guideline) only those relating to the effective work time (TE) were recorded, as well as the accessory time for the tractor turn-around (TAV), which together represent the net work time (TN). With reference to the net time (TN), the hourly operating cost of each tractor and piece of machinery used was determined by means of specific analytical methods, and successively, the cost per surface-area unit was determined for each cultivation operation. The operating cost of the tractors and pieces of machinery is identified by considering two main parameters: fixed costs and variable costs. The former involve the reintegration of the invested capital, the cost of using the capital, and the various expenses (insurance, storage and taxes). These cost items must also be borne even when the machinery is not used. On the other hand, the variable costs are related to the use of the agricultural machinery and include the expenses incurred for repairs and maintenance, fuel, lubricants and labour. The methods proposed in the bibliography are substantially similar in relation to the calculation of the fixed costs, whereas they differ in the formulas and coefficients adopted in calculating the variable costs. As far as this last item is concerned, reference has been made to a specific method (Biondi, 1999) which is more complete and more up-to-date compared to the others and has precise references to the technical standards that indicate the technical and economic coefficients to be used in the calculations (ASAE, 2003a, 2003b).

Fixed costs

Depreciation

The annual depreciation rate is the portion of the basic value of an asset which, depending on the allocation process, is considered as convenient and is included among the operating costs of the year. Therefore, it represents the sum of money that must be set aside annually so that after a certain period of time, there is a sufficient amount available for purchasing the same asset again. Also to be added to this amount is the eventual final recovery value that could possibly be obtained if the asset is still usable and can be sold on the second-hand market. In this study we have considered a linear type of calculation system, with constant amounts, that envisages the following items:

CFD (€ year^{-1}) = $\frac{(Vo - Vf)}{n}$ where Vo is the replacement value of the tractor or piece of machinery (€), Vf is the final recovery value (€), and n is the service life of the machine (years).

Replacement value of the tractor

Given the need to adopt a common criterion for determining the replacement value of all the tractors used in the cultivation operations monitored, and which at times are obsolete, a market survey was conducted on the current pricelists of all farm tractors available on the domestic market. Following this, with a statistical analysis of the data, the current average unit value was determined for the tractors in relation to their power (€ kW^{-1}). This parameter, multiplied by the nominal power of each specific tractor used, allowed to determine the replacement value of all the various tractors included in the monitoring. The data used for this analysis were obtained from the publication 'Buyers' guide 2013' edited by the sectoral magazine 'L'informatore Agrario'. Unlike what was analysed for crawler tractors, the average unit value of the standard type of wheeled tractors was determined by dividing them into the following power classes: from 25 to 50 kW, from 51 to 74 kW, and above 75 kW. Furthermore, it was also necessary to carry out an economic assessment of all the operating machinery (ploughs, seeders, trenchers, harrows, etc.) used in the cultivation activities. The replacement value of the various machines was determined by referring to the 2013 pricelists. Due to the numerous types of operating machines, in the case of several obsolete models no longer available on the market, for assimilation purposes, the pricelist of equipment on the market having similar technical, functional and qualitative characteristics was used.

Interest

This is the cost borne by the entrepreneur for using the capital invested in the purchase of the machine. This can generally be calculated as a constant annual value based on the representative average of the value of the machine throughout all the years of ownership:

CFI (€ year^{-1}) = $\frac{(Vo + Vf)}{2} r$ where Vo is the replacement value of the machine (€), Vf is the final recovery value (€), and r is the interest rate (value used, 4%).

Miscellaneous expenses (storage, insurance, taxes)

This item includes all the expenses incurred for the storage of the machinery, insurance for third-party liability, and the costs related to taxes. The extent of the expenditure was determined as a percentage of the purchase cost for the replacement of the machine: CFV (€ year^{-1}) = a * Vo where Vo is the replacement value of the machine (€) and a is a coefficient varying between 1% and 4% (value used, 2%).

Total fixed cost

CFA (€ year^{-1}) = $CFD + CFI + CFV$

Variable costs

The calculation method proposed is based on the purchase price of the machinery, on its service life, on the power used, and on other coefficients.

Repair and maintenance costs

The cumulative calculation of the maintenance and repair rates used, *CRM*, is carried out on the basis of the average usage costs, *Crm*, according to the following equations:

$$\text{CRM } (€) = Rf1Vo\left[\frac{h}{1000}\right]^{Rf2} \qquad \text{Crm } (€\ h^{-1}) = \text{CRM/h}$$

where V_0 is the replacement value of the machine (€), Rf_1 and Rf_2 are the repair and maintenance factors, and h the cumulative hours of usage. The Rf_1, Rf_2 and h values used in the calculations are those reported in the D 497.4 standard (ASAE, 2003b).

Fuel and lubricant costs

The assessment of the expenses relating to fuel and lubricants is based not only on the purchase price of the diesel oil and the lubricants, but also on the determination of the machine consumption, identified by means of the following formulas:

Fuel consumption

CG (€ h^{-1}) = Cg1 + Cg2 where Cg1 (fuel consumption over time TE) (€ h^{-1}) = Cc * Cs * P_{te}, Cg2 (fuel consumption over time TAV) (€ h^{-1}) = Cc * Cs * P_{tav}, where Cc is the purchase cost of the diesel oil (€ kg^{-1}), Cs is the specific consumption of a farm machine diesel engine at full power (kg kWh^{-1}), P_{te} (the power used during effective operation) (kW) = P * d_{te}, P_{tav} (the power used during the turn-around) (kW) = P * d_{tav}, P = maximum engine power (kW), and d_{te} and d_{tav} the power utilisation factors: 80-90% in difficult operations where maximum traction force (ploughing) or maximum speed is required, and 30-40% in non-arduous activities, such as light harrowing or swathing of forage (Biondi, 1999). In relation to this parameter, our intention was to differentiate the utilisation factor during effective operation (d_{te}), from that relating to turn-around operations and manoeuvres (d_{tav}).

Lubricant consumption

As regards the lubricant consumption the following equation was adopted: CL (€ h^{-1}) = Cl * Cs * P, where Cl is the cost of the lubricant (expressed in € kg^{-1}), Cs is the specific lubricant consumption (kg kWh^{-1}), and P is the maximum engine power (kW).

Labour

In order to evaluate this item, information was acquired regarding the totality of retribution aspects of the agricultural workers. Therefore, this analysis was conducted on a provincial basis as provided for in the 2013-2015 national collective contracts for agricultural workers, by examining the provinces of the farms being monitored, as well as the reference data obtained from the trade union association 'Confederazione Italiana Agricoltori' *(Italian Farmers' Confederation)*. Based on the work activities carried out in the agricultural holdings being monitored, two principal qualifications were identified:

i) Specialised agricultural worker; Super Area 1
ii) Qualified agricultural worker; Super Area 2

The above-mentioned differentiation allowed to use the appropriate reference cost for each of the operations carried out in the agricultural holdings monitored.

Total variable cost

CH (€ h^{-1}) = Crm + CG + CL + CM

Average unit cost per hour of utilisation

By using the values obtained previously and considering the annual utilisation (*U*) (hours), it is possible to calculate the average unit cost per hour of utilisation, both for tractors and operating machines:

$$Ch\ (€\ h^{-1}) = \frac{(CFA)}{U} + CH$$

Once this equation is known the costs per surface area unit can then be calculated (€ ha^{-1}).

Manual processes

The cost of manual processes (€ h^{-1}) has been calculated by considering the hourly labour rate and the time monitored during the course of the operations.

Cost of the production factors

In some standards it was necessary to draw up the economic budget of the crops grown also by considering the cost of other factors and the possible revenues. Where possible, data obtained during the course of the monitoring were used: where such data were not available, the official ISTAT (National Institute of Statistics) production data (ISTAT, 2014) were used, whereas for the selling price of the product, data were obtained from the ISMEA (Agricultural Market Study, Research and Information Institute) (ISMEA, 2014), the CCIAA - Chambers of Commerce (CCIAA Arezzo, 2014; CCIAA Brescia, 2014; CCIAA Forlì-Cesena, 2014), and from other sources (Casati, 2014). Data relating to the production factors were obtained from publications of the Plant Production Research Centre (CRPV, 2014) and the Sardinian Region (Regione Sardegna, 2014).

Calculation of the economic competitiveness gap

Via use of the methodology described above, the economic competitiveness gap was determined according to two different methods. In those cases in which the compliance with the commitments of the standard has negligible or no effects on the value of the gross saleable production of the crop or livestock monitored, or where said effects are deferred over time and not monitorable during the course of the project, in order to calculate the economic competitiveness gap, reference was only made to the cost variations generated by the application of the standard. On the other hand, where the compliance with the commitments of the standard instead induces variations in the gross saleable production, the economic competitiveness gap was calculated as the difference between the gross margin of the agricultural or livestock activity both in the condition of compliance and the condition of non-compliance with the commitments of the standard. The calculations of the economic competitiveness gap of each standard were repeated by using the minimum, medium and maximum values of each cultivation operation monitored, in this way obtaining a variation range of the aforementioned gap. Based on the numerous types of cultivation operations monitored and the relative execution costs calculated as indicated above, an original software was also developed during the course of the project, which for the purpose of dissemination, offers the possibility to compare the overall machinery costs of a hypothetical agricultural holding that does not comply with the cross-compliance commitments, with those of the same agricultural holding that adopt the compliance system. This allows us to obtain a rough estimation of the competitiveness gap that would arise.

Multivariate modelling approach to predict ploughing costs

A multivariate modeling approach was used to predict ploughing costs by using six auto-scaled variables: four quantitative (working time *per* surface area unit (h ha^{-1}), maximum engine power (kW), and purchase price of the machinery and equipment (€) and two qualitative (ploughing in conditions of excessive soil moisture and ploughing in good soil moisture conditions, ploughing with and without unloaded return). The dataset was composed by 54 observations. For the multivariate regression approach, a Partial Least Squares (PLS) regression was applied (Wold *et al*., 2001; Costa *et al*., 2012; Infantino *et al*., 2015). The regression analysis objective is achieved by using the equation that minimizes the residual mean square error, or maximizes the coefficient of multiple determination r^2, which is the most commonly used statistic to measure the forecasting potential of a multiple regression equation. The predictive ability of the model depends also on the number of latent vectors used. Generally, a good predictive model should have high values of Pearson correlation coefficient (r) and low values for Root Mean Square Error in Calibration (RMSEC) and Root Mean Square Error in Cross Validation (RMSECV). The PLS model was developed from a calibration set (training/evaluation set; Forina *et al*., 2008) composed by 50% of the samples. The PLS model (cross-validated) was then validated on an internal test set composed by the remaining (50%) samples. The partitioning was conducted by using the SPXY algorithm (Harrop Galvao *et al*., 2005) that takes into account the variability in both X- and Y-spaces. The performance of the PLS model with 4 LVs in the determination of ploughing costs showed a correlation coefficient (r) in both calibration/validation and test sets equal to 0.99; these values are very high. The bias value was consistent (-206.98) and considered in correcting the predicted values. The biased observations are well distributed along the bisecting line, indicating a good performance in predicting the ploughing costs using the PLS model.

Results

Listed below for each standard monitored are the values of the economic competitiveness gap obtained by means of the method described above. Due to problems of available space, the discussion and interpretation of the results of each standard are presented in detail in the relative publications.

Standard 1.1a – Temporary water ditches

The economic competitiveness gap varies between € 1.95 and € 2.72 ha^{-1} year^{-1}. Therefore, compliance with the commitment envisaged by this standard imposes an increase in costs that represents a slight economic loss for the farmer.

Standard 1.1c – Cleaning of collector ditches on plains

The economic competitiveness gap varies between € 13.54 and € 26.24 ha^{-1} year^{-1}. Consequently the compliance with the commitments envisaged by this standard represents an economic disadvantage brought about by increased costs.

Standard 1.2g - Minimum soil coverage

The burden for the farmer in the event of having to construct vegetable coverage, is represented by the economic competitiveness gap referring to the year of sowing the vegetation that varies between € 160.50 and € 232.73 ha^{-1}.

Standard 2.1 – Management of stubble and crop residues

With reference to the monitoring, the annual economic competitiveness gap assumes values ranging between -€ 23.36 and -€ 88.27 ha^{-1} year^{-1} for the farmer. This situation always gives rise to a financial loss for farmers acceding to this standard.

Standard 2.2 – Biannual alternation

With reference to the crops grown and the geographic area considered, the annual economic competitiveness gap assumes values ranging between -€ 2.24 and -€ 51.07 ha^{-1} year^{-1}. Therefore, compliance with this standard represents a financial loss caused by a reduction in the gross margin.

Standard 3.1 – Tillage of the soil in appropriate moisture conditions (tempering processes)

The economic competitiveness gap may assume either negative or positive values that vary between -€ 264.85 and € 334.67 ha^{-1} year^{-1} and therefore, depending on the crop grown they can either represent a financial loss (minus sign), or an indirect benefit (plus sign) for the farmer acceding to this standard.

Standard 4.2c - Preventing the encroachment of undesirable vegetation on the agricultural land

The economic competitiveness gap for adopting this standard varies between € 36.55 and € 63.89 ha^{-1} year^{-1}. Observance of the commitment required by the standard configures as an increase in costs for the farmer acceding to the cross-compliance system.

Standard 4.1 – Protection of permanent pastures

In relation to the study cases monitored, the economic competitiveness gap assumes values found between € 16.84 and € 552.26 ha^{-1} year^{-1} which always represent a financial burden for the farmer.

Standard 4.6 – Livestock density 0.2 - 4 UBA ha^{-1} year^{-1}

With reference to the livestock density limits per hectare required by this standard plus the grazing quality of the lands monitored and the rental instalments of the farmland, the economic competitiveness gap may assume either negative or positive values that vary between -€ 86.73 and € 50.93 year^{-1} per head of sheep^{-1}, and therefore they can represent a financial loss (plus sign) or benefit (minus sign) for the breeder acceding to this standard.

Standard 4.3 - Pruning, suckering and trimming of olive trees

The economic competitiveness gap always represents a burden for farmers and in the two monitored studies, it assumes values amounting to € 390.89 and € 843.78 ha^{-1} year^{-1} which correspond to the unit values of € 2.02 and € 3.91 olive tree^{-1} year^{-1} respectively.

Standard 4.3 – Pruning and trimming of vines

In the case study monitored, the economic competitiveness gap is a burden for the farmer and assumes a value equal to € 551.70 ha^{-1} year^{-1} corresponding to € 0.25 vine^{-1} year^{-1}.

Standard 5.2 – Buffer strips

With reference to the crops monitored and the percentage of UAA occupied by the buffer strip, the farmer acceding to this standard undergoes financial losses as the economic competitiveness gap varies between a value close to zero (€ 0.22) and up to € 130.13 ha^{-1} year^{-1}. Concerning the linear development of the buffer strip, the aforementioned values vary between € 0.006 (3-metre-wide buffer strip) and € 0.434 m^{-1} year^{-1} (5-metre-wide buffer strip).

SMR Acts A7 and A8 - Identification and registration of livestock

Act A7 Identification and registration of cattle

With reference to the two case studies monitored, in case of compliance with the standard, the burden on the farmer represented by the economic competitiveness gap varies between € 3.48 and € 4.67 fulfilment^{-1}.

Act A8 Identification and registration of sheep and goats

As regards the case studies monitored and the species considered, the values of the competitiveness gap that represent the cost borne by the farmer due to compliance with this standard vary between € 4.90 (goats) and € 5.27 (sheep) head^{-1}.

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