Oats for grain production in the subtropical environments of Brazil

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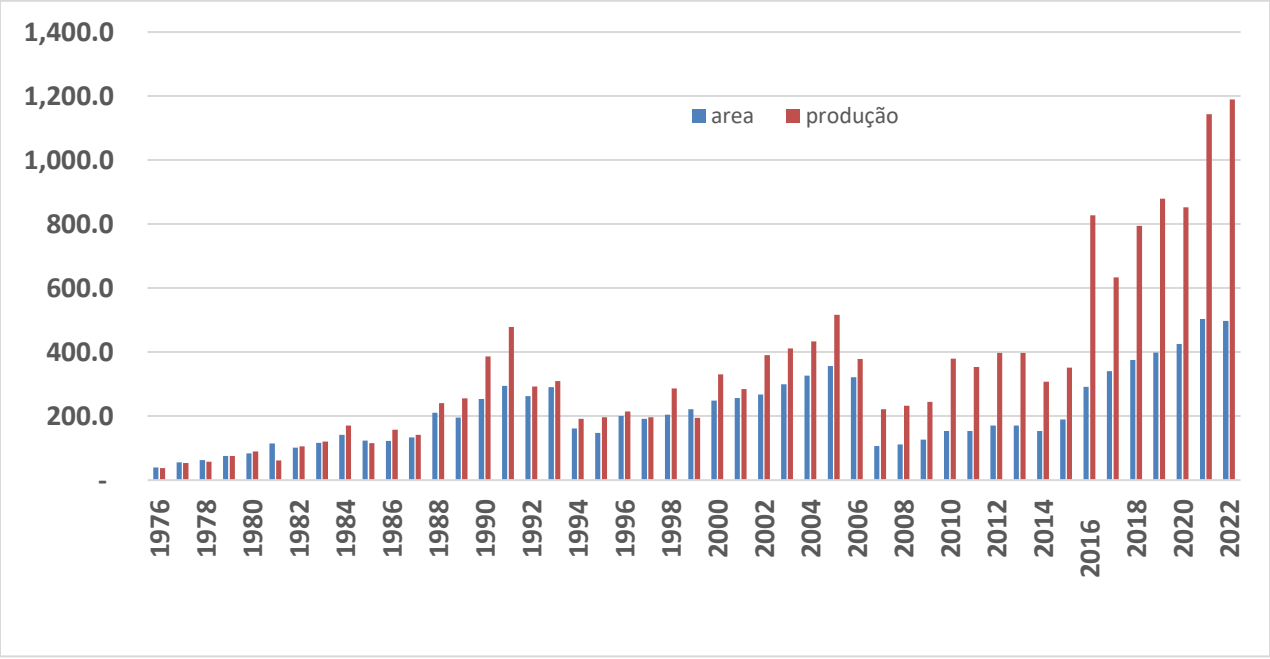
INTRODUCTION

Oats (*Avena sativa* L.) grown for grain play an important role in the agricultural systems used by producers in southern Brazil. The area planted with oats for quality grain production has grown steadily in recent years (Figure 1) (CONAB, 2023). Since 2006, the area cultivated has increased considerably and, in 2021, Brazil produced more than one million tons, becoming one of the world's leading producers of oat grain for the first time (Table 1). The increases in production can be attributed to increases in area (154%) and, more importantly, increases in productivity (203%).



Source: Conab 2023.

Figure 1. Area harvested (in thousand ha) and grain production (thousand tons) of oats in Brazil from 1976 to 2022.

Table 1. Cultivated area, average grain yield, and total oat production in different countries in the years 2020 and 2021.

	Area (Million hectares)		Yield (thousand kg ha)		Production (million tonnes)	
Year/ Country	20/21	21/22	20/21	21/22	20/21	21/22
United States	0.41	0.26	2.34	2.2	0.95	0.58
European Union	2.56	2.56	3.31	2.95	8.47	7.53
Russia	2.33	2.17	1.77	1.72	4.13	3.73
Canada	1.31	1.21	3.48	2.39	4.58	2.9
Argentina	0.24	0.35	2.13	2.07	0.51	0.73
Brazil	0.43	0.50	2.00	2.27	0.85	1.14
Chile	0.11	0.12	4.65	4.7	0.53	0.58
Australia	1.07	0.84	1.77	2.06	1.9	1.74
China	0.41	0.41	1.48	1.48	0.6	0.6
United Kingdom	0.21	0.21	4.91	5.62	1.03	1.12

Source: https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads

In the southern region of Brazil, summer crops, such as soybeans and corn, play a major role in the production chain. However, winter cultivation should not be considered less important, since it allows the producer to obtain a second source of income within the same agricultural year. In addition, winter cultivation integrates crop rotation and succession systems and allows for the establishment and maintenance of a no-till system.

The production of summer crops is very well established and has provided significant gains to growers. With winter crops, farmers face major problems with fluctuations in the production and marketing of the grain. However, winter cultivation is important, because it helps to keep fields covered, reduces soil losses from the frequent rains during this period, helps to dilute the costs of agricultural machinery and equipment that are used in both winter and summer, and increases farm incomes, thus diluting the production costs of the entire system.

Growing oats for their agronomic properties and for the quality of the grain can be an excellent choice, but oats can also be used to produce green forage, hay, silage, and green/dead soil covers in winter.

Advances in oat production have been achieved because of the development of new cultivars with better adaptation to subtropical environments and because of improvements in the technical management of the crop adopted by producers. Oats as a winter crop participates in the production system by contributing more biomass to that system, sequestering more carbon and bringing diversity to crop rotation and succession (Pacheco and Federizzi, 2020). Even at the Agronomic Experimental Station of UFRGS, located in the Municipality of Eldorado do Sul, with a warmer growing season that's less favourable to the oat crop, the cultivars

produce a lot of biomass after the grain is harvested. In average years, such as 2017, more than 5 tons can be produced and, in years with better springs, such as 2018, dry mass production can be greater than 7 tons (Figure 2). This contribution of good amounts of biomass allows the direct planting and production systems to function well (Musa 2019).

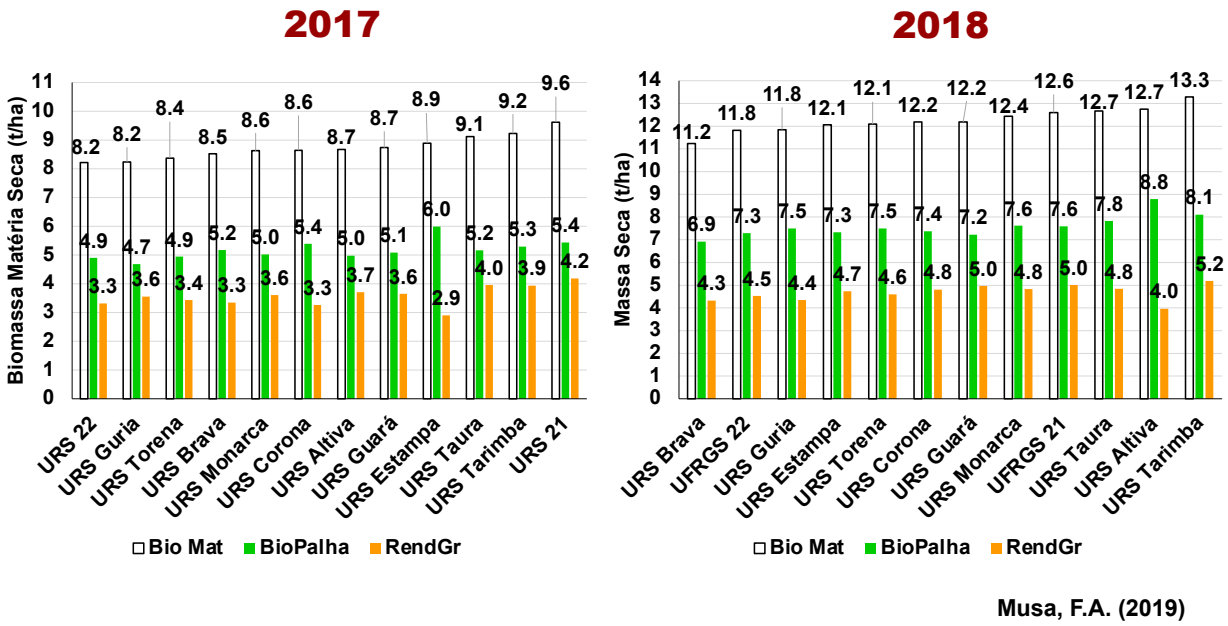


Figure 2. Total biomass, straw biomass, and grain yield in the maturation of different oat cultivars in the years 2017 and 2018 at the Agronomic Experimental Station of UFRGS.

The oat genetic improvement program of UFRGS has been developing oat cultivars with wide adaptation, high yield, and high grain quality since 1982, when the first three cultivars were commercially released. A cultivar takes twelve to fifteen years to be created, with the genetic improvement part taking five to six years, testing in different years and locations taking four to five years, and another two to three years being needed for the multiplication of seeds to supply producers.

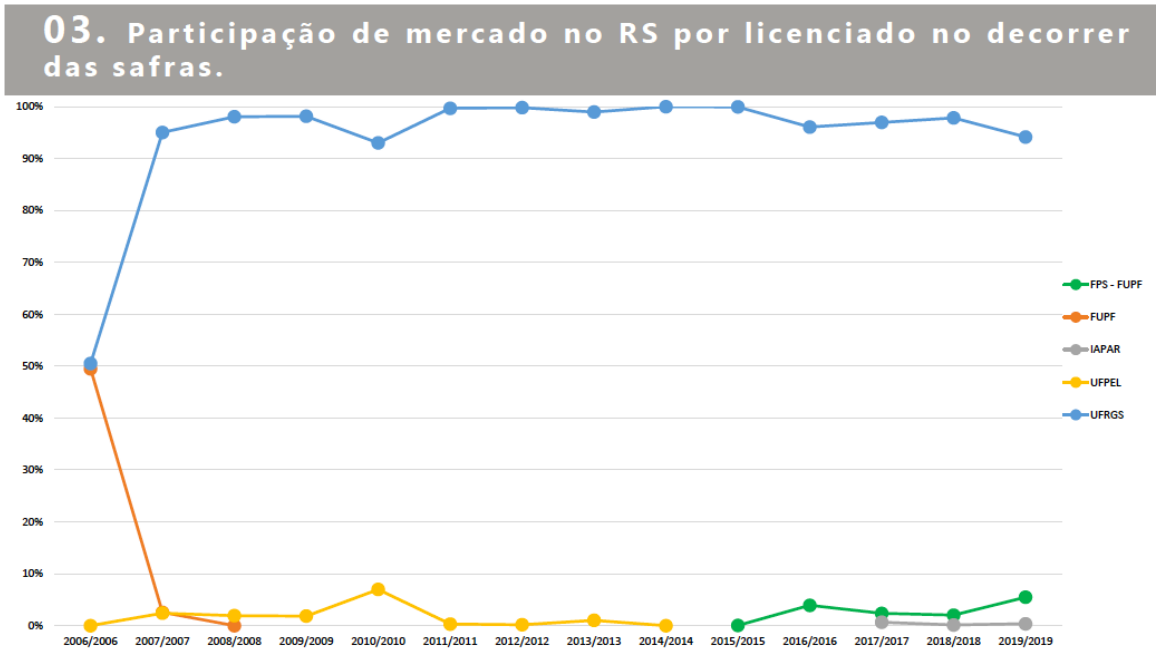
Winter crops in southern Brazil have to fit the space available in the growing season that is delimited by the start of soybean planting in mid-October. Thus, a successful cultivar has to flower early enough to be planted in May-June and harvested in early October. It must also have high grain yield when grown in various types of soil with various cultivation techniques, have good grain quality that is acceptable to millers, be resistant to the main diseases that attack oats, and have good resistance to lodging.

One of the main characteristics of UFRGS cultivars is earliness. This was quickly achieved by removing the main photoperiod response genes present in cultivars from the northern hemisphere when developing Brazilian cultivars. These photoperiod response genes cause cultivars to head on the long days that, in southern Brazil, occur at the end of September and early October. Cultivars with these genes are quite late, which impinges on the

best planting season for the soybeans being planted afterwards, making the use of these oat cultivars unfeasible.

The continuing work of selecting early genotypes has had great success and, today, cultivars developed at UFRGS are not only cultivated in several other countries (Argentina, Uruguay, United States, India), but the earliest flowering oat germplasm in the world is that of UFRGS (Nava *et al.*, 2016; Zimmer *et al.*, 2018). With the introduction of no-till, the increasingly early harvest of soybeans, and the possibility of harvesting oats and planting soybeans on the same day, there is now the opportunity to have oat cultivars with a slightly longer cycle, which would allow producers to take advantage of the entire growing season, with accompanying increases in grain yield.

The physical quality of the grain is also important for a cultivar to succeed in the market. Physical characteristics vary from cultivar to cultivar and are fundamental for the grain to be acceptable to millers. The ease of husk removal, percentage of whole grains, percentage of groat, and percentage of unthreshed grains are important parameters. The uniformity of the grains and the test weight (TW) are also relevant factors, as they correlate with groat percentage. The UFRGS program has released cultivars with excellent milling yield for many years and, together with grain yield, is the main factor contributing to the success of the current UFRGS cultivars on the market (Figure 3).



Fonte : https://www.apassul.com.br/sementes

Figure 3. Market share of the different oat breeding programs in Brazil.

The search for resistance to the main diseases of oats is another important stage of the oat breeding program. In the sub-tropics, conditions are ideal for the development of diseases, as there are no months with snow, nor are there mountain ranges separating different countries. In addition, it rains and has sun all year round, which allows plants to survive all year round. Thus, in the southern cone of the Americas, there are live oat plants in the fields or along fences throughout the year. This allows for a green bridge for fungi and insects to spread throughout the year, greatly increasing the severity of diseases and variability in the populations of pathogens and insects, and hindering the development of cultivars with lasting resistance.

The strategy of the program is to take the main existing resistance genes in the world and incorporate them into Brazilian material, thus creating resistant cultivars, which, at least at their release, are resistant to the main diseases. The development of cultivars with long-lasting resistance is also possible, although much more difficult to achieve. An example is the cultivar UFRGS 21 and the cultivars derived from it, such as URS BRAVA, that maintained resistance to leaf rust for many years. The recently-released cultivars URS OLADA, URS ALTANERA, and URS POENTE all show resistance to leaf rust. UFRGS cultivars also show excellent resistance to barley yellow dwarf virus (BYDV), which is transmitted by aphids.

With the use of no-till, there was a significant increase in leaf spots caused by the fungus *Pyrenophora avenae*. Because it is a recent disease, the previous cultivars had little resistance. However, modern cultivars have excellent resistance to disease caused by this fungus.

The main cultivars on the market are:

URS TAURA – commercially released in 2010, has wide adaptation (not only in Brazil; licensed in the United States and India), excellent yield and ease of dehulling of grains, short plant height, doesn't lodge, and is preferred by the milling industry. At the time of release, it had resistance to leaf rust (Pc68).

URS CORONA – commercially released in 2012, has excellent adaptation, produces large amounts of biomass, has high yield and good grain quality, has been used in the production of high quality forage, is tall, and does have a lodging problem. At the time of release, it had resistance to leaf rust.

URS BRAVA - commercially released in 2014, with partial resistance to leaf rust, wide adaptation, excellent biomass production, high yield, and high grain quality. It is currently widely planted in Uruguay, and has been losing resistance to leaf rust, but remains an excellent option for cultivation.

URS ALTIVA – commercially released in 2018, has a very early cycle, is tall, but resistant to lodging, with excellent biomass production, good grain yield, and excellent grain quality. When it was released, it had resistance to all races of leaf rust, but it is already susceptible.

URS MONARCA – commercially released in 2020, is of medium height, has good resistance to lodging, is adaptated to the sub-tropics, and has high yield potential and grain quality. It is susceptible to leaf rust.

URS OLADA – commercially released in 2022, has early flowering and maturation, has high yield potential and exceptional grain quality for milling. It is resistant to the main races of leaf rust present in Brazil.

URS ALTANERA – commercially released in 2022, has high grain yield potential and excellent resistance to lodging. It also has resistance to the main races of leaf rust present in Brazil.

URS POENTE – commercially released in 2022, is later, but can be planted early in order to take better advantage of the growing season. It has resistance to the main races of leaf rust present in Brazil.

URS PUJANTE - commercially released in 2023, has high yield potential and grain quality, and is resistant to the main races of leaf rust present in Brazil.

URS ALTEZA – commercially released in 2023, has high yield potential and grain quality, and is resistant to the main races of leaf rust present in Brazil.

In Table 2 below, we present the grain yield (kg/ha) of each cultivar observed at different locations in Brazil in 2022. Fungicides were applied to these trials. Yields varied greatly from place to place and were dependant on the planting season, whether the spring was warmer or colder, the occurrence of frosts, and the presence of leaf rust. The average grain yield obtained was quite high, with most cultivars approaching or exceeding 4,000 kg per hectare. The cultivars URS PUJANTE and URS ALTEZA, released in 2023, were not part of the experiment in 2022, but will be part of the Brazilian Cultivar Trial in 2023.

Table 2. Average grain yield (kg/ha) of UFRGS oat cultivars grown at different locations in 2022 with the application of fungicides.

Cultivar	URS Altiva	URS Brava	URS Corona	URS Monarca	URS Taura	URS Olada	URS Altanera	URS Poente	Mean
Eldorado	4715	5611	**5901**	5494	5957	5114	5570	**6293**	**5582**
Tres de Maio	4057	5090	4453	3293	3743	5690	5790	4013	**4516**
Lages	5093	3310	5036	3811	4761	2227	2509	6054	**4100**
Londrina	**5510**	**5887**	5191	**6430**	**6114**	**6455**	**6050**	3241	**5610**
Arapoti	3,456	3,949	3,019	3,964	3,303	3,878	3,163	3,839	**3571**
Castro	2,850	2,168	2,622	3,273	3,343	4,066	3,189	1,672	**2898**
Guara puava	4510	3247	4242	4829	5688	3819	4777	5166	**4535**
Pinhão	1953	1103	4451	3307	5520	1711	2875	3930	**3106**
Maua da Serra	2598	2310	1690	2514	2784	4452	4871	5061	**3285**
Capão Bonito	1563	2176	2746	2363	3203	2560	2353	3620	**2573**
Mean	**3631**	**3485**	**3935**	**3928**	**4442**	**3997**	**4115**	**4289**	**3978**

DIFFICULTIES

One major problem is that the market has expanded rapidly in recent years, especially for animal feed to replace corn. Before planting oats, it is important that a producer knows to whom he will sell or what market he will serve.

In the 70s and 80s, there was a belief that, in the conditions of the sub-tropics, it was almost impossible to meet the standard of grain quality required by the milling industry of the time. Thus, since, 2006, the genetic improvement program of UFRGS has released only cultivars that farmers using average technology can grow to produce grain meeting milling quality specifications. These cultivars allowed for the emergence of many small and medium-sized companies that process oat grain in the southern states of Brazil.

Although all cultivars, when released commercially, have total resistance to leaf rust in the conditions of southern Brazil, this resistance is quickly defeated because of variations in the rust population. Thus, the application of fungicides for the control of diseases is recommended.

Brazilian oat cultivars still produce more biomass from straw than from grain. The best cultivars have a grain-to-straw ratio of 0.43, while other cereals like wheat have a ratio greater than 0.50. The main oat cultivars are still tall and have lodging problems with higher applications of fertilizer.

FUTURE

Despite the advances made with the oat crop, both in grain yield potential of the cultivars and in techniques used by producers, there is still a long way to go to make oats more competitive. The development of cultivars requires the constant introduction of genetic material from other countries, which makes the process slower and more difficult, in large part because of Brazilian import legislation. The cultivation conditions of other countries are also quite different from those found in the south of Brazil.

Efforts have been made in the oat genetic improvement program of UFRGS to create cultivars with high yield, high grain quality, and short stature to increase resistance to lodging. In the year 2022, many producers had crop yields above 4,000 kg per hectare, revealing the potential of the current cultivars.

Given the qualities that the oat plant offers, it should still expand in cultivated area, since, compared to the cultivated area of summer crops, the winter species still only occupy a small part. Like wheat, oats are being planted more and more to the north of Brazil, and there are already quite expansive areas in the states of Mato Grosso do Sul and Minas Gerais, with very good grain yields.

The support of the Brazilian Oat Research Commission (CBPA), composed of all the institutions that work with the cultivation of oats in southern Brazil, has been fundamental to the progress observed in the development of new cultivars and in the techniques currently employed by farmers.

(Photos from the field can be seen here.)

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