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Durum wheat production chain: research, quality and future challenges

Maroun Atallah, Cesare Ronchi, Marco Silvestri, Luca Ruini

Barilla G e R Fratelli Società per Azioni Socio Unico. Parma, Italy

Abstract. Barilla ranks as one of today's top Italian food groups, leading in the global pasta business, the pasta sauces business in continental Europe, the bakery products business in Italy, and the crispbread business in Scandinavia. Being the first user of durum wheat worldwide for its pasta production, Barilla focused its research activity, since more than 20 years ago, on durum wheat breeding to meet its needs in terms of quality for pasta manufacturing. Moreover, the limited availability of durum wheat at the global level, compared to the other major cereals, led Barilla to adopt an integrated approach to manage its production chain from the field to the finish product.
Recently, Barilla has carried out a study on the environmental impacts of pasta conducted with the life cycle assessment methodology, through the publication of the Environmental Product Declaration. The study showed that, through durum wheat production chain, the cropping system is responsible for more than 80% of the ecological footprint, approximately 60% of the carbon footprint and almost for the entirety of the water footprint.
As a consequence, Barilla launched a specific project, the "Barilla Sustainable Farming" with the aim to increase the widespread use of sustainable cropping systems. The project has been focusing on identifying potential improvements of the most diffused cropping systems for the cultivation of durum wheat in Italy, maintaining high levels of quality and plant health conditions.

Keywords. Durum Wheat – Pasta – Breeding – Integrated chain – Sustainability.

Chaîne de production du blé dur : recherche, qualité et défis de demain

***Résumé**. Barilla est classé parmi les principaux groupes alimentaires italiens d'aujourd'hui, leader dans le secteur mondial des pâtes, dans le secteur des sauces pour pâtes en Europe continentale, dans le secteur des produits de boulangerie en Italie, et le secteur des biscottes en Scandinavie. Etant le premier utilisateur de blé dur dans le monde entier pour sa production de pâtes, Barilla a concentré son activité de recherche, depuis plus de 20 ans, sur l'amélioration du blé dur pour satisfaire ses besoins en termes de qualité pour la fabrication de pâtes. En outre, la disponibilité limitée de blé dur au niveau mondial, par rapport aux autres principales céréales, a conduit Barilla à adopter une approche intégrée pour la gestion de sa chaîne de production du champ au produit fini.*

Récemment, Barilla a réalisé une étude sur les impacts environnementaux des pâtes basée sur la méthodologie d'évaluation du cycle de vie, pour la publication de la Déclaration Environnementale de Produit. L'étude a montré que, tout au long de la chaîne de production du blé dur, le système de culture est responsable de plus de 80% de l'empreinte écologique, d'environ 60% de l'empreinte carbone et presque pour la totalité de l'empreinte eau.

Par conséquent, Barilla a lancé un projet spécifique, "L'agriculture durable Barilla" dans le but de promouvoir l'utilisation généralisée des systèmes de culture durables. Le projet a mis l'accent sur l'identification des améliorations potentielles des systèmes de culture les plus répandus pour le blé dur en Italie, en maintenant des niveaux élevés de qualité et de conditions phytosanitaires.

***Mots-clés.** Blé dur – Pâtes – Sélection – Chaîne intégrée – Développement durable.*

I – Introduction

The major use of durum wheat is for pasta production, particularly in the European and North American countries, whereas in other areas, such as the Middle East and North Africa, it is also used to make couscous, and for baking various types of bread (Troccoli *et al*., 2000).

In Italy, Pasta can be made with durum wheat semolina and water only, according to the Italian Law No. 580, 1967. Therefore, being the only ingredient used beside water, the semolina quality has a significant impact on the finished product quality. A high-quality pasta begins with good quality grain. The protein content and the gluten quality are the most important variables in determining the pasta cooking quality (D'Egidio. *et al.*, 1990; Novaro *et al.*, 1993). A good quality cooked pasta maintains a good texture, being resistant to surface starch leaching and stickiness, and retains a firm structure of "*al dente"* consistency. The Bright Yellow color of semolina is an important factor in high quality pasta manufacturing. This color is the result of the natural carotenoid pigments present in the kernel (Cubadda *et al.*, 1988).

II – Barilla "Integrated supply Chain" model

The production chain is a complicated network of interconnected businesses and activities related to the production and sourcing of raw materials, their processing towards finished products and distribution.

The continuous improvement of the sustainability of Barilla's strategic supply chains is implemented through projects and initiatives, developed together with partners along the supply chain.

Concerning durum wheat, Barilla operates by integrating the various stages of the production chain to create an "Integrated Supply Chain" model. Unlike the conventional supply chain concept where players follow each other in a top-down flow, Barilla's supply chain model has a circular structure in which players that operate at different stages are involved in a shared project that is focused on the same objective. Barilla's durum wheat breeding program, in collaboration with the breeding Company Produttori Sementi Bologna (PSB) represents the first step of this model: new and dedicated durum wheat varieties are developed to meet the production requirements and Barilla's quality standards (e.g., Svevo, Normanno and Aureo). The innovation embedded into new high quality varieties is transferred to farmers through the seeds, provided under cultivation agreements with Barilla, which uses the durum wheat produced for its pasta production closing the integrated supply chain.

Through a mutual collaboration among the production chain players, Barilla aims to manufacture safer, superior and more sustainable products.

III – Sustainability of the Barilla integrated supply chain

In order to assess the environmental impact of its production chain, Barilla carried out a Life Cycle Assessment analysis (LCA), using Carbon Footprint, Water Footprint and Ecological Footprint as indicators.

Barilla carried out this study at first on durum wheat pasta to evaluate the footprints of durum wheat cultivation and milling, pasta production, transport, packaging production and cooking for consumption. Results of this study have been published on durum wheat semolina dry pasta Environmental Product Declaration (EPD) (Ref. International EPD Consortium and EPD of durum wheat semolina dried pasta Barilla) (Fig.1).

The study underlined that the cultivation stage of durum wheat is the most significant in terms of emissions together with pasta cooking. The manufacturing of the packaging and transport contribute the least to greenhouse gas emissions (less than 5% each). The major impacts associated with farming activities are due to the use of nitrogen fertilizers and mechanical operations, particularly for working the land. More information on Barilla's activities, related to sustainability, is reported in the Sustainability report of the Company.

Figure 1. Life Cycle Assessment results of durum wheat pasta

IV – Barilla Sustainable Farming

Since it has been widely demonstrated that farming generates the most of pasta environmental impact, Barilla undertook a specific project using LCA methodology to analyze different cropping systems for durum wheat production. Carbon, water and ecological footprints were integrated with specific economic and agronomic indicators, in order to provide guidance on the "sustainability" - including the "feasibility" - of cropping systems that can represent alternatives for the cultivation of durum wheat in Italy, maintaining and improving quality and food safety standards of the products.

The system boundaries includes important elements, such as crop rotation, tillage activities, crop yields, fertilizers, herbicides and pesticides use, including relative emission to air, and water.

The durum wheat cultivation was analyzed by identifying different cropping systems currently followed in the three main geographical Italian areas: Northern Italy, Central Italy, and Southern Italy. The standard cropping system is a four-year rotation in which the cultivation of different crops, other than durum wheat, are involved.

The results of this study were published in the *Handbook for sustainable cultivation of quality durum wheat in Italy*, which was distributed to farmers. This document is intended as tool to disseminate knowledge and practical suggestions. It contains several guidelines concerning issues of crop rotation, soil tillage, nitrogen fertilization, sowing, and weed and pest management (*Barilla's Handbook*).

According to the *Handbook*, selecting appropriate *crop rotation* is a key issue for the sustainability of a farming system. When cultivating durum wheat it is best to avoid cereals as the preceding crop because the cultural residues of such crops are a favourable habitat for the fungi that propagate mycotoxins (i.e., deoxynivalenol**,** DON). Cultivation of a legume crop is recommended whenever possible insofar as it is able to fix the atmospheric nitrogen in the soil and, therefore, allow reduction of additional fertilizers required for crop growth in the following year.

Tillage is another important aspect both for the environmental and economic impacts which are mainly linked to diesel fuel use. The hilly central regions of Italy have a tradition of plowing yearly, which increases risk of erosion and costs due to fuel. Plowing, however, is not necessary for all

cases, and minimal or no tillage could be a valid solution to reduce environmental impacts and increase profitability. In areas with high risk of mycotoxins, such as Northern Italy, this solution cannot be implemented because plowing helps reduce mycotoxins.

The use of *fertilizers* is another key issue given the high impacts on both the production and use phase. Nitrogen fertilization causes the emissions of the greenhouse gas N_2O, and so certain factors must be contemplated, such as the timing of treatments, the quantity of nitrogen distributed in fields, and excessive and often unnecessary use of fertilizer applications during pre-sowing.

Seeding can indirectly influence the indicators considered because seeding time, rate and variety can affect the yield, which is the parameter by which the impacts of one hectare are divided by and hence "diluted".

This same reason also makes it important to undertake prompt and effective *management of weeds and pests* for sustainable crop production.

In 2011 – 2012, Barilla launched a specific project called "Barilla Sustainable Farming" with the aim to increase the widespread use of sustainable cropping systems. Thirteen farms (4 in Lombardia, 1 in Toscana, 6 in Marche and 2 in Puglia Regions) are involved in the project activities.

Farmers were asked to make a comparison of two different durum wheat crop management systems:

1. Usual and traditional crop management (own choices and strategies); and

2. Crop management implementing the Barilla's Handbook.

The results were very positive. By choosing implementing the handbook's recommendations, Farmers obtained an increase in yield (up to 20%), a reduction in carbon footprint (up to 36%), and in direct production costs (up to 31%).

Currently, in the 2012 – 2013 campaign, a second year of trials involves 25 farms and the results will be coming out soon with the next harvest. The objective for Barilla is to buy in the coming years, an ever increasing amount of durum wheat grown according to the identified sustainable farming techniques. The project is going be extended to other countries and to other strategic raw materials such as soft wheat, rye, and tomatoes. Furthermore, a prototype "*Decision Support System*" via web (www.granoduro.net) has been developed by Horta s.r.l (spin-off company of the University of Piacenza, http://www.horta-srl.com.) to provide wider assistance to Farmers. Also, the prototype can help to further reduce costs and environmental impacts.

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