

Review

Italian Ancient Wheats: Historical, Agronomic, and Market Characteristics: A Comprehensive Review

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Abstract

Ancient wheats can be understood as dynamic populations of historically cultivated wheat, which, unlike modern varieties, have not been developed through organised genetic improvement programmes, but rather through traditional farmer selection and local adaptation over centuries. Recently, ancient wheats have enjoyed renewed popularity, particularly in Italy, due to their wide genetic diversity and the significant role of wheat and its derivatives (e.g., bread, pasta, and baked goods) in the country's culinary and cultural heritage. However, information on the characteristics of Italian ancient wheats remains limited and fragmented. Therefore, this review aims to collect, organise and compare the available evidence on the historical, agronomic, economic and sustainability parameters of ancient wheats, in order to provide an overall assessment of these varieties. The results showed that 34 Italian ancient wheats were studied, mainly from Tuscany and Sicily. With plant heights of up to 180 cm and yields of 1.4–4.8 t/ha, ancient wheats are characterised by greater height but lower productivity compared to modern wheats. They demonstrate good adaptability to poor soils and climatic stress, natural competitiveness with weeds and potential resistance to pathogens, rendering them suitable for sustainable, low-input agricultural systems. Furthermore, ancient wheat flours cost more than twice as much as commercial flours, with average prices of €3.00–5.10/kg, mainly due to artisanal production methods and belonging to short or niche supply chains. Finally, considerable variability in test weight (TW) and thousand kernel weight (TKW) could negatively affect flour or semolina yields. In conclusion, despite their low productivity, ancient wheats could offer significant opportunities in terms of environmental sustainability and biodiversity conservation, proving to be a strategic resource for more resilient and sustainable agriculture.

Keywords: ancient wheats; Italy; cereals; biodiversity



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1. Introduction

From a subjective point of view, the term ‘ancient wheat’ may conjure up images of centuries-old traditions, as it refers to a group of wheats and landraces that have been cultivated since classical antiquity and before the Green Revolution [1]. While there is no official definition of ancient wheat, it is generally accepted that these varieties have remained essentially unchanged over centuries of cultivation. Unlike their more modern counterparts, they have never been subjected to modern genetic selection programmes [2]. Some studies [3–5] suggest that ancient wheats could offer a more nutritious and healthier profile than

currently cultivated grains, boasting higher levels of micronutrients, vitamins, minerals, and nutraceutical compounds. However, other studies, such as Cattivelli (2023) [6], show that the superior nutritional value of ancient wheats is not clear-cut. However, interest in ancient wheats may also reflect broader cultural and socio-economic dimensions linked to their historical roots and symbolic value within local communities. In recent years, in line with the European Union's approach to participatory conservation of plant genetic resources, citizens, custodian farmers and local communities in Italy, a country particularly rich in ancient wheats, have become increasingly involved in safeguarding agrobiodiversity. Not only could their active participation in maintaining and promoting local wheat landraces help preserve genetic diversity, but it could also strengthen the cultural identity and territorial heritage associated with traditional Italian cereals. However, it is also important to consider these dynamics in the context of the global relevance of wheat production and consumption. Wheat is a staple food for almost one-third of the global population, serving as a primary source of daily energy intake and thus being relevant to global food security. In fact, wheat production amounted to 0.73 billion tons (26.3% of global cereal production) in the 2022–23 marketing year, making it the third most cultivated cereal after maize (1.15 billion tons, 41.5%) and rice (0.77 billion tons, 27.8%) [7,8]. Around 95% of wheat production comprises soft wheat (*Triticum aestivum* L.) [9], which is particularly used in the Mediterranean region for products such as bread and pizza. The remaining share is made up of durum wheat (*Triticum turgidum* L. spp. durum), which is mainly used for pasta production.

From a nutritional perspective, wheat provides essential nutrients, including dietary fibre and bioactive compounds, particularly when consumed in its wholemeal form [10]. Regularly including wholemeal grains in one's diet has been consistently associated with reductions in major cardio-metabolic risk factors such as total cholesterol, triglycerides, blood glucose, blood pressure and body mass index (BMI) [11], as well as a lower incidence of coronary heart disease [12]. These protective effects are attributed to wheat's complex grain structure, fibre content, phytochemical profile, and balance of amylose and amylopectin [13]. However, given the recent global increase in mortality from chronic diseases related to nutrition and diet [14], it is important to improve the nutritional quality of wheat. In this regard, ancient wheat may represent a valuable opportunity.

In recent years, ancient wheats have received increasing attention in food applications and experienced a resurgence in popularity, as evidenced by a large body of scientific research [15–18]. This is probably due to the search for healthier and more diverse food options, reflecting consumer demand for higher-quality, more sustainable and more natural products. This has renewed farmers' interest in cultivating them in different countries around the world [1,19], which is why it is useful to examine their characteristics, peculiarities, advantages, and disadvantages from multiple perspectives. This is particularly significant in the case of ancient Italian wheats, given the important role that wheat and derived products play in Italy, both economically and nutritionally. Despite their popularity and usefulness, information on Italian ancient wheats is currently limited, fragmented and scattered. Therefore, this review aims to collect, organise, and compare the available information on the quality, sustainability, economic parameters, and agronomic characteristics of Italian ancient wheats to provide an overall assessment. This could contribute to expanding the knowledge base on these wheats and offer a more structured, in-depth view of their characteristics. An attempt was therefore made to answer two research questions (RQs):

1. RQ1: What are the characteristics of Italian ancient wheats, also compared to modern ones?

2. RQ2: How can the valorization of Italian ancient wheats contribute to the sustainability and competitiveness of national cereal supply chains, with particular reference to the production of pasta and bread?

There are two main reasons for the decision to study ancient Italian wheats:

- (i) Durum and soft wheat represent the main raw materials for the production of pasta and bread, respectively, two foods that are deeply rooted in Italian culture and are the basis of the Mediterranean diet. Considering pasta, globally, it represents one of the main emblematic expressions of ‘Made in Italy’ and is characterized by a well-defined profile in which one can recognize high professionalism, high know-how, work, knowledge, and quality of extraordinary value. Similarly, soft wheat reinforces Italy’s rich tradition of bread and bakery products, which hold both nutritional and cultural significance. For these reasons, there could be a certain interest in improving the knowledge base regarding the healthiness, quality, and sustainability of wheat.
- (ii) In Italy, wheat cultivation involves a total of 2.35 million hectares, between soft and durum wheat, for a production of 6.60 million tons [20], making it one of the countries most involved in wheat cultivation at a European level.

Unlike previous articles and reviews [21–23] that have mainly focused on the genetic or nutritional aspects of ancient wheats and a limited number of cultivars, this article stands out by focusing on ancient Italian wheats. It systematically collects, organises and integrates historical, agronomic, economic and sustainability information on more than thirty varieties of ancient wheats. This work brings together fragmentary data from numerous sources for the first time, many of which are only available in local literature or not in English. This provides an important, up-to-date, and accessible knowledge base on Italy’s cereal heritage. The wealth of material it contains contributes to offering a broader and more representative picture of traditional varieties, promoting their value as resources of interest for agricultural sustainability and biodiversity conservation. Therefore, this review could fill an information gap in the international literature and offer useful insights to agronomists, researchers and industry professionals interested in the sustainable management and promotion of these crops.

2. Origin and History of Ancient Wheats

There is currently no universally recognised definition to distinguish so-called ancient wheats from other wheat varieties. There is also no official statistical data available on the cultivation and production of ancient wheat; only information made available by private parties interested in cultivating it is currently in circulation. Pending an agreed agronomic or legal definition, ancient wheats can be understood as dynamic wheat populations of historical origin, characterised by a distinct identity and an absence of genetic improvement through modern crossbreeding programmes [19]. More generally, although this classification is strongly contested by those who cultivate true ancient wheats and is convenient for those who have conducted or are conducting commercial operations with them, the term ‘ancient wheat’ tends to refer to all ancient cereals cultivated before the Green Revolution [24], initiated in 1944 by the Rockefeller Foundation [25], which financed early projects in Mexico aimed at increasing agricultural production. New wheat varieties have been created that offer numerous advantages, including higher yields, reduced vulnerability to disease and pests, uniform ripening across the field, and a high gluten content (which improves the rheological properties of bread and pasta) [26].

However, while the Green Revolution and genetic improvement programmes have produced numerous benefits in terms of food security, they have also unintentionally led to a reduction in genetic diversity and a loss of nutritional properties in wheat [19]. Before the Green Revolution, each region cultivated ancient wheat varieties that had adapted to

their local terrain and climate over the years. However, over the last century, around 75% of the genetic diversity of agro-biodiversity has been lost as farmers around the world have abandoned their local and native varieties in favour of genetically homogeneous, high-yielding strains [27]. This is because modern grains have been placed at the centre of the agri-food chain by industrial logic, as they ensure shorter working times, and almost all producers tend to prefer them to ancient wheat. Consequently, they are commonly referred to as ‘ancient wheats’ to distinguish them from modern varieties, which were developed to meet the demands of the food industry. In Italy, in particular, there is a wide variety of ancient wheats, descended from soft and durum wheat, which have remained unchanged since they were first documented or selected. These range from early records dating back to classical antiquity (e.g., Timilia, mentioned by Theophrastus and Pliny the Elder in 322–79 BC), to cultivars officially bred in the late 19th and early 20th centuries. Sicily, the southernmost region of Italy, is the region most involved in the cultivation of ancient wheats. With 806,284 tons of durum wheat and 350 tons of soft wheat produced, it ranks as the second largest wheat-producing region in the country after Puglia [28].

Due to its location in the heart of the Mediterranean, Sicily has a subtropical climate with semi-desert features. This climatic condition has played a key role in the evolutionary history of wheat, acting as a crossroads, particularly with regard to its significance as a food source, connecting Asia, Africa, and Europe [29]. Currently, 57 local varieties of wheat are cultivated in Sicily, compared to a regional heritage of 124 potential ancient wheat varieties. Furthermore, 27 cultivars, accounting for half of the national total, are officially listed in the Registry of Conservation Varieties, a national database overseen by the Ministry of Agriculture. The registry was created to promote the traceability and legal recognition of authentic ancient wheats, enabling custodian farmers to market certified seeds commercially while preserving agrobiodiversity.

The Registry of Conservation Varieties was created under Directive 98/95/EC, implemented in Italy by Legislative Decree 212/2001. According to this decree, conservation varieties include all populations, landraces, clones, and cultivars of agricultural interest that meet at least one of the following criteria:

1. Autochthonous or allochthonous varieties not previously included in national registers but integrated into local agroecosystems for at least fifty years.
2. Varieties no longer listed in official registers and at risk of genetic erosion.
3. Varieties no longer cultivated in Italy but preserved in germplasm banks, botanical gardens, or research centers, whose reintroduction is justified by economic, scientific, cultural, or landscape interest.

However, despite the existence of this registry, there is still no comprehensive or official list that clearly enumerates and defines Italian ancient wheats.

The current listings are fragmented across multiple documents and regional inventories, which often overlap or apply different classification criteria. This fragmentation makes it difficult to establish a unified national framework for identifying, conserving, and valorizing ancient Italian wheats.

3. Ancient Wheats Characteristics

3.1. Geographical Distribution and Historical Characteristics

From what has been found in the literature, research on scientific databases has shown that the Italian ancient wheats considered are those listed in Table 1.

Table 1. Ancient wheats found in the literature review. Type, origin, pedigree, and main uses.

Genotype	Synonyms/ Traditional Names	Origin Region	History and Pedigree	Refs.	Traditional Use
Soft wheat (<i>T. aestivum</i> . spp. Aestivum)					
Andriolo	No well documented synonym	Tuscany	Tuscan wheat selected in 1945	[30]	Bread and focaccia
Autonomia B			Established in 1942 by Marco Michahelles at the Fontarronco Estate (Arezzo) from the cross Frassineto 405" × Mentana	[31]	Breadmaking, flours
Benco			No information available on historical origin	[32]	Not documented
Bianco nostrale			Not well-known origin. Resistant to allurement and rust. Large plants, white aristate spikes, light red caryopses.	[33]	Traditional Tuscan white bread and rustic biscuits
Frassineto			Selected in 1922 at Frassineto (Tuscany) from Gentil Rosso. Still cultivated in Arezzo and Val di Chiana	[34,35]	Tuscan bread, schiacciata, local pastries
Gentil Bianco			Not well-known origin. It is estimated to be indigenous to Tuscany	n.a.*	Not documented
Gentil Rosso			Obtained in the mid-1800s, originating in central Tuscany	[36]	Soft wheat bread, cakes, and biscuits
Inallettibile			Dating back to 1920. Native to southern Tuscany, now grown across northern and central Italy	[36]	Bread and pizza
Sieve			Created in 1953 by Prof. Gasparini of Florence, it is indigenous to Tuscany, where it is still cultivated today.	[16]	Bread and pizza
Verna			Obtained in 1953 from Est Mottin 72 × Mont Calme 245. Grown in Casentino, Val di Chiana, and Val d'Orcia (Tuscany).	[34]	Organic wholemeal bread, pane Verna
Maiorca	Majorca	Sicily	Wheat was reported as far back as 1696. Currently grown in Agrigento, Caltanissetta, Enna, Palermo, Ragusa, Siracusa, and Trapani	[37–39]	hosts, bread, "Ciambella di San Cataldo", Sicilian cannoli pastry
Maiorcone	no well documented synonym		Cultivated for centuries in Sicily, mainly in arid and marginal areas of Agrigento, Caltanissetta, Catania, Enna, Messina, Siracusa, and Palermo provinces.	[40]	Bread and artisanal pasta

Table 1. Cont.

Genotype	Synonyms/ Traditional Names	Origin Region	History and Pedigree	Refs.	Traditional Use
Rieti originario	No well documented synonym	Lazio	Writings from the early 1900s date its origin to the second half of the 1800s, particularly in the Rieti plain	[41]	Breadmaking
San Pastore			Made in 1929 by Nazareno Strampelli. Registered as ‘Bruno’ in 1940 and then ‘San Pastore’ in 1946, it is named after the Rieti company where Strampelli carried out his first experiments, while Bruno is the name of one of Mussolini’s sons	[42]	Breadmaking
Solina D’Abruzzo		Abruzzo	Cultivated at least since the 16th century, it is mentioned in some notarial deeds of purchase and sale stipulated at the Lanciano Fair. Currently cultivated in the Marsica, Peligna and Subequana Valleys	[43–45]	Mountain bread, pane di Solina, rustic sweets
Carosello		Basilicata, Campania	It was cultivated at the end of the 19th century in many areas of Cilento (Campania) and southern Italy.	[46]	Bread and traditional pizza flours
Terminillo		Emilia-Romagna	Selected in 1907 by Nazareno Strampelli from a rye × ‘Rieti’ backcross. Cultivated between 1913–1934 in high hill and mountain areas for its cold resistance.	[47]	Breadmaking
Gamba di Ferro		Emilia-Romagna/Tuscany	Typically cultivated in the Tuscan-Emilian Apennines until the middle of the last century	[32]	Breadmaking
Jervicella		Marche	Selected in the Marche region in the 1940s from the landrace Gentil Rosso.	[48,49]	Traditional Marche bread (pane di Jervicella)
Carme Jacometti		Piedmont	Created in 1942 as a cross between ‘Villa Glori’, Strampelli’, and ‘Manitoba’.	[50]	Breadmaking, pizza
Canove		Veneto	It was cultivated on the ‘Altopiano dei Sette Comuni’ in the early 1900s	[51]	Breadmaking, household use
Aquilante		not documented	No information available on the historical origin	[16]	not documented

Table 1. Cont.

Genotype	Synonyms/ Traditional Names	Origin Region	History and Pedigree	Refs.	Traditional Use
Durum wheat (<i>T. turgidum</i> spp. Durum)					
Biancolilla	Biancuccia/ Bianculidda	Sicily	Wheat originated in the areas of Salemi and Marsala (province of Trapani), with the main information coming from the website of a Sicilian mill, as no official data on the year of origin has been found.	n.a. *	Bread and homemade pasta (e.g., busiate)
Bidì	Margherito/ Marrone/ Mahmoudi		Tunisian in origin. Introduced to Sicily by Prof. Tucci. According to E. De Cillis, it shares genetic kinship with Senatore Cappelli, regarded as its progenitor	[52]	Pasta
Bufala nera	No well documented synonym		Until the 1970s, it was cultivated in the most inland and mountainous areas in Cesarò, Bronte and Randazzo (province of Catania) and in Novara di Sicilia (province of Messina)	[53]	Wholemeal bread and artisanal pasta
Perciasacchi	Farro Lungo, Perciavisazzi, Gnolu, Farrone, Settecentanni		No official documentation. Local milling websites date its cultivation to at least 1809.	n.a.*	Wholemeal bread and artisanal pasta
Realforte	No well documented synonym		No official records. Milling websites report cultivation as early as 1830	[54]	Artisanal pasta
Russello	Rossello/ Ruscio/ Russieddru		It was cultivated in Sicily as early as the early 1900s, especially in the western areas of Agrigento, Caltanissetta, and Palermo	[55]	bread, pizza, focaccia
Scorsonera	Scorzonera		No official information has been found about its history.	[54]	not documented
Timilia	Tumminia, Tûminia Nigra, Trimminia, Tummulia, Diminia, Diminè, Rìminia, Marzuddu		A native Sicilian variety mentioned as early as Theophrastus (322 BC) and Plinio the Elder (23–79 AD). Currently cultivated in the areas of Agrigento, Enna, Messina, Palermo, Ragusa, and Trapani	[56]	“Pane nero di Castelvetro” and “Pane di Monreale”
Tripolino	Azizia/ Gargaresc/ Eiti/ Tripolone	Abruzzo	Libyan landrace of Palestinian origin	[54,57]	Artisan pasta and semolina bread
Saragolla	No well documented synonym		Introduced to Abruzzo by Balcanian populations in 400 AD. Cultivated in northwestern Basilicata and Abruzzo.	[58–60]	Pasta (“sagne”), and wholegrain bread

Table 1. Cont.

Genotype	Synonyms/ Traditional Names	Origin Region	History and Pedigree	Refs.	Traditional Use
Senatore Cappelli	Cappelli	Apulia	Developed in 1915 by N. Strampelli at the Foggia Cereal Research Center from North African wheat Jenah Rhetifah (genealogical selection n° 231/1915).	[61]	Artisanal pasta, bread
Marzuol D’Aqui	Marzuolo D’Aqui	Tuscany	Cultivated in the upper Garfagnana (province of Lucca) until the 1970s–80s, it is of unknown origin	[62]	Ferratelle abruzzesi, Bread and rural bakery

* n.a. = not available.

In total, the literature has shown studies on 34 ancient wheats. At a territorial level, the two regions most affected are Tuscany and Sicily (Figure 1), with eleven varieties each.



Figure 1. Geographical distribution of Italian ancient wheats.

They are followed by Abruzzo (2), Lazio (2), Apulia (1), Piedmont (1), Emilia-Romagna (1), Veneto (1), Basilicata/Campania (1), and Marche (1). There is another Wheat, Gamba di Ferro, whose origin is uncertain, but is estimated to come from the Tuscan-Emilian Apennines. Sicily, where durum wheat has traditionally held a prominent place as a primary crop, is one of the richest regions in terms of native varieties [53], which represent an important source of biodiversity. In 2022, in Sicily, the cultivation of ancient wheats, most of which belong to *Triticum turgidum* spp. Durum covered about 10,000 hectares, corresponding to approximately 3.7% of the total area devoted to durum wheat (270,000 hectares). The areas most involved are located in the province of Ragusa (around 50%), confirming that the cultivation of ancient wheats plays an important role in the valorization of inland and marginal rural territories, where the adoption of modern intensive farming systems is limited by pedoclimatic and economic constraints. Different soil and climate zones where this grain thrives have thus given rise to a series of ancient wheats with different peculiarities. For example, the Timilia [63] is the oldest Sicilian cultivar (Theophrastus and Plinio spoke of it in ancient times) [56] and is still used to produce local bread. But besides Timilia, different soil and climate zones where wheat thrives have also led to another wide range of locally adapted cultivars.

For example, Maiorca wheat is another of the most widespread cultivars [37–39], which was mentioned as early as 1696, and is mainly used for bakery and pastry products, although recent studies have shown great potential for beer production as well [64]. Rus-

sello, which is particularly widespread in the provinces of Agrigento, Caltanissetta, and Palermo [58], is still used in Sicily today for the production of hard bread and bronze-drawn pasta [65]. Perciasacchi, whose name means ‘sack-hole’ due to the pointed shape of the caryopsis that perforates jute sacks, is a durum wheat cultivated mainly in some areas of the province of Agrigento [66], and is mainly used in bakeries. Another region where ancient wheat varieties have been preserved is Tuscany, where cultivars such as Gentil Rosso, Frassineto, Inallettibile, Verna, and Andriolo exist. Gentil Rosso, which originated in the Arezzo area in the mid-19th century [15], is a soft wheat that owes its name to the coloring of its ears, which turn red when they ripen, and from which an amber-colored flour used for the production of bread, pizza, and focaccia is made [36]. From the pure line selection of the Gentil rosso, other varieties were then born, such as the Frassineto [34], characterized by a high rusticity and a high adaptability to different environments [35]. Similarly, also of Tuscan/Central Italian origin is the Inallettibile soft wheat [36], as well as Verna, whose name derives from Mount Verna in Casentino, where it was cultivated by the monks [17] and mainly used for the production of Tuscan PDO bread [34]. Finally, the last ancient Tuscan wheat considered in the literature is Andriolo, a soft wheat selected in 1945 [51]. Tuscan wheats are protected under Regional Law 64/2004, which safeguards 17 native varieties at risk of extinction through the establishment of regional genetic archives. [34]. Other Italian ancient wheats found in the literature were, then, the Rieti originario wheat [67], a soft wheat from Lazio, and the Solina d’Abruzzo [68] grown at 750 m above sea level [44], particularly in the Gran Sasso Park area [43]. It has a low productivity [69] but guarantees constant production, which has contributed significantly to the food security of farming families [45]. Its adaptation to harsh climatic and edaphic conditions, combined with the long-standing work of local farmers, has made it a key element of Abruzzo’s agricultural identity. For its biodiversity value, Solina has received designation as a Prodotto Agroalimentare Tradizionale (PAT) [70], inclusion in the National Register of Conservation Varieties, recognition as a Slow Food Presidium, and participation in the EU project Preparatory Action on Genetic Resources in Agriculture [71], aimed at conserving and valorizing traditional crop varieties. Finally, among durum wheats, of particular interest is Senatore Cappelli wheat, a cultivar dating back to 1915, obtained by the Marche geneticist Nazareno Strampelli [61].

Its ‘purity maintenance’ has been entrusted by the CREA to Società Italiana Sementi (SIS) SpA, with an exclusive license to multiply and commercially exploit the seeds, until 2031 [72]. Among the ancient wheats, Saragolla is the most studied, with 43 articles in total. This interest could derive from its favorable nutritional profile, such as a high amylose-to-amylopectin ratio, low glycemic index [73] and rich phenolic composition [74], as well as from the fact that, in 2004, the name Saragolla was also used for a modern cultivar obtained by crossing ‘Iride’ with the elite line ‘0114’ by Produttori Sementi Bologna [59], which further increased the number of references in the literature. However, it is interesting to note that among ancient wheats, the most studied are durum wheats, which are mainly used for the production of pasta, of which Italy is the global leader in production and consumption. Finally, there is a further group of wheats, mentioned by Di Silvestro et al. (2012) [51] and Boukid et al. (2020) [16], who, however, do not provide exhaustive and detailed descriptions for all of them: Biancolilla, Bidì, Maiorccone, Benco, Bianco nostrale, Canove, Carosello, Marzuol D’Aqui, Gentil Bianco, Sieve, Terminillo, Gamba di Ferro, San Pastore, Carme Jacometti, Aquilante, Realforte, Tripolino and Scorsonera. With regard to their characteristics and pedigrees, from an Internet search, it was, however, possible to extrapolate some information, which has been collected and shown in Table 1.

3.2. Agronomic Characteristics

3.2.1. Yields

The yields of Italian ancient wheats, both soft and durum, show wide variability, as described in Table 2, generally lower than those of modern cultivars (Table 3).

Table 2. Yields and heights of ancient wheats found in the literature.

Genotype	Yield		Height	
	Range	Average	Range	Average
Soft wheat (<i>T. aestivum</i> spp. Aestivum)				
Frassineto	2.09 t/ha [15]–2.67 t/ha [34]	2.38 t/ha	131 cm [15]–133 cm [34]	132 cm
Gentil Rosso	1.57 t/ha [15]–2.01 t/ha [34]	1.79 t/ha	122 cm [15]–145 cm [34]	133.5 cm
Inallettibile	2.18 t/ha [34]	2.18 t/ha	110 cm [34]	110 cm
Verna	2.24 t/ha [34]–4.79 t/ha [16]	3.5 t/ha	120 cm [34]–126 cm [51]	123 cm
Majorca	1.8 t/ha [75]	1.8 t/ha	180 cm [76]	180 cm
Solina D’Abruzzo	2.00 t/ha [44]	2 t/ha	163 cm [68]	163 cm
Jervicella	n.a.		100–130 cm [49]	115 cm
Rieti originario	3.00 t/ha [41]	3 t/ha	n.a.	
Andriolo	2.46 t/ha [34]–3.77 t/ha [16]	3.11 t/ha	135 cm [34]	135 cm
Gamba di Ferro	2.51 t/ha [32]	2.51 t/ha	141 cm [32]	141 cm
Autonomia B	4.56 t/ha [16]	4.56 t/ha	121 cm [51]	121 cm
Gentil Bianco	3.53 t/ha [51]	3.53 t/ha	124 cm [51]	124 cm
San Pastore		n.a.		
Maiorcone		n.a.		
Benco	3.01 t/ha [16]	3.01 t/ha	121 cm [32]–143 cm [51]	132 cm
Bianco nostrale	4.21 t/ha [16]	4.21 t/ha	120 cm [51]	120 cm
Sieve	3.29 t/ha [16]	3.29 t/ha	119 cm [51]	119 cm
Terminillo		n.a.		
Canove	n.a.		112 [32]–138 [51]	125 cm
Carosello	4.12 t/ha [16]	4.12 t/ha	92 [51]	92 cm
Carme Jacometti		n.a.		
Aquilante		n.a.		
Durum wheat (<i>T. turgidum</i> spp. Durum)				
Timilia	1.9–3.42 t/ha [77,78]	2.66 t/ha	n.a.	
Perciasacchi	2.27–3.15 t/ha [77], 2.4 t/ha [78]	2.71 t/ha	n.a.	
Saragolla	1.4 t/ha [60]–2.13 t/ha [79]	1.75 t/ha	86 [80]–160 [60]	123
Russello	2.78–3.21 t/ha [77]	2.99 t/ha	n.a.	
Senatore Cappelli	2.51 t/ha [79]–3.63 t/ha [77]	3.07 t/ha	105–113 [79]	109
Marzuolo D’Aqui	3.82 t/ha [16]	3.82 t/ha	121 [51]	121
Tripolino	2.3 t/ha [78]	2.3 t/ha	n.a.	
Biancuccia	1.6 t/ha [78]	1.6 t/ha	n.a.	
Scorsonera	2.5 t/ha [78]	2.5 t/ha	n.a.	
Realforte		n.a.		
Bidi		n.a.		
Bufala nera		n.a.		

Table 3. Yields of modern wheats found in literature.

Soft Wheat (<i>T. aestivum</i> spp. <i>Aestivum</i>)	
Bolero	2.64 t/ha [15]
Blasco	2.14 t/ha [15]
Bologna	3.87 t/ha [15]
Fureka	4.16 t/ha [15]
Mieti	4.18 t/ha [15]
Palesio	4.19 t/ha [15]
Bilancia	5.62 t/ha [15]
Average	3.83 t/ha
Durum wheat (<i>T. turgidum</i> spp. <i>Durum</i>)	
Saragolla	4.09 t/ha [81]
Karalis	3.22 t/ha [81]
Pablo	2.99 t/ha [81]
San Carlo	3.45 t/ha [81]
Benco	3.44 t/ha [32]

This difference could mainly reflect the long process of genetic improvement that has characterized modern wheat breeding, aimed at maximizing yield potential and uniformity. Ancient varieties, by contrast, have retained traits associated with biodiversity, adaptability, and end-product quality rather than productivity.

Among soft wheats, yields usually range between 1.5 and 4.5 t/ha, with an average around 3 t/ha. The highest values are observed in cultivars such as Autonomia B, Bianco Nostrale, and Carosello, while others like Gentil Rosso and Majorca remain below 2 t/ha. In the case of durum wheats, yields span approximately 1.4–3.8 t/ha, averaging 2.9 t/ha. Some genotypes, such as Saragolla and Biancuccia, display lower productivity, whereas Russello, Senatore Cappelli, and Marzuolo D’Aqui show values comparable to those of modern durum cultivars. On average, yield differences between ancient and modern varieties are more pronounced in soft wheats (+25–30%) than in durum wheats (+15–20%). Nonetheless, the presence of competitive ancient genotypes (e.g., Cappelli, Russello, Marzuolo D’Aqui) suggests that yield could not strictly be determined by the age of the variety but results from complex interactions between genotype and environment. Modern wheats, on the other hand, achieve higher and more stable yields due to decades of selective breeding, further enhanced by the adoption of intensive cultivation systems that optimize resource use and fertilization regimes. It should be noted, therefore, that the yield data summarized in Table 2 derive from different studies conducted under heterogeneous pedoclimatic and agronomic conditions. So, these figures are indicative and should not be interpreted as directly comparable across varieties.

3.2.2. Heights

Another agronomic feature that distinguishes ancient wheats is their generally greater plant height, a parameter influencing competition with weeds, resistance to lodging, and adaptability to diverse cropping systems. As reported in Table 2, ancient wheats show a broad height range, with soft wheats generally taller than durum wheats. Heights typically vary between 90 cm and 180 cm, with Majorca and Solina d’Abruzzo among the tallest varieties, while Carosello and Senatore Cappelli show intermediate values. Overall, these values are considerably higher than those recorded for modern wheats, which usually range between 60 and 100 cm. The greater height of ancient wheats compared to mod-

ern varieties could induce both agronomic advantages and disadvantages. For example, higher heights could provide greater competitiveness with weeds, as some taller varieties (e.g., Majorca, Solina d'Abruzzo, Gamba di Ferro) could create more shade on the ground, reducing weed growth and thus the need for herbicides. Therefore, tall wheats may be more suitable for organic or traditional farming practices, where natural competition with weeds is an advantage. In addition, the abundant crop residue production may be useful for soil fertility improvement or animal feed [82]. In terms of disadvantages, heights above 140 cm increase the risk of the plant bending under the weight of the ear or due to wind and rain, reducing yield and making it more susceptible to lodging. Modern wheat varieties have been developed to have smaller heights, with plants generally not exceeding 100–110 cm [83]. This trait is the result of the introduction of Reduced Height (Rht) dwarfing alleles (semi-dwarf genes), which improved resistance to lodging and increased efficiency in wheat production [14]. In particular, the lower height reduces the risk of allurement and facilitates mechanized harvesting. However, the reduced height in modern wheats has also reduced their ability to compete with weeds, necessitating the use of herbicides in conventional farming systems.

3.2.3. Environmental Sustainability

In any case, despite the obvious potential of ancient wheats in terms of agronomic sustainability, their actual environmental performance compared to modern varieties remains poorly investigated and largely unquantified. In fact, the literature review also highlights an important research gap: except the studies by Verdi et al. (2022) [17] and Di Cristofaro et al. (2024) [84], there is an almost complete absence of comparative analyses based on quantitative tools, such as Life Cycle Assessment (LCA), to assess and compare the environmental impacts of ancient wheats versus modern varieties. In fact, quantifying the sustainability of ancient wheats through LCA could provide concrete data to better understand the environmental impacts associated with their cultivation, provide a framework for comparison with modern cultivars by identifying the true strengths and weaknesses of ancient varieties, and support decision-making for more sustainable agricultural practices that could apply to different regions globally.

3.3. Cultivation Characteristics

Interestingly, some varieties of ancient wheats have characteristics that make them suitable in sustainable farming contexts. For example, the literature review shows that some varieties, such as Gentil Rosso [85], Russello [86], Rieti originario [41], and Senatore Cappelli [79] are particularly resistant to rust, thus being able to induce a reduction in fungicide use. Russello is also shown to be particularly resistant to *Ophiobolus graminis* (an infestation known as foot-root disease) [86], while Saragolla expresses high levels of resistance to Mexican races of *P. tritici* [58,87], as well as Timilia, overcomes dry spells well and is very competitive with weeds, including *Portulaca oleracea* and *Stellaria* [88] and *Fusarium culmorum* [89,90]. Or their low nitrogen requirements [79] could make them a viable choice for rotation with legumes in small areas of cereal systems in Mediterranean environments under organic or low-input farming as a result of low soil fertility and traditional management practices. Many of these formerly extensively cultivated areas are at risk of abandonment because they cannot be adapted to take advantage of the high-yielding potential of modern cultivars. For this reason, ancient cultivars may offer an opportunity to recover them. In fact, ancient wheats, being plant species that have long been locally adapted, can be considered, for all intents and purposes, expressions of traditional forms of agriculture. For these reasons, too, the cultivation of ancient wheats is particularly suitable for the recovery and enhancement of inland, marginal, or areas

tending toward marginalization. This is because, in such areas, it is almost impossible to carry out agricultural activities capable of being competitive in the commodity markets and, often, the only alternative to abandonment (and consequent degradation) is, precisely, represented by the possibility of recovering crops, whose products can be appreciated, also in terms of price, by particular narrow bands of consumers. In fact, ancient wheats, both because of certain biological characteristics considered to be characterizing compared to conventional wheat varieties (such as the presence of non-tenacious gluten), and because of a greater adaptability to traditional, less intensive forms of agriculture, make it possible to obtain products capable of meeting a demand that is particularly attentive to aspects such as sustainability, healthiness, and naturalness of food. For example, it is useful to mention the case of Verna wheat and Solina D'Abruzzo. Verna grows at very high altitudes (>600 MASL), proving to have exceptional resistance to cold and rust, a sensitive tillering potential that allows it to produce a large root system with greater efficiency in nutrient and water use than modern varieties, and better resistance to stress than modern varieties [17], as well as being particularly well adapted to medium to fertile soils [34]. The areas of Solina d'Abruzzo, on the other hand, are also located in mountainous areas (500–1400 MASL), proving to be a very productive grain and resistant to low winter temperatures [45], in addition to the fact that it is adapted to the lean and skeleton-rich soils of the mountains [43]. Consequently, ancient wheats could play a strategic role not only in preserving agricultural biodiversity but also in promoting more sustainable agricultural models and resilience.

3.4. Ancient Wheats for Quality Production

The market price of flour made from ancient wheats appears to be significantly higher than that of flour made from modern ones (Table 4). The prices of commercial soft wheat flours range between €1.12 and €1.29/kg, while durum wheat flours range between €1.29 and €1.80/kg. Examining the prices reported in the online shops of mills that sell ancient wheat flours, they show a significantly higher price range, as shown in Table 4. For soft wheats between €2.00–7.00/kg, with an average of about €3–5/kg, while for durum grains between €2.40–7.55/kg, with flours exceeding €6/kg. Therefore, according to analyses on various online marketplaces, it appears that the price differential between ancient wheats flours and industrial flours can be more than double. The price range could vary depending on several factors. For example, artisanal manufacturing processes, including stone milling, a technique that better preserves the nutritional characteristics of the product, increasing its commercial value, but involves slower production and therefore higher costs [91]. Or, the added value of the short supply chain, since selling directly from producers and small mills avoids the steps of large retailers but keeps prices higher. And finally, the fact that most of the cultivation of ancient wheats (about 80%) is done organically, which contributes to higher prices. This is because less intensive cultivation reduces the need for fertilization and chemical treatments, lowering operating costs but at the same time affecting production yields and increasing production costs per unit of output. Conversely, the low productivity and wide genetic diversity of ancient wheats can be enhanced through the production of traditional quality products, such as stone-ground flour and typical baked goods. In fact, ancient wheats are often used in the preparation of products with designations of origin, which contribute to the enhancement of local productions and short and artisanal supply chains, ensuring a more natural product with unique organoleptic characteristics. For example, Verna wheat is used in the preparation of Tuscan PDO bread [34,51], which could enhance local productions, reward a short and artisanal supply chain, resulting in a product processed more naturally, guaranteeing its quality and origin, preserving smells, colors, and flavors of the past time [92]. Or Solina D'Abruzzo wheat [43], is used for the production of "Ferratelle Abruzzesi", typical dry cakes from Abruzzo similar to waffles. Or also, in

Sicily, Majorca wheat is used for the production of the “Ciambella di San Cataldo” [93], a traditional sweet from the municipality of San Cataldo (province of Caltanissetta, Sicily), just as Timilia wheat is used to produce the “Pane nero di Castelvetro” (protected as a Slow Food presidium) [94] and “Pane di Monreale”, which is included in the national list of Sicilian PAT [66], established under Ministerial Decree 350/1999.

Table 4. Market prices of flours of major ancient wheats and commercial flours.

Type of Flour	Price	
	Range	Average
ANCIENT WHEATS		
Soft wheat (<i>T. aestivum</i> spp. Aestivum)		
Majorca	3.20–7.00 €/kg	5.10 €/kg
Andriolo	4.09–6.00 €/kg	5.04 €/kg
Sieve	3.00–5.90 €/kg	4.45 €/kg
Gentil Rosso	2.84–5.50 €/kg	4.17 €/kg
Frassineto	2.95–5.20 €/kg	4.08 €/kg
Inallettibile	3.00–5.00 €/kg	4.00 €/kg
Jervicella	3.45–4.50 €/kg	3.98 €/kg
Verna	3.50–4.10 €/kg	3.80 €/kg
Solina D’Abruzzo	2.80–4.20 €/kg	3.50 €/kg
Rieti originario	3.47 €/kg	3.47 €/kg
Carosello	2.90–3.99 €/kg	3.45 €/kg
Terminillo	3.00–3.50 €/kg	3.25 €/kg
San Pastore	2.50–3.80 €/kg	3.15 €/kg
Carme Jacometti	3.00 €/kg	3.00 €/kg
Autonomia B	2.00–3.30 €/kg	2.65 €/kg
Gamba di Ferro	n.a.	
Gentil Bianco	n.a.	
Maiorcone	n.a.	
Benco	n.a.	
Bianco Nostrale	n.a.	
Canove	n.a.	
Aquilante	n.a.	
Durum wheat (<i>T. turgidum</i> spp. Durum)		
Biancolilla	3.60–7.55 €/kg	5.58 €/kg
Perciasacchi	3.50–6.60 €/kg	5.05 €/kg
Timilia	3.00–6.00 €/kg	4.50 €/kg
Senatore Cappelli	2.40–5.50 €/kg	3.95 €/kg
Bidi	3.70–4.10 €/kg	3.90 €/kg
Saragolla	2.99–4.30 €/kg	3.65 €/kg
Russello	2.94–3.95 €/kg	3.45 €/kg
Marzuolo d’Aqui	3.20 €/kg	3.20 €/kg
Bufala nera	3.00 €/kg	3.00 €/kg

Table 4. Cont.

Type of Flour	Price	
	Range	Average
Tripolino		n.a.
Scorzonera		n.a.
Realforte		n.a.
MODERN WHEATS		
Soft wheat (<i>T. aestivum</i> ssp. <i>Aestivum</i>)	1.12–1.29 €/kg	1.20 €/kg
Durum wheat (<i>T. turgidum</i> ssp. <i>Durum</i>)	1.29–1.80 €/kg	1.50 €/kg

These examples show how ancient wheats are not only an agricultural resource, but also a cultural heritage, strongly linked to local food traditions. Their valorization in the production of typical specialties can represent an opportunity for the rural economy, while providing an incentive for the conservation of biodiversity.

3.5. Technological Parameters

Among the main technological parameters used to assess wheat quality, test weight (TW) and 1000 kernel weight (TKW) are particularly relevant, because both provide essential information on grain density, size, and milling potential, influencing yield, processing efficiency, and final product quality.

3.5.1. Test Weight (TW)

TW (kg/hL) represents the weight of a standard volume of grain (typically one hectoliter) [95] and indicates the firmness and fullness of the grains. A higher TW is generally associated with better milling quality, as denser, fleshier grains indicate higher starch content and a lower proportion of bran, promoting higher flour or semolina yields. According to Sissons et al. (2020) [96], TW is a variable influenced by both genotype and genotype-environment interactions, as well as the expression of several genes. In fact, the specific gravity of wheat can vary depending on several factors, including genetics (some wheat varieties tend to have a higher specific gravity than others), environmental conditions (e.g., water stresses, nutritional deficiencies, and unfavorable weather conditions) that can reduce its weight, or agronomic techniques. In the case of Italian ancient wheats, literature data (Table 5) show significant variability in TW among different varieties, with values of 70–82 kg/hL. TW is considered acceptable when it exceeds 76–78 kg/hL for soft wheat and 78–80 kg/hL for durum wheat.

Table 5. Test weight of ancient wheats.

Genotype	Test Weight	
	Range	Average
Soft wheat (<i>T. aestivum</i> ssp. <i>Aestivum</i>)		
Bianco nostrale	82.8 kg/hL [51]	82.80 kg/hL
Majorca	82.1 kg/hL [75]	82.10 kg/hL
Maiorcone	81.6 kg/hL [75]	81.60 kg/hL
Benco	76.0 kg/hL [51]–80.1 kg/hL [32]	78.08 kg/hL

Table 5. Cont.

Genotype	Test Weight	
	Range	Average
Gentil Bianco	78.5 kg/hL [51]	78.50 kg/hL
Verna	77.2 kg/hL [34]–74.5 kg/hL [51], 72.3 kg/hL [91], 76.9 kg/hL [16]	77.05 kg/hL
Solina D’Abruzzo	77.4 kg/hL [43]	77.40 kg/hL
San Pastore	77.4 kg/hL [16]	77.40 kg/hL
Frassineto	75.6 kg/hL [51], 78.2 kg/hL [15], 78.4 kg/hL [34]	77.00 kg/hL
Aquilante	77.3 kg/hL [16]	77.30 kg/hL
Gamba di ferro	75.3 kg/hL [15], 77.8 kg/hL [32]	76.57 kg/hL
Gentil Rosso	74.6 kg/hL [15], 78.1 kg/hL [51], 79.0 kg/hL [34]	76.81 kg/hL
Autonomia B	75.9 kg/hL [51]	75.90 kg/hL
Inallettabile	73.7 kg/hL [16], 77.5 kg/hL [34]	75.60 kg/hL
Terminillo	75.3 kg/hL [16]	75.30 kg/hL
Andriolo	71.83 kg/hL [91], 75.8 kg/hL [51], 77.1 kg/hL [34]	74.47 kg/hL
Carme Jacometti	74.1 kg/hL [16]	74.10 kg/hL
Sieve	72.3 kg/hL [91], 73.6 kg/hL [15]	73.56 kg/hL
Canove	72.2 kg/hL [51]	72.20 kg/hL
Carosello	70.4 kg/hL [51]	70.40 kg/hL
Jervicella	n.a.	
Rieti originario	n.a.	
Durum wheat (<i>T. turgidum</i> . spp. Durum)		
Bidi	82.0 [97]	82.00 kg/hL
Timilia	77.4–79.8 kg/hL [77], 81.4 kg/hL [75]	79.44 kg/hL
Russello	76.9–81.1 kg/hL [77], 80.2 kg/hL [75]	79.07 kg/hL
Senatore Cappelli	77.0 kg/hL [98], 79.4–80.5 kg/hL [77]	78.75 kg/hL
Saragolla	75.0 kg/hL [98], 76.7–80.7 kg/hL [79], 81.6 kg/hL [75]	78.33 kg/hL
Marzuol d’Aqui	78.1 kg/hL [51]	78.10 kg/hL
Perciasacchi	76.0 kg/hL [75], 77.7 kg/hL [97], 78.7 kg/hL [66], 77.9–79.5 kg/hL [77]	77.76 kg/hL
Tripolino	81.00 kg/hL [97]	81.00 kg/hL
Biancolilla	80.70 kg/hL [97]	80.70 kg/hL
Scorsonera	80.60 kg/hL [97]	80.60 kg/hL
Realforte	80.10 [97]	80.10 kg/hL
Bufala nera	n.a.	

Some varieties are close to typical values for modern wheats, suggesting good technological potential, while others have lower TWs, which could reflect lower efficiency in starch accumulation or a higher proportion of bran in the grains. Varieties with TW > 80 kg/hL that exhibit high grain density, suggesting good milling yield and interesting quality potential include, such as Bianco Nostrale, Majorca, Bidi, Saragolla, Russello, Timilia, Tripolino, Scorsonera, Benco, and Realforte. These landraces are characterized

by higher grain density, suggesting excellent semolina yield for durum wheat and flour yield for soft wheat. A large group of varieties, such as Senatore Cappelli, Perciasacchi, Gentil Rosso, Frassineto, Solina d’Abruzzo, Inallettibile, and Verna, exhibit TWs of 75–80 kg/hL, indicating variable quality depending on growing conditions. Senatore Cappelli and Perciasacchi show relatively high values, suggesting a good milling yield. On the other hand, cultivars such as Verna and Inallettibile show lower TWs, which could translate into lower flour yield. Finally, among the ancient wheats with a TW < 75 kg/hL, it indicates a lower grain density, which could negatively affect milling yield. Among these cultivars are Andriolo, Carosello, Canove, Sieve, and Carme Jacometti, which might be less suitable for industrial processing but might retain special nutritional and organoleptic properties, making them interesting for niche production or organic farming. In contrast, modern wheat varieties are generally selected to have higher and more stable TW. Typical values for modern wheats range around 78–83 kg/hL for durum wheat and 76–81 kg/hL for soft wheat [1].

However, comparing these data with those of ancient wheats, some varieties such as Bianco Nostrale, Majorca, and Bidi show similar or even higher values, showing high milling potential. However, although TW is a key parameter for milling quality, in the case of ancient wheats, it should be considered together with other factors, such as protein content and nutritional profile.

3.5.2. 1000 Kernel Weight (TKW)

The Thousand Kernel Weight (TKW) is an agronomic parameter that indicates the weight in grams of 1000 grains of wheat or another wheat, and is an indicator of seed size and mass. Several authors [95,99,100] estimate how, for durum wheat, the average TKW varies from 38.8 to 49.3 g, as well as Dexter and Marchylo (2001) [101] observed that TKW values < 40 g were associated with reduced milling quality and flour extraction rates. In contrast, for soft wheat, the average TKW varied from 35 to 50 g [72].

Generally, TKW is also a particularly significant parameter in assessing the quality and productivity of a wheat variety and is closely related to several aspects of yield and milling processing [95]. For example, larger and heavier grains tend to have a higher TKW. But a higher TKW may suggest better grain filling capacity, which often results in higher grain yield per hectare, and thus, better flour or semolina yield. Although TKW and TW are related, they are not synonymous. TW measures the bulk density of grain in a fixed volume (100 L), while TKW measures the average weight of a single grain. A higher TKW generally indicates better grain filling quality, while a higher TW suggests higher grain density in the volume considered. The TKW data resulting from the review, as shown in Table 6, show wide variability. Some varieties stand out for particularly high values, suggesting large, well-structured grains that could provide a higher milling yield.

Table 6. 1000 kernel weight of ancient wheats.

Genotype	1000 Kernel Weight	
	Range	Average
Soft wheat (<i>T. aestivum</i> spp. <i>Aestivum</i>)		
Solina D’Abruzzo	43.4–54.4 g/100 g [102]	48.9 g/100 g
Jervicella	47–50 g/100 g [48]	48.5 g/100 g

Table 6. Cont.

Genotype	1000 Kernel Weight	
	Range	Average
Gamba di ferro	47.13 g/100 g [32]	47.13 g/100 g
Benco	34.2 [51]–53.78 g/100 g [32]	43.99 g/100 g
Majorca	41.6 g/100 g [75]	41.6 g/100 g
Inallettabile	40.5 g/100 g [34]	40.5 g/100 g
Gentil Bianco	39.8 g/100 g [51]	39.8 g/100 g
Verna	37.7 g/100 g [34]–37.46 g/100 g [91]	37.58 g/100 g
Gentil Rosso	34.1 g/100 g [51], 40.9 g/100 g [34]	37.50 g/100 g
Sieve	37.4 g/100 g [91]	37.40 g/100 g
Andriolo	26.9 g/100 g [51], 40.4 g/100 g [34]–44.32 g/100 g [91]	35.61 g/100 g
Canove	33.1 g/100 g [51]	33.1 g/100 g
Frassineto	23.4 g/100 g [51], 42.2 g/100 g [34]	32.8 g/100 g
Carosello	31.1 g/100 g [51]	31.1 g/100 g
Autonomia B	28.7 g/100 g [51]	28.7 g/100 g
Bianco nostrale	28.6 g/100 g [51]	28.6 g/100 g
Aquilante	n.a.	
Carme Jacometti	n.a.	
Maiorcone	n.a.	
Rieti originario	n.a.	
San Pastore	n.a.	
Terminillo	n.a.	
Durum wheat (<i>T. turgidum</i> . spp. Durum)		
Perciasacchi	65.0 g/100 g [97]	65 g/100 g
Senatore Cappelli	54.0 g/100 g [97]	54 g/100 g
Bidi	49.2 g/100 g [97]	49.2 g/100 g
Scorsonera	48.2 g/100 g [97]	48.2 g/100 g
Russello	40.1 g/100 g [75]–44.2 g/100 g [97]	42.4 g/100 g
Tripolino	42.4 g/100 g [97]	42.4 g/100 g
Biancolilla	38.4 g/100 g [97]	38.4 g/100 g
Timilia	33.2 g/100 g [75]–41.2 g/100 g [97]	37.2 g/100 g
Marzuolo D’Aqui	27.2 g/100 g [51]	27.2 g/100 g
Bufala nera	n.a.	
Realforte	n.a.	
Saragolla	n.a.	

For example, for durum wheat, Perciasacchi, Senatore Cappelli, and Bidi indicate good starch accumulation capacity. For durum wheat, Solina D’Abruzzo, Jervicella, Gamba di ferro, and Benco. Thus, these varieties could have a very good milling yield, advantageous for flour or semolina production. This aspect could be particularly appreciated by the milling industry, which needs wheat types with high yield and good processing quality. For example, Perciasacchi and Senatore Cappelli could be particularly suitable for the production of dry or fresh pasta, just as Jervicella, Solina d’Abruzzo, and Bidi could be

excellent for traditional bread making and sourdough bread production. Other cultivars, including Russello, Timilia, Gentil Rosso, Majorca, and Verna, fall within an intermediate TKW range, showing a good balance between grain size and yield. Finally, Andriolo, whose TKW ranges from 26.9 to 44.32 g, shows a marked difference between the available measurements, probably due to the different agronomic conditions under which it was grown. Therefore, cultivars such as Russello, Timilia, Gentil Rosso, Majorca, Verna, and Andriolo seem to have a good seed filling capacity, but without reaching the size of Perciasacchi, Senatore Cappelli, Solina d'Abruzzo, Jervicella, Bidì, and Scorsonera, which instead have a higher milling yield. On the other hand, the cultivars mentioned seem to have a fair milling yield, which could suggest how they can be mixed with other flours in more or less variable proportions. Furthermore, compared to ancient wheats with higher TKW, Russello, Timilia, Gentil Rosso, Majorca, Verna, and Andriolo could have a slightly higher bran percentage, which, on the one hand, can reduce the flour yield, but can increase its nutritional value. Anyway, it is important to consider that this variability in these ancient wheats may also reflect data collected under a wide range of cultivation conditions across different studies, including differences in soil fertility, sowing density, irrigation regimes, and nitrogen availability. As a result, part of the observed variation may not be intrinsic to the genotype itself but rather due to external environmental and management factors that were not standardized among experiments.

4. Conclusions

The main findings of this research can be summarized as follows:

- Thirty-four varieties of ancient Italian wheats have been identified, with a particular concentration in Tuscany and Sicily. Saragolla is one of the most studied, probably due to its favorable nutritional composition and relatively low glycemic index, as well as the presence of a modern variant registered in 2004, which has encouraged further studies.
- Ancient wheats are characterized by greater height, good adaptability to difficult soil and climate conditions, competitiveness with weeds, and potential resistance to pathogens, qualities that make them suitable for sustainable, low-input agricultural systems. However, the scarcity of quantitative data on their environmental impact limits a full comparative assessment with modern varieties.
- Analysis of the yields of ancient Italian wheats shows considerable variability in production, with values generally lower than those of modern wheats, mainly as a result of a long selection process that has favored modern varieties, optimized to ensure high productivity and uniformity in high-intensity agricultural systems.
- Ancient wheat flours have a significantly higher market value due to artisanal production methods (e.g., stone grinding), organic cultivation, greater perceived value by consumers, and belonging to short or niche supply chains.
- There are still several gaps in research, especially regarding the agronomic, nutritional, and technological characterization of some lesser-known varieties, such as Biancolilla, Bidì, Canove, and Gamba di Ferro. Many of these wheats are mentioned in literature without sufficient details about their properties, leaving room for further study.
- There is considerable variability in the technological parameters (TW and TKW), which can negatively affect flour or semolina yields, while offering interesting opportunities for artisanal production, traditional bread-making, and products with a higher fiber content.

Therefore, in response to RQ1, the analysis conducted highlights how ancient Italian wheats have distinctive agronomic and technological characteristics compared to modern varieties. Although they have lower yields, they boast high adaptability to local soil

and climate conditions, greater plant height, which is useful for natural weed control, and significant genetic variability, now considered strategic for addressing the challenges of climate change. From a qualitative point of view, some varieties show good milling potential (e.g., Perciasacchi, Senatore Cappelli). However, the available data are still uneven and partly fragmentary, with gaps in knowledge to be filled, especially for the less studied varieties.

As for RQ2, it appears that the promotion of ancient wheats could represent a strategic lever for promoting more sustainable agricultural models and increasing the competitiveness of Italian cereal supply chains, particularly those linked to pasta and bread, products that are symbols of Made in Italy. The higher market value of flours obtained from ancient wheats, their suitability for cultivation in marginal contexts, and the growing consumer interest in traditional, organic, and short supply chain products can offer new economic opportunities for farmers. Furthermore, the reintroduction of these varieties into cropping systems could contribute to the conservation of agricultural biodiversity and the protection of the territory. However, to maximize this potential, it will be essential to develop support policies, certification tools, targeted communication strategies, and comparative studies on environmental impact, capable of supporting the full integration of ancient wheats into contemporary agri-food supply chains. Future research should focus on:

- Optimize cultivation techniques to improve yield without sacrificing quality.
- Further promote the link between ancient wheats and traditional products to strengthen their cultural and commercial value.
- Focus on detailed quantification of the environmental impact of ancient wheats, using Life Cycle Assessment to evaluate their real contribution to agricultural sustainability and identify strategies for improvement.
- Strategies to capitalize on the high price of ancient wheats flour, transforming it into an opportunity to guarantee greater market value for farmers and encourage the cultivation of these varieties. However, as previously discussed, higher market prices are often offset by increased production costs related to lower yields, manual processing, and smaller-scale supply chains. Therefore, it could be important to evaluate how these price differentials actually translate into farmers' net income and long-term profitability. Future strategies should focus not only on price premiums but also on reducing production costs through optimized agronomic practices, cooperative processing systems, and enhanced market access for small producers.
- The development of short supply chains and highly profitable niche products promotes economic sustainability for farms that adopt low-impact production models.
- Create a centralized database on the agronomic, nutritional, and technological characteristics of Italian ancient wheats varieties.
- The adoption of blended cultivation systems, where ancient wheats with lower yields are cultivated together with more productive or resilient varieties. These blends could generate added value through the complementarity of agronomic and nutritional traits, while simultaneously reinforcing species' resilience by fostering natural protection mechanisms. In practice, such systems could involve intercropping or mixed sowing of ancient and modern wheat varieties, allowing farmers to combine the high-quality and biodiversity benefits of ancient wheats with the yield stability and disease resistance of improved cultivars. This approach may also enhance soil structure and microbial diversity, reduce pest and disease pressure, and improve overall system resilience under climate variability. For example, the "BIOADAPT" project (Alma Mater University of Bologna) tested intercropping ancient wheats with modern ones in organic farming, achieving overall yields similar to modern monocultures, but

with better N balance, higher nutritional quality, and greater microbial biodiversity in the soil.

In conclusion, despite their low productivity, ancient wheats offer significant opportunities in terms of environmental sustainability, nutritional quality, and biodiversity conservation, proving to be a strategic resource for more resilient and sustainable agriculture, as well as a valuable agricultural, cultural, and economic heritage. However, further scientific studies, market strategies, and institutional support will be needed to fully exploit their potential. The future of their cultivation will depend on the ability to balance tradition and innovation, improving the sustainability of production and strengthening their position in the global market.

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References

- Cooper, R. Re-Discovering Ancient Wheat Varieties as Functional Foods. *J. Tradit. Complement. Med.* **2015**, *5*, 138–143. [CrossRef]
- Roumia, H.; Kókai, Z.; Mihály-Langó, B.; Csobod, É.C.; Benedek, C. Ancient Wheats—A Nutritional and Sensory Analysis Review. *Foods* **2023**, *12*, 2411. [CrossRef] [PubMed]
- Garvin, D.F.; Welch, R.M.; Finley, J.W. Historical Shifts in the Seed Mineral Micronutrient Concentration of US Hard Red Winter Wheat Germplasm. *J. Sci. Food Agric.* **2006**, *86*, 2213–2220. [CrossRef]
- Fan, M.S.; Zhao, F.J.; Fairweather-Tait, S.J.; Poulton, P.R.; Dunham, S.J.; McGrath, S.P. Evidence of Decreasing Mineral Density in Wheat Grain over the Last 160 Years. *J. Trace Elem. Med. Biol.* **2008**, *22*, 315–324. [CrossRef] [PubMed]
- Shewry, P.R.; Pellny, T.K.; Lovegrove, A. Is Modern Wheat Bad for Health? *Nat. Plants* **2016**, *2*, 16097. [CrossRef]
- Cattivelli, L. *Pane Nostro: Grani Antichi, Farine e Altre Bugie*; Il Mulino: Bologna, Italy, 2023; ISBN 978-8815383525.
- OECD-FAO. *OECD-FAO Agricultural Outlook 2021–2030*; OECD-FAO: Paris, France, 2021.
- UFOP. *Report on Global Market Supply 2022/2023*; UFOP: Berlin, Germany, 2023; Available online: https://www.ufop.de/files/8217/0548/9837/UFOP-2116_Report_Global_Market_Supply_A5_EN_23_24_160124.pdf (accessed on 14 February 2025).
- Khalid, A.; Hameed, A.; Tahir, M.F. Wheat Quality: A Review on Chemical Composition, Nutritional Attributes, Grain Anatomy, Types, Classification, and Function of Seed Storage Proteins in Bread Making Quality. *Front. Nutr.* **2023**, *10*, 1053196. [CrossRef]
- Ann Bock, M.; Flores, N. Nutrition Information Related to Battered and Breaded Food Products. In *Batters and Breadings in Food Processing*; Woodhead Publishing: Cambridge, UK; AACC International Press: St. Paul, MI, USA, 2011; pp. 153–168. [CrossRef]
- Reynolds, A.; Mann, J.; Cummings, J.; Winter, N.; Mete, E.; Te Morenga, L. Carbohydrate Quality and Human Health: A Series of Systematic Reviews and Meta-Analyses. *Lancet* **2019**, *393*, 434–445. [CrossRef]
- Harris, K.A.; Kris-Etherton, P.M. Effects of Whole Grains on Coronary Heart Disease Risk. *Curr. Atheroscler. Rep.* **2010**, *12*, 368–376. [CrossRef]
- Gil, A.; Ortega, R.M.; Maldonado, J. Wholegrain Cereals and Bread: A Duet of the Mediterranean Diet for the Prevention of Chronic Diseases. *Public Health Nutr.* **2011**, *14*, 2316–2322. [CrossRef]
- Wang, Q.; Xiong, H.; Guo, H.; Zhao, L.; Xie, Y.; Gu, J.; Zhao, S.; Ding, Y.; Liu, L. Genetic Analysis and Mapping of Dwarf Gene without Yield Penalty in a γ -Ray-Induced Wheat Mutant. *Front. Plant Sci.* **2023**, *14*, 1133024. [CrossRef]

15. Migliorini, P.; Spagnolo, S.; Torri, L.; Arnoulet, M.; Lazzerini, G.; Ceccarelli, S. Agronomic and Quality Characteristics of Old, Modern and Mixture Wheat Varieties and Landraces for Organic Bread Chain in Diverse Environments of Northern Italy. *Eur. J. Agron.* **2016**, *79*, 131–141. [CrossRef]
16. Boukid, F.; Gentilucci, V.; Vittadini, E.; De Montis, A.; Rosta, R.; Bosi, S.; Dinelli, G.; Carini, E. Rediscovering Bread Quality of “Old” Italian Wheat (*Triticum aestivum* L. ssp. *aestivum*.) through an Integrated Approach: Physicochemical Evaluation and Consumers’ Perception. *LWT* **2020**, *122*, 109043. [CrossRef]
17. Verdi, L.; Marta, A.D.; Falconi, F.; Orlandini, S.; Mancini, M. Comparison between Organic and Conventional Farming Systems Using Life Cycle Assessment (LCA): A Case Study with an Ancient Wheat Variety. *Eur. J. Agron.* **2022**, *141*, 126638. [CrossRef]
18. Suo, X.; Pompei, F.; Bonfini, M.; Mustafa, A.M.; Sagratini, G.; Wang, Z.; Vittadini, E. Quality of Wholemeal Pasta Made with Pigmented and Ancient Wheats. *Int. J. Gastron. Food Sci.* **2023**, *31*, 100665. [CrossRef]
19. Dinu, M.; Whittaker, A.; Pagliai, G.; Benedettelli, S.; Sofi, F. Ancient Wheat Species and Human Health: Biochemical and Clinical Implications. *J. Nutr. Biochem.* **2018**, *52*, 1–9. [CrossRef] [PubMed]
20. FAOSTAT. Crops and Livestock Products. Available online: <https://www.fao.org/faostat/en/#data/QCL> (accessed on 10 March 2025).
21. Sollai, M. The Fascist Green Revolution. *Plants People Planet.* **2024**, *6*, 1094–1103. [CrossRef]
22. Marzario, S.; Sica, R.; Taranto, F.; Fania, F.; Esposito, S.; De Vita, P.; Gioia, T.; Logozzo, G. Phenotypic Evolution in Durum Wheat (*Triticum durum* Desf.) Based on SNPs, Morphological Traits, UPOV Descriptors and Kernel-Related Traits. *Front. Plant Sci.* **2023**, *14*, 1206560. [CrossRef]
23. Careddu, M.L.; Giunta, F.; Motzo, R. Lessons from the Varietal Evolution of Durum Wheat in Italy. *Agronomy* **2024**, *14*, 87. [CrossRef]
24. Milani, P.; Torres-Aguilar, P.; Hamaker, B.; Manary, M.; Abushamma, S.; Laar, A.; Steiner, R.; Ehsani, M.; de la Parra, J.; Skaven-Ruben, D.; et al. The Whole Grain Manifesto: From Green Revolution to Grain Evolution. *Glob. Food Secur.* **2022**, *34*, 100649. [CrossRef]
25. Nally, D.; Taylor, S. The Politics of Self-Help: The Rockefeller Foundation, Philanthropy and the ‘Long’ Green Revolution. *Political Geogr.* **2015**, *49*, 51–63. [CrossRef]
26. Pronin, D.; Börner, A.; Scherf, K.A. Old and Modern Wheat (*Triticum aestivum* L.) Cultivars and Their Potential to Elicit Celiac Disease. *Food Chem.* **2021**, *339*, 127952. [CrossRef]
27. French, B. Food Plants International Database of Edible Plants of the World, a Free Resource for All. *Acta Hort.* **2019**, *1241*, 1–6. [CrossRef]
28. ISTAT. Superfici e Produzione—Dati in Complesso—Prov. Available online: https://esploradati.istat.it/databrowser/#/it/dw/categories/IT1,Z1000AGR,1.0/AGR_CRP/DCSP_COLTIVAZIONI/IT1,101_1015_DF_DCSP_COLTIVAZIONI_2,1.0 (accessed on 13 October 2025).
29. Blangiforti, S.; Venora, G. *I Grani Antichi Siciliani—Manuale Tecnico per Il Riconoscimento delle Varietà Locali dei Frumenti Siciliani*; Le Fate: Rome, Italy, 2017; ISBN 978-88-940976-6-5.
30. Di Silvestro, R.; Di Loreto, A.; Bosi, S.; Bregola, V.; Marotti, I.; Benedettelli, S.; Segura-Carretero, A.; Dinelli, G. Environment and Genotype Effects on Antioxidant Properties of Organically Grown Wheat Varieties: A 3-Year Study. *J. Sci. Food Agric.* **2017**, *97*, 641–649. [CrossRef] [PubMed]
31. Regione Emilia-Romagna. L. R. N. 1/2008 Tutela del Patrimonio di Razze e Varietà Locali di Interesse Agrario del Territorio Emiliano-Romagnolo. Scheda Tecnica per L’iscrizione al Repertorio Mara Rer V 209. Available online: <https://agricoltura.regione.emilia-romagna.it/produzioni-agroalimentari/agricoltura-sostenibile/agrobiodiversita/schede-specie-vegetali/cereali/allegato-10-mara.pdf> (accessed on 13 February 2025).
32. Bosi, S.; Negri, L.; Fakaros, A.; Oliveti, G.; Dinelli, G. Valorization of Wheat Production in Marginal Areas: Farmer-Centric Experimentation for Variety Choice and Evolutionary Population Development. *Ital. J. Agron.* **2023**, *18*, 2210. [CrossRef]
33. Regione Toscana Varietà Bianco Nostrale. Available online: http://germoplasma.regione.toscana.it/MESI_Menu/Elemento.php?ID=1000 (accessed on 20 February 2025).
34. Ghiselli, L.; Rossi, E.; Whittaker, A.; Dinelli, G.; Baglio, A.P.; Andrenelli, L.; Benedettelli, S. Nutritional Characteristics of Ancient Tuscan Varieties of *Triticum aestivum* L. *Ital. J. Agron.* **2016**, *11*, 237–245. [CrossRef]
35. Amministrazione Provinciale di Siena—Settore Sviluppo Rurale Pane. Nuovo da Grani Antichi: Evoluzione delle Varietà di Grano, della Tecnica Molitoria e Panificatoria. Amministrazione Provinciale di Siena: Siena, Italy. Available online: <https://desbri.org/sites/default/files/panenuovodagraniantichi.pdf> (accessed on 9 April 2025).
36. Ercoli, L.; Ciccolini, V.; Pellegrino, E. Frumenti Teneri Toscani: Caratteri Nutrizionali e Nutraceutici di Varietà Iscritte al Repertorio Regionale. 2018. Available online: http://germoplasma.arsia.toscana.it/Germo_Img/14_1_1533031619.pdf (accessed on 8 February 2025).

37. Colella, A. Tra Saperi Contadini e Cultura Scientifica: Identificazione e Decodificazione delle Varietà di Grano in Età Moderna. *Quad. Stor.* **1994**, *29*, 769–804.
38. Regione Sicilia—Assessorato Regionale dell'Agricoltura dello Sviluppo Rurale e della Pesca Mediterranea Manifestazione d' Interesse e Prequalificazione per Collaborare Alla Realizzazione del Cluster Biomediterraneo in Attuazione della Convenzione Tra Expo 2015 Spa e Regione Siciliana-Assessorato Agricoltura, Sviluppo Rurale e Pesca Mediterranea Allegato 2 Prodotti di Sicilia e Biodiversità. Available online: <https://web.archive.org/web/20160304094633/http://www.biomediterraneo.com/bandi/bando1/Allegato2.pdf> (accessed on 8 February 2025).
39. Ministero del Lavoro e delle Politiche Sociali—Direzione Generale del Terzo Settore e della Responsabilità Sociale delle Imprese Avviso N° 1/2018 “Slow Food in Azione: Le Comunità Protagoniste del Cambiamento”, Ai Sensi dell’ Articolo 72 del Codice del Terzo Settore, di Cui al Decreto Legislativo n 117/2017. Available online: <https://www.fondazione Slow Food.com/it/arca-del-gusto-slow-food/ciambella-di-san-cataldo/> (accessed on 8 February 2025).
40. Ministero Dell'Agricoltura della Sovranità Alimentare e Delle Foreste (MASAF). *Gazzetta Ufficiale. Iscrizione di Varietà da Conservazione di Specie Agrarie al Relativo Registro Nazionale*; (18A02171) (GU Serie Generale n.76 del 31-03-2018); MASAF: Rome, Italy, 2025.
41. Palmegiani, F. *Rieti e la Regione Sabina: Storia, Arte, Vita, Usi e Costumi del Secolare Popolo Sabino: La Ricostituita Provincia Nelle Sue Attività*; Latina Gens: Gravellona, Italy, 1932.
42. Consorzio San Pastore Scheda Varietale: San Pastore. Available online: https://www.consorziosanpastore.it/wp-content/uploads/2022/03/compresso_san-pastore-storia-completa_07-12-21.pdf (accessed on 21 February 2025).
43. Silveri, D.D.; Dalla Ragione, I.; Porfiri, O.; Torricelli, E.; Tosti, N.; Veronesi, F. Collection, Evaluation and Conservation of Plant Genetic Resources in the Abruzzo Region, Central Italy. In *IPGRI Genetic Resources Newsletter*; FAO: Rome, Italy, 2001.
44. De Flaviis, R.; Tumino, G.; Terzi, V.; Morcia, C.; Santarelli, V.; Sacchetti, G.; Mastrocola, D. Exploration of the Genetic Diversity of Solina Wheat and Its Implication for Grain Quality. *Plants* **2022**, *11*, 1170. [\[CrossRef\]](#)
45. Masciarelli, E.; Di Luigi, M.; De Flaviis, R.; Beni, C.; Di Santo, M.; Silveri, D.; De Amicis, F.; Menna, O.; Casorri, L. Solina: An Example of Ancient Wheat Suitable for the Protection of Agrobiodiversity and Agricultural Workers' Health. *Agronomy* **2024**, *14*, 2821. [\[CrossRef\]](#)
46. Presidio Slow Food Grano Carosello. Available online: <https://www.fondazione Slow Food.com/it/arca-del-gusto-slow-food/grano-carosella/> (accessed on 21 February 2025).
47. Regione Emilia-Romagna. L. R. N. 1/2008 Tutela del Patrimonio di Razze e Varietà Locali di Interes-Se Agrario del Territorio Emiliano-Romagnolo. Grano Terminillo. Available online: <https://agricoltura.regione.emilia-romagna.it/produzioni-agroalimentari/agricoltura-sostenibile/agrobiodiversita/schede-specie-vegetali/cereali/grano-terminillo-rer-v-172.pdf> (accessed on 13 February 2025).
48. AMAP. *AMAP Frumento Jervicella—Accessione Di Monte Giberto*; AMAP: Ancona, Italy, 2011.
49. Tavoletti, S.; Pasquini, M.; Mozzon, M.; Foligni, R. Effect of Sowing Season on Fatty Acid Profile Ability to Discriminate Modern and Old Varieties of Common Wheat (*Triticum aestivum* L. subsp. *Aestivum*). *J. Cereal Sci.* **2024**, *116*, 103864. [\[CrossRef\]](#)
50. Frison, G. I due Padri della Pioppicoltura Italiana: Jacometti e Piccarolo Lo Scienziato Dimenticato e Il Tecnico Applaudito. *Arbor* **2022**, *3*, 10–27.
51. Di Silvestro, R.; Marotti, I.; Bosi, S.; Bregola, V.; Carretero, A.S.; Sedej, I.; Mandic, A.; Sakac, M.; Benedettelli, S.; Dinelli, G. Health-Promoting Phytochemicals of Italian Common Wheat Varieties Grown under Low-Input Agricultural Management. *J. Sci. Food Agric.* **2012**, *92*, 2800–2810. [\[CrossRef\]](#) [\[PubMed\]](#)
52. De Cillis, E. *I Grani d'Italia*; Tipografia Della Camera Dei Deputati: Rome, Italy, 1927.
53. Perrino, P.; Hammer, K. Sicilian Wheat Varieties. *Die Kult.* **1983**, *31*, 227–279. [\[CrossRef\]](#)
54. De Vita, P.; Timpanaro, S.; Codianni, P. Antiche Varietà Di Cereali: Realforte, Un Altro Storico Grano Duro Siciliano. *Vita Camp.* **2011**, *29*, 35.
55. Taranto, F.; Di Serio, E.; Miazzi, M.M.; Pavan, S.; Saia, S.; De Vita, P.; D'agostino, N. Intra-and Inter-Population Genetic Diversity of “Russello” and “Timilia” Landraces from Sicily: A Proxy towards the Identification of Favorable Alleles in Durum Wheat. *Agronomy* **2022**, *12*, 1326. [\[CrossRef\]](#)
56. Romano, M.M.M. Il Grano Antico Tumminia: Storia Di Un Termine e Dei Suoi Diversi Usi Mediterranei. *Riv. Di Stor. Dell'agricoltura* **2023**, *62*, 5–37. [\[CrossRef\]](#)
57. Di Loreto, A.; Bosi, S.; Montero, L.; Bregola, V.; Marotti, I.; Sferrazza, R.E.; Dinelli, G.; Herrero, M.; Cifuentes, A. Determination of Phenolic Compounds in Ancient and Modern Durum Wheat Genotypes. *Electrophoresis* **2018**, *39*. [\[CrossRef\]](#)
58. Racioppi, M.; Tartaglia, M.; de la Rosa, J.M.; Marra, M.; Lopez-Capel, E.; Rocco, M. Response of Ancient and Modern Wheat Varieties to Biochar Application: Effect on Hormone and Gene Expression Involved in Germination and Growth. *Agronomy* **2020**, *10*, 5. [\[CrossRef\]](#)
59. Rascio, A.; Fiorillo, F.; Paone, S.; De Santis, G.; Sorrentino, G. Quantitative Botanical Characterization of Saragolla Wheat Landraces from Abruzzo and Puglia Regions of Italy. *Plant Genet. Resour. Characterisation Util.* **2022**, *20*, 434–441. [\[CrossRef\]](#)

60. Simoniello, T.; Coluzzi, R.; D'emilio, M.; Imbrenda, V.; Salvati, L.; Sinisi, R.; Summa, V. Going Conservative or Conventional? Investigating Farm Management Strategies in between Economic and Environmental Sustainability in Southern Italy. *Agronomy* **2022**, *12*, 597. [\[CrossRef\]](#)
61. Tateo, F.; Bononi, M.; Castorina, G.; Colecchia, S.A.; De Benedetti, S.; Consonni, G.; Geuna, F. Whole-Genome Resequencing-Based Characterization of a Durum Wheat Landrace Showing Similarity to 'Senatore Cappelli'. *PLoS ONE* **2023**, *18*, e0291430. [\[CrossRef\]](#)
62. Regione Toscana Varietà Marzuolo. Available online: http://germoplasma.regione.toscana.it/MESI_Menu/Elemento.php?ID=1179 (accessed on 20 February 2025).
63. Fiore, M.C.; Blangiforti, S.; Preiti, G.; Spina, A.; Bosi, S.; Marotti, I.; Mauceri, A.; Puccio, G.; Sunseri, F.; Mercati, F. Elucidating the Genetic Relationships on the Original Old Sicilian *Triticum* Spp. Collection by SNP Genotyping. *Int. J. Mol. Sci.* **2022**, *23*, 13378. [\[CrossRef\]](#)
64. Gugino, I.M.; Alfeo, V.; Ashkezary, M.R.; Marconi, O.; Pirrone, A.; Francesca, N.; Cincotta, F.; Verzera, A.; Todaro, A. Maiorca Wheat Malt: A Comprehensive Analysis of Physicochemical Properties, Volatile Compounds, and Sensory Evaluation in Brewing Process and Final Product Quality. *Food Chem.* **2024**, *435*, 137517. [\[CrossRef\]](#)
65. De Cillis, U. *I Frumenti Siciliani*; Stazione Sperimentale di Granicoltura per la Sicilia: Catania, Italy, 1942.
66. Visioli, G.; Giannelli, G.; Agrimonti, C.; Spina, A.; Pasini, G. Traceability of Sicilian Durum Wheat Landraces and Historical Varieties by High Molecular Weight Glutenins Footprint. *Agronomy* **2021**, *11*, 143. [\[CrossRef\]](#)
67. Orlandi, F.; Ranfa, A.; Fornaciari, M. Principal Morphological and Agronomic Characteristics of Some Durum Wheat Varieties in Central Italy Influenced by Meteorological Anomalies. *Ital. J. Agrometeorol.* **2018**, *2018*, 3. [\[CrossRef\]](#)
68. Morcia, C.; De Flaviis, R.; Terzi, V.; Gasparelli, M.E.; Ghizzoni, R.; Badeck, F.W.; Rizza, F.; Santarelli, V.; Tumino, G.; Sacchetti, G. Long-Term In Situ Conservation Drove Microevolution of Solina d'Abruzzo Wheat on Adaptive, Agronomic and Qualitative Traits. *Plants* **2023**, *12*, 1306. [\[CrossRef\]](#) [\[PubMed\]](#)
69. Piergiovanni, A.R. Evaluation of Genetic Variation and Grain Quality of Old Bread Wheat Varieties Introduced in North-Western Italian Environments. *Genet. Resour. Crop Evol.* **2013**, *60*, 325–333. [\[CrossRef\]](#)
70. Regione Abruzzo Elenco Nazionale dei Prodotti Agroalimentari Tradizionali Ai Sensi dell'Articolo 12, Comma 1, della Legge 12 Dicembre 2016, n. 238. Allegato I (Di Cui All'art. 1 Comma 1). Available online: www.regione.abruzzo.it/system/files/sviluppo-economico/marchio-ristorante-tipico/prodotti_agroalimentari_tradizionali_Abruzzo.pdf (accessed on 13 February 2025).
71. European Commission. Preparatory Action, EU Plant and Animal Genetic Resources in Agriculture. No 2, Final Report, Publications Office. Available online: <https://op.europa.eu/en/publication-detail/-/publication/a8fcf3b6-97c2-11e9-9369-01aa75ed71a1> (accessed on 13 February 2025).
72. Società Italiana Sementi (SIS) Catalogue Soft Wheat 2023/2024. Available online: https://www.sisonweb.com/wp-content/uploads/SIS-SpA-SOFT_WHEAT_EN_CATALOGUE.pdf (accessed on 30 January 2025).
73. Di Renzo, T.; Cascone, G.; Crescente, G.; Reale, A.; Menga, V.; D'Apolito, M.; Nazzaro, S.; Volpe, M.G.; Moccia, S. Ancient Grain Flours with Different Degrees of Sifting: Advances in Knowledge of Nutritional, Technological, and Microbiological Aspects. *Foods* **2023**, *12*, 4096. [\[CrossRef\]](#)
74. Grande, T.; Souid, A.; Ciardi, M.; Della Croce, C.M.; Frassinetti, S.; Bramanti, E.; Longo, V.; Pozzo, L. Evaluation of Antioxidant and Antimicrobial Activities of Whole Flours Obtained from Different Species of *Triticum* Genus. *Eur. Food Res. Technol.* **2023**, *249*, 1575–1587. [\[CrossRef\]](#)
75. CREA Progetto BioDURUM—Rafforzamento dei Sistemi Produttivi del Grano Duro Biologico Italiano. MiPAAF DM n. 95989, 22 December 2016. Available online: https://www.researchgate.net/profile/Massimo-Palumbo-2/publication/351845101_RAFFORZAMENTO_DEI_SISTEMI_PRODUTTIVI_DEL_GRANO_DURO_BIOLOGICO_ITALIANO_Risultati_finali_del_progetto_BIODURUM/links/60acf85592851c168e3bdfba/RAFFORZAMENTO-DEI-SISTEMI-PRODUTTIVI-DEL-GRANO-DURO-BIOLOGICO-ITALIANO-Risultati-finali-del-progetto-BIODURUM.pdf (accessed on 12 February 2025).
76. Marrelli, M.; Sprovieri, P.; Conforti, F.; Statti, G. Phytochemical Content and Antioxidant Activity of Ancient Majorca and Carosella (*Triticum aestivum* L.) Wheat Flours. *Agronomy* **2021**, *11*, 1217. [\[CrossRef\]](#)
77. Ficco, D.B.M.; Beleggia, R.; Pecorella, I.; Giovanniello, V.; Frenda, A.S.; de Vita, P. Relationship between Seed Morphological Traits and Ash and Mineral Distribution along the Kernel Using Debranning in Durum Wheats from Different Geographic Sites. *Foods* **2020**, *9*, 1523. [\[CrossRef\]](#)
78. Spina, A.; Vaccino, P. Grani "Antichi", Alternativa Reale. Available online: https://www.granicoltura.it/manuale_riconos_grani_antichi_agg/TV28_2018_PAGG_50_53.pdf (accessed on 21 February 2024).
79. Pagnani, G.; Galieni, A.; Stagnari, F.; Pellegrini, M.; Del Gallo, M.; Pisante, M. Open Field Inoculation with PGPR as a Strategy to Manage Fertilization of Ancient *Triticum* Genotypes. *Biol. Fertil. Soils* **2020**, *56*, 111–124. [\[CrossRef\]](#)
80. Latini, A.; Fiorani, F.; Galeffi, P.; Cantale, C.; Bevivino, A.; Jablonowski, N.D. Phenotyping of Different Italian Durum Wheat Varieties in Early Growth Stage with the Addition of Pure or Digestate-Activated Biochars. *Front. Plant Sci.* **2021**, *12*, 782072. [\[CrossRef\]](#)

81. Fagnano, M.; Fiorentino, N.; D'Egidio, M.G.; Quaranta, F.; Ritieni, A.; Ferracane, R.; Raimondi, G. Durum Wheat in Conventional and Organic Farming: Yield Amount and Pasta Quality in Southern Italy. *Sci. World J.* **2012**, *2012*, 973058. [CrossRef] [PubMed]
82. Fu, B.; Chen, L.; Huang, H.; Qu, P.; Wei, Z. Impacts of Crop Residues on Soil Health: A Review. *Environ. Pollut. Bioavailab.* **2021**, *33*, 164–173. [CrossRef]
83. Friedli, C.N.; Abiven, S.; Fossati, D.; Hund, A. Modern Wheat Semi-Dwarfs Root Deep on Demand: Response of Rooting Depth to Drought in a Set of Swiss Era Wheats Covering 100 Years of Breeding. *Euphytica* **2019**, *215*, 85. [CrossRef]
84. Di Cristofaro, M.; Marino, S.; Lima, G.; Mastronardi, L. Evaluating the Impacts of Different Wheat Farming Systems through Life Cycle Assessment. *J. Clean. Prod.* **2024**, *436*, 140696. [CrossRef]
85. Corneli, E. Rilievi sullo Sviluppo delle Ruggini sul Frumento. *Riv. Patol. Veg.* **1933**, *23*, 17–25.
86. Melini, V.; Melini, F.; Acquistucci, R. Nutritional Characterization of an Italian Traditional Bread from Ancient Grains: The Case Study of the Durum Wheat Bread “Pane di Monreale”. *Eur. Food Res. Technol.* **2021**, *247*, 193–200. [CrossRef]
87. Kthiri, D.; Loladze, A.; N'Diaye, A.; Nilsen, K.T.; Walkowiak, S.; Dreisigacker, S.; Ammar, K.; Pozniak, C.J. Mapping of Genetic Loci Conferring Resistance to Leaf Rust from Three Globally Resistant Durum Wheat Sources. *Front. Plant Sci.* **2019**, *10*, 1247. [CrossRef]
88. Scavo, A.; Pandino, G.; Restuccia, A.; Caruso, P.; Lombardo, S.; Mauromicale, G. Allelopathy in Durum Wheat Landraces as Affected by Genotype and Plant Part. *Plants* **2022**, *11*, 1021. [CrossRef]
89. Campanella, V.; Petralia, R. Resistance Assessment of Durum Wheat Landraces to Fusarium Foot Rot. *Physiol. Mol. Plant Pathol.* **2022**, *121*, 101879. [CrossRef]
90. Quartana, C.; Faddetta, T.; Anello, L.; Di Bernardo, M.; Petralia, R.; Campanella, V. Activity of Bacterial Seed Endophytes of Landrace Durum Wheat for Control of Fusarium Foot Rot. *Phytopathol. Mediterr.* **2022**, *61*, 95–106. [CrossRef]
91. Guerrini, L.; Parenti, O.; Angeloni, G.; Zanoni, B. The Bread Making Process of Ancient Wheat: A Semi-Structured Interview to Bakers. *J. Cereal Sci.* **2019**, *87*, 9–17. [CrossRef]
92. Consorzio di Tutela Pane Toscano DOP Filiera Del Pane Toscano DOP. Available online: <https://www.panetoscanodop.it/it/filiera> (accessed on 15 February 2025).
93. Benanti, A.; Ashkezary, M.R.; Gugino, I.M.; Canale, M.; Yeganehzad, S.; Todaro, A. Evaluation of Biscuits Obtained from Novel Composite Flour Containing Maiorca Malt Flour. *Ital. J. Food Sci.* **2023**, *35*, 49–56. [CrossRef]
94. Giancaspro, A.; Colasuonno, P.; Zito, D.; Blanco, A.; Pasqualone, A.; Gadaleta, A. Varietal Traceability of Bread ‘Pane Nero Di Castelvetro’ by Denaturing High Pressure Liquid Chromatography Analysis of Single Nucleotide Polymorphisms. *Food Control* **2016**, *59*, 809–817. [CrossRef]
95. Cabas-Lühmann, P.; Arriagada, O.; Matus, I.; Marcotuli, I.; Gadaleta, A.; Schwember, A.R. Comparison of Durum with Ancient Tetraploid Wheats from an Agronomical, Chemical, Nutritional, and Genetic Standpoints: A Review. *Euphytica* **2023**, *219*, 61. [CrossRef]
96. Sissons, M.; Kadkol, G.; Taylor, J. Genotype by Environment Effects on Durum Wheat Quality and Yield-Implications for Breeding. *Crop Breed. Genet. Genom.* **2020**, *4*, e200018. [CrossRef]
97. Ruisi, P.; Ingrassia, R.; Urso, V.; Giambalvo, D.; Alfonzo, A.; Corona, O.; Settanni, L.; Frenda, A.S. Influence of Grain Quality, Semolinas and Baker’s Yeast on Bread Made from Old Landraces and Modern Genotypes of Sicilian Durum Wheat. *Food Res. Int.* **2021**, *140*, 110029. [CrossRef]
98. Acquistucci, R.; Melini, V.; Galli, V. Durum Wheat Grain and Pasta from Locally-Grown Crops: A Case-Study on Saragolla (*Triticum turgidum* ssp. *Turanicum*) and Senatore Cappelli (*Triticum turgidum* ssp. *durum*) Wheats. *Emir. J. Food Agric.* **2020**, *32*, 47–54. [CrossRef]
99. Fatiukha, A.; Klymiuk, V.; Peleg, Z.; Saranga, Y.; Cakmak, I.; Krugman, T.; Korol, A.B.; Fahima, T. Variation in Phosphorus and Sulfur Content Shapes the Genetic Architecture and Phenotypic Associations within the Wheat Grain Ionome. *Plant J.* **2020**, *101*, 555–572. [CrossRef]
100. Rachoń, L.; Bobryk-Mamczarz, A.; Kiełtyka-Dadasiewicz, A. Hulled Wheat Productivity and Quality in Modern Agriculture against Conventional Wheat Species. *Agriculture* **2020**, *10*, 275. [CrossRef]
101. Dexter, J.E.; Marchylo, B.A. Recent Trends in Durum Wheat Milling and Pasta Processing: Impact on Durum Wheat Quality Requirements. In *Durum Wheat, Semolina and Pasta Quality: Recent Achievements and Trends*; INRA: Paris, France, 2000.
102. Durazzo, A.; Casale, G.; Melini, V.; Maiani, G.; Acquistucci, R. Total Polyphenol Content and Antioxidant Properties of Solina (*Triticum aestivum* L.) and Derivatives Thereof. *Ital. J. Food Sci.* **2016**, *28*, 221.

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