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Almeida J.P.F., Alberto D., Maçãs B.M.

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Portuguese annual Mediterranean pastures: an economic approach to understand sown pastures failure

J.P.F. Almeida[1,*], D. Alberto[1] and B.M. Maçãs[2]

[1]Escola Superior Agrária – Instituto Politécnico Castelo Branco
Centro de Estudos de Recursos Naturais, Ambiente e Sociedade – CERNAS
Qta Mércules, Apartado 119, 6001 Castelo Branco codex (Portugal)
[2]Estação Nacional Melhoramento de Plantas, Unidade Estratégica de Biotecnologia e Recursos Genéticos,
Instituto Nacional de Investigação Agrária e Veterinária, I.P. Elvas (Portugal)
*e-mail: falmeida@ipcb.pt

Abstract. After Portugal joined the EEC, in 1986, huge land use changes occurred: Cereal crops area was strongly reduced; native pastures (low productive) area sharply increased (2.1 fold); sown pastures (high productive legumes and grasses mixtures) area remain unchanged. Thus, pasture production potential is far from fulfilled. Farmers resist sowing improved cultivars, arguing their low persistency. Therefore we tested the hypothesis that the low persistence of improved cultivars reduces the profit of the sown pastures. Based on experiments data on representative ecological sites – high soil fertility (HSF), medium (MSF) and low (LSF) levels – we determined costs and income for a pastures-cattle system, comparing sown pastures (SP) to natural pastures (NP). Results showed a higher NP profit than SP in all sites. Fertiliser costs (phosphorus – P) were determinant in profit level. The increase from 20% to 30% on the P-uptake efficiency rate induced a higher SP profit than NP, on the HSF and MSF levels. We suggest that SP failure might be due to lower profit. The use of P-fertilisers below the quantity that supports biomass productivity at pasture carrying capacity level could affect persistence and make farmers give up SP techniques.

Keywords. Mediterranean grasslands – Rain fed pastures – Phosphorus uptake efficiency.

Prairies méditerranéens annuelles au Portugal : une approche économique pour comprendre l'échec des pâturages semés

Résumé. *Depuis que le Portugal a rejoint la CEE, en 1986, des changements importants se sont produits dans l'utilisation des terres et leur répartition territoriale. La surface des cultures de céréales a été fortement réduite. Les pâturages naturels à faible productivité ont vu leurs surfaces multipliées par deux alors que les prairies semées, à plus forte productivité potentielle, n'ont pas vues leur proportion augmenter. Ainsi, le potentiel de production des prairies n'a pas réellement augmenté. Les agriculteurs semblent être réticents à utiliser les semis de cultivars améliorés, en faisant valoir leur faible persistance. Dans ce travail, nous avons testé l'hypothèse selon laquelle la faible persistance des cultivars améliorés est la cause de la réduction des revenus que l'on peut espérer tirer de ces prairies temporaires. Nous avons déterminé les coûts de production et les revenus générés pour des systèmes d'élevage bovin au pâturage. Nous avons comparé les pâturages semés (SP) avec de pâturages naturels (NP), en nous basant sur des données expérimentales obtenues sur des sites écologiques représentatifs. Nous avons considéré trois sites en fonction de la fertilité du sol: haute (HSF), moyenne (MSF) et faible (LSF). Les résultats ont montré que le revenu était plus élevé en NP qu'en SP, pour tous les sites. Les coûts des engrais (phosphore – P) ont été déterminants dans le niveau de revenu généré. Dans les sites HSF et MSF, une augmentation de 20% à 30% du taux d'assimilation du P par les plantes permettrait d'augmenter le revenu des SP au-dessus de celui des NP. Nous suggérons que l'échec des SP pourrait être imputable au faible revenu permis en comparaison de celui généré par les NP. L'utilisation d'engrais P en-dessous du niveau permettant la production correspondante au chargement animal possible pourrait affecter la persistance des SP et conduire les agriculteurs à les abandonner.*

Mots-clés. *Prairies méditerranéennes – Pâturages annuels – Efficience d'absorption du phosphore.*

I – Introduction

Three quarters of Portuguese territory is under a Termo-mediterranean climate. Most of its representative soils are shallow, acid and with low organic matter content and water field capacity. Since 1899 until 1986, Portuguese agriculture developed under a protectionism policy based on strong import barriers and subsidised cereal production, independent from ecological limitations to these crops. As a result, soil erosion was high, and even today, its risk is classified from Moderate to High all over the country (European Environment Agency, 2003). In 1986, Portugal joined the European Economic Community. Since then, huge changes in the agricultural production systems occurred: cereal crop areas decreased from 896,507 ha in 1989 to 345,556 ha in 2009; in contrast grassland increased sharply from 828,691 ha in 1989 to 1,738,185 in 2009 (INE, 2012). There has been a clear replacement of cereal marginal areas by natural pastures (1,336,707 ha in 2009, INE, 2012), i.e. rainfed pastures composed of annual native species. Sown pastures (mainly subterranean clover, other annual legumes and ryegrass mixtures), despite having higher productivity than natural pastures (Almeida, 2002), benefitting from Common Agricultural Policy support investment measures, Agri-environment annual payments and Portuguese Carbon Fund payments, decreased from 480,000 ha in 1989 to 401,000 ha in 2009 (INE, 2012). Available cultivars in Portuguese market are mainly from Australian origin, which is likely to explain the low adaption to drought years (Almeida, 2002). Farmers also argue that these cultivars have a low persistence. Persistency of these annual species was suggested to be dependent on high soil phosphorus (P) availability (Bolland and Paynter, 1990; Thomson and Bolger, 1993), which could be explained by low nutrient assimilation efficiency, since P taken up from fertiliser is quite low, i.e. 15% (Isherwood, 2000).

Low persistence of sown pastures could decrease the income and increase investment risk of this pasture system. Therefore we tested the hypothesis that persistence time of improved cultivars significantly reduces the profit of the sown pasture system as compared to the natural pastures. Our main objective was to perform an economic analysis to access the relative importance of the major cost components and income and how variation in cost structure affects profit. Also, since P assimilation efficiency is considered to be very low, we estimated the sensitivity of P fertiliser costs on profit.

II – Material and methods

From a field experiment on comparative pasture production (Barradas, 2009) we select 3 representative ecological sites: Coruche, Elvas and Cercal. Coruche site has low soil fertility (LFS) on a cambisol (dystric), Elvas a medium fertility (MSF) on a Calcic Luvisol and Cercal high soil fertility (HSF) on a Leptosol (Aridic). Natural pastures (NP), fertilised natural pastures (FNP) and sown mixtures of annual clover and ryegrass pasture (SP) productivity was compared (Table 1).

Table 1. Annual rainfall, soil characteristics and pasture productivity of three sites (Barradas, 2009). NP: Natural pasture; FNP: Fertilized Natural pasture; SP: Sown pasture

Site	Annual rainfall mm	pH H_2O	Organic Matter %	P_2O_5 mg/kg	K_2O mg/kg	NP kg DM/ha year	FNP (kg DM/ha year)	SP (kg DM/ha year)
Cercal (HSF)	566	5.3	3.0	80	79	6 145	6 553	10 642
Elvas (MSF)	526	7.2	1.8	42	250	4 999	5 539	9 016
Coruche (LFS)	605	5.5	0.7	10	53	993	1 689	3 902

† Egner-Riehm; DM – Dry Matter.

For each pasture, a specific economic account was developed, after estimating the need for fertilisers, seeds and traction per ha.

From the pastures production averages (Table 1), we calculated stocking rates (Unit Live Stock –UL– per ha) according to Dikman (1998). Applying standard technical criteria (600 kg live weight; 85% cow fertility rate; 400 days parturition interval; 5% young calves mortality; 132 kg carcass weight) to stocking rates, we calculated calf production for each site and pasture type. Supplementation of animals was calculated from each stocking rate, as the difference between daily intake and the observed daily seasonal growth.

Costs and income were estimated using current Portuguese market prices (2013): traction 35 €/hour, 1.19 €/kg N, 1.44 €/kg P_2O_5, 0.46 €/kg K_2O, mixture of annual legumes-ryegrass 125 €/ha, 1 Unit labour 8215 €/year, hay 0.12 €/kg and 4 €/kg carcass; we use the CAP direct payments for Cattle as 200 € per UL. From the pasture accounts and the market prices, we calculated the following economic indicators, in a surface basis (ha): (a) Initial sowing investment (traction, fertilisers and seeds), included in the final cost as a fraction of pasture persistence (10 years by default); (b) Annual costs (fertilizers, traction, labor and animals supplementation, i.e. hay); (c) Income (annual carcass production and CAP direct payments); (d) Profit (Income – Annual costs – Initial investment/persistence); (e) Capital efficiency [Income/(Annual cost + Initial investments/persistence)].

For the cost sensitive analysis, we decreased SP persistence from 11 to 5 years. P fertiliser cost dependency on assimilation efficiency was analysed by recalculation fertilisation quantities after varying the phosphorus efficiency assimilation rate from 20% up to 30%.

III – Results and discussion

At Elvas (MFS) and Coruche (LFS) SP profit was lower than NP and FNP (Table 2). In contrast, in Cercal (HFS), SP profit was at the same level as NP and higher than FNP. However, in all sites, irrespective of soil fertility, SP capital efficiency was always lower.

Table 2. Estimated Economic indicators per hectare. NP – Natural pasture; FNP – Fertilized Natural pasture; SP – Sown pasture

Site	Pasture type	Initial investment	Annual cost	Income	Profit	Capital efficiency
Elvas	NP		51 €	224 €	173 €	4.43 €
Elvas	FNP		88 €	248 €	161 €	2.83 €
Elvas	SP	589 €	202 €	390 €	129 €	1.50 €
Cercal	NP		47 €	275 €	228 €	5.85 €
Cercal	FNP		104 €	294 €	190 €	2.82 €
Cercal	SP	415 €	207 €	477 €	229 €	2.22 €
Coruche	NP		7 €	45 €	38 €	6.83 €
Coruche	FNP		57 €	76 €	19 €	1.33 €
Coruche	SP	478 €	149 €	134 €	-62 €	0.68 €

† Considered as 1/10 (10 years persistence) for profit calculation.

On the other hand, if CAP direct payments are removed from income (data not shown), then SP profit would fall below other pasture types, indicating that SP are more dependent from external subsidies than the other pastures.

Fertiliser costs were the most important in all situations corresponding to: 48% and 51% in Coruche (LFS), 38% and 51% in Elvas (MLS) and 55% and 57%, in Cercal (HFS), respectively to FNP and SP, as a percentage of cost. The high cost of fertilisers could explain the higher profit of NP (no fertilisers) in general, despite the lowest productivity of NP pastures. Avoidance of P fertiliser use by farmers in SP pastures is expected to cause a decrease in productivity, a lower seed production and, therefore, a decrease in cultivar persistence (Bolland and Paynter, 1990; Thomson and Bolger, 1993). The sensitive analysis to a decrease of 5 years in persistence showed a sharp reduction of SP profit -77% at Coruche (LSF), -46% Elvas (MFS) and -18% at Cercal (HFS).

To test the effect of P assimilation efficiency rate of plants on profit, we did a sensitive analysis on this factor. Increasing the assimilation rate from 20 to 30% resulted in an SP profit increase of 31% at Coruche (LSF), 47% at Elvas (MSF) and 10% at Cercal (HSF).

These results clearly show that P nutrition is a major constraint of technical and, thus, of economic results of SP pastures. The option for improvements in P assimilation efficiency has been considered an important issue for plant breeding programs, from the time when the genotype variability was identified in many pasture species (Klimashevsky, 1990).

IV – Conclusions

Our results show that persistence time of improved cultivars reduces the profit of sown pasture systems as compared to natural pastures. Considering ten years persistence, the economic performance of sown pastures was lower than that of natural pastures. These results might explain the decision by farmers to increase natural pasture surface in detriment of sown pastures. P fertilisers seem to be the major constraint of SP development. Therefore, we suggest that improving P plant assimilation efficiency should be a priority of Portuguese pasture plant breeding programmes.

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