

# Transforming food systems: Ethics, innovation and responsibility

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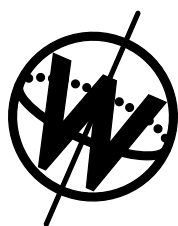


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**P u b l i s h e r s**

## 43. Reducing feed-food competition: impact of by-products and grazing in ruminant feeding

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### Abstract

World population and global food demand are expected to increase in the next decades. Although some improvements have been achieved, livestock sector remains a major contributor to the impacts of agriculture. One of the sustainability themes that has recently seen an increasing interest is the conflict between feeding edible crops to people or to livestock. Large amounts of cereals and legumes used in conventional systems could instead be used more efficiently by monogastric animals or be consumed directly by humans. Therefore, reducing human-edible crops in animals' diets represents a promising way to increase the sustainability of ruminants with noticeable ethical implications. Two indicators are available in literature to assess the potential human-edible content in animal diets. In two experimental trials carried out with dairy cows, these two indexes improved significantly both when hazelnut skin, a by-product from hazelnut industry, was included in the diet of cows and with increasing level of grazing in mountain dairy farms. Ruminants play a major role in food supply chain: thanks to the microbiota in the rumen, they are able to convert fibrous feedstuffs (unsuitable for human consumption) into high valuable and nutrient-dense food (i.e. milk and meat), with increased nutraceutical quality of the products if grass or by-products are used. Moreover, the use of grasslands and pastures by ruminants, especially when land is unsuitable for crop production like in mountain areas, provides ecosystem services. It preserves land abandonment and provides a livelihood for populations living such areas, conserves local traditions and cultural heritage related to cheese-making activity, enriches biodiversity of pastures consequently increasing the accessibility for tourists. Using by-products in livestock diets transforms waste into source of nutrients, feeding the virtuous cycle of circular economy. Confirming previous findings, our results show that both grass-based feeding and use of by-products are effective feeding strategies to make dairy systems more sustainable, considerably reducing the feed-food competition as well as providing ecosystem services with relevant ethical and socio-cultural advantages.

**Keywords:** sustainability, human-edible feed, livestock systems, circular economy

### Introduction

World population is expected to increase in the next decades, reaching 9.8 billion in 2050 (UN, 2019). This trend will bring along increasing global demand of food, including animal-derived products: milk and meat request is reported to increase by 60% in the future (Revell, 2015). Although significant improvements in reducing environmental impacts of livestock activities have been achieved in the past decades (Herrero *et al.*, 2015), livestock sector is a major contributor to the environmental impact of agriculture, due to greenhouse gas emission (Steinfeld *et al.*, 2006). Therefore, it is essential that sustainability guides the development of agriculture and animal productions. However, environmental issue is just one of the several aspects that are involved in the complex concept of sustainability. One of the topics that has recently seen an increasing interest is the feed-food competition (i.e. the use of potential human food in livestock feeding), especially in ruminant nutrition (Wilkinson and Lee, 2018). Worldwide, feeds containing large amounts of cereals and legumes are used in conventional systems to meet high nutrients' requirements of high producing cows. However, cereal grains and legumes seeds

could be used more efficiently by monogastric animals or be consumed directly by humans. On the other hand, ruminants, thanks to their microbiota in the rumen, are able to use fibrous feedstuffs that are unsuitable for human consumption, converting them into high valuable and nutrient-dense food (i.e. milk and meat) (Eisler *et al.*, 2014). Reducing the inclusion of human-edible crops and feedstuffs in animals' diets leads to a decrease in food–feed competition, representing a promising way to increase the sustainability of ruminants' production (Schader *et al.*, 2015).

## Assessing feed–food competition at farm level

In livestock sector, feed efficiency refers to the capability of animals to produce high output (milk and meat) by using low input (feed). However, this index does not consider the type of feed fed to animals, but only its amount. In order to assess the feed–food competition at farm level, it's necessary to quantify the potential human-edible content in animal diets.

Two indicators are available in literature for that aim. The human-edible feed conversion efficiency (heFCE) is defined as the ratio between human-edible output in the form of animal products and the potential human-edible input via feedstuffs (Ertl *et al.*, 2015). Similarly, net food production (NFP) is calculated as the difference between the human-edible content in the milk (or meat) and the potential human-edible content in the feed consumed (Ertl *et al.*, 2016). The two indexes are expressed on a crude protein (CP) and gross energy (GE) basis. The feed–food competition indicators were determined in two different experiments. In a first study, the inclusion of hazelnut skin (HS), a by-product from hazelnut industry, was evaluated as a source of nutrients for lactating cows, replacing part of the concentrate (Renna *et al.*, 2020). Although the inclusion of HS in the treated group represented a small percentage of dry matter intake (about 6%), the cows fed with HS showed higher heFCE (CP: +21% and GE: +24%) and higher NFP (CP: +128% and GE: +149%) compared to control group (Figure 1).

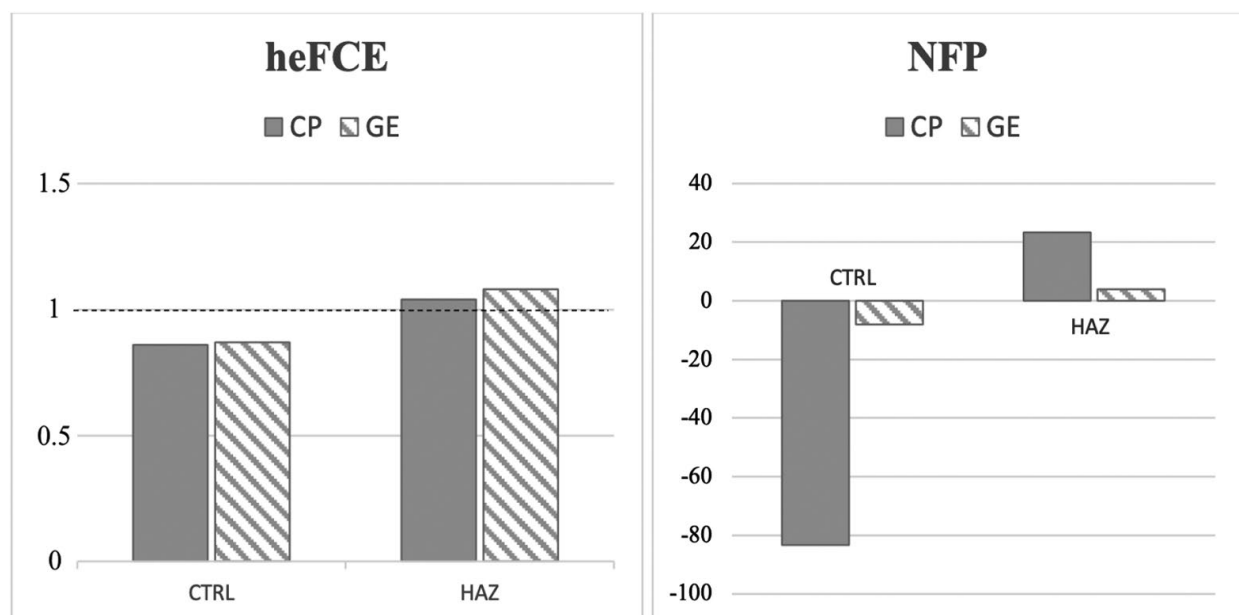


Figure 1. Human-edible feed conversion efficiency (heFCE) and net food production (NFP) for crude protein (CP) and gross energy (GE) of cows fed the control (CTRL) and hazelnut skin (HAZ) diets; the dashed line in heFCE sets at 1.0 indicates the efficiency threshold.

**Section 5**

In a second study, four scenarios of mountain dairy farms characterized by different use of environmental resources were compared (Verduna *et al.*, 2020). With increasing level of grazing as main feed ingredients in cows' diet (during the favorable season around the farm and at Alpine pastures on summer) the two indicators improved progressively. Compared to the indoor feeding in winter season, heFCE showed 5.3 to 8.2-fold increase for CP and 9.3 to 14.3-fold increase for GE (Figure 2). Similarly, NFP for protein and energy resulted negative in the indoor feeding scenario, showing that the cows during the winter season consumed more human-edible protein and energy than they produced in the milk.

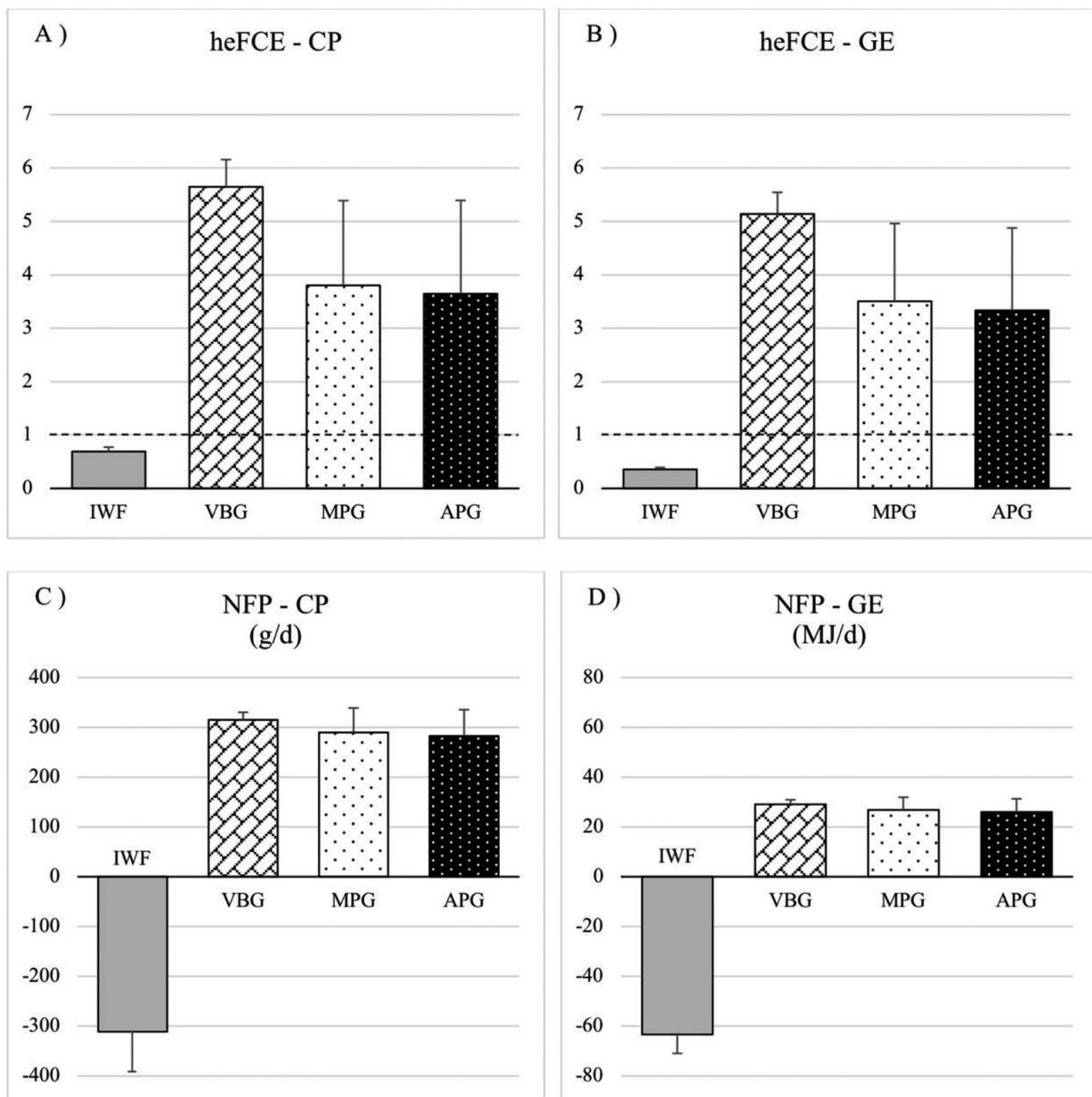


Figure 2. Human-edible feed conversion efficiency (heFCE) (A,B) and net food production (NFP) (C,D) for crude protein (CP) and gross energy (GE) comparing the four scenarios (IWF, Indoor Winter Feeding; VBG, Valley Bottom Grazing; MPG, Mountain Pasture Grazing); the dashed line in (A) and (B) sets at 1.0 indicates the efficiency threshold.

## Reducing feed-food competition: an ethical responsibility

The two above-mentioned studies confirm that livestock systems based on grazing and use of by-products are able to reduce the feed-food competition without impairing productive performance of the animals. If this is a significant result from a zootechnical perspective, there are also additional ethical remarks that are worth to be highlighted.

From an environmental point of view, ruminants produce food by using marginal lands that cannot be cropped (Mottet *et al.*, 2018). Well-managed grazing activities in marginal land and mountain areas prevent hydrogeological disruption and landscape degradation by increasing the cover and abundance of perennial grasses and thus reducing soil erosion (Teague and Kreuter, 2020). Sustainable grazing strategies have long-term biodiversity benefits: selective defoliation due to dietary choices, treading and nutrient cycling maintain and enhance structural heterogeneity of sward, and thus botanical and faunal diversity (Fraser *et al.*, 2014). The production of food through pastoral resources also has evident repercussions on the containment of GHG emissions through the action of carbon sinks in the soil (O'Mara, 2012). Similarly, agro-industrial by-products are addressed as innovative raw materials to be used in feed formulations for livestock animals to reduce the environmental impact of animal-derived food production: recycling agricultural wastes in animal feeding represents a concrete opportunity for realizing circular economy in agriculture and thus creating sustainable agricultural systems (Halmemies-Beauchet-Filleau *et al.*, 2018).

From a social perspective, agricultural activities in marginal areas provide a livelihood for those areas' populations, for which agro-pastoral activities are often one of the few only feasible economical activities. This is even more relevant because rural and marginal mountain areas have been strongly affected by depopulation over several decades (Bätzing *et al.*, 1996). Moreover, sustainable agriculture is recognized as an effective way to safeguard local farming traditions and cultural heritage, especially traditions linked to pastoralism activity, cheese-making, etc.

Concerning the quality of the products obtained through grass-based systems, grazing and consumption of fresh grass are known for their beneficial effects on the nutraceutical properties of derived products. Pasture feeding has been demonstrated to have a positive impact on the nutrient profile of milk, increasing the content of some beneficial nutrients such as omega-3 polyunsaturated fatty acids, vaccenic acid, and conjugated linoleic acid (Joubran *et al.*, 2021). Similarly, vegetable by-products have considerable amounts of bioactive components such as polyphenols, including tannins, and vitamins. These compounds, when included in animals' diets, have positive effects on productive performance and improve the quality of livestock products, especially increasing their oxidative stability (Kasapidou *et al.*, 2015).

Finally, outdoor farming systems, if properly managed, have been demonstrated to increase animal welfare (Spigarelli *et al.*, 2020). Grazing and extensive systems allow animals to behave in a more natural way. Walking on pasture induce positive modifications of the animal's metabolism, with beneficial effect on animal's health, as well as reducing hock damage, lameness, and claw disorders. As previously mentioned, several vegetable wastes are rich in compounds that enhance the quality of milk and meat. Moreover, the same bioactive substances are also able to positively affect animals' health: polyunsaturated fatty acids, vitamins, and antioxidants introduced with the diet support animals' health improving immune response, reducing inflammatory processes, and enhancing the antioxidant status of animals (Salami *et al.*, 2019).

## Section 5

### Conclusions

Confirming previous findings, our results show that both grass-based feeding and use of by-products are effective feeding strategies to make dairy systems more sustainable, considerably reducing the feed-food competition as well as providing ecosystem services with relevant ethical and socio-cultural advantages.

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