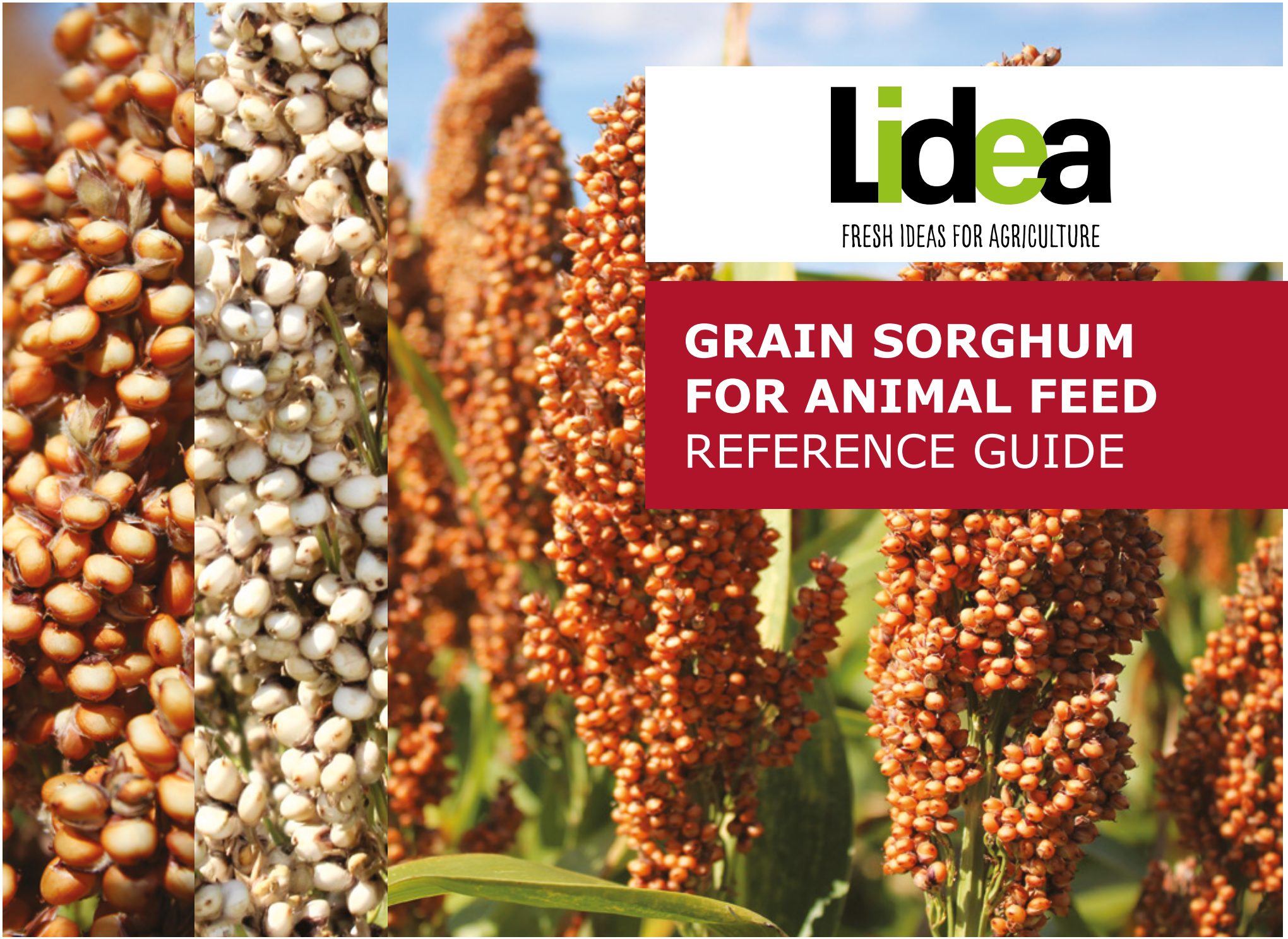
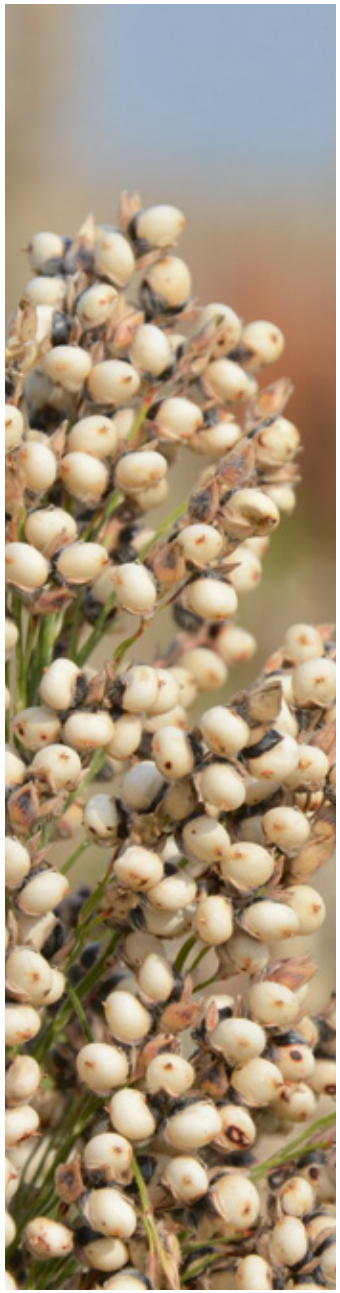


Lidea

FRESH IDEAS FOR AGRICULTURE

GRAIN SORGHUM FOR ANIMAL FEED
REFERENCE GUIDE



GROWING DIFFERENTLY

Climate change and the rise of agroecology, driven by the need to reduce input use, means that European agriculture is undergoing major changes.

New strategies are based on innovation, agronomy, and smart plant breeding. In this regard, sorghum cultivation has clear benefits.

Given that some 80% of Europe's agricultural land is not irrigated, sorghum's robustness to drought conditions has been raising its profile among farmers. It is also known for its low susceptibility to pests. With 60% of wheat, barley, and corn currently destined for animal feed, sorghum could have a major role to play: it has a high protein content and starch to provide energy, it contributes to a better quality of meat (low linoleic- and polyunsaturated-acid-content) and has low sensitivity to mycotoxins in the field, thereby enhancing the health quality and nutritional quality of feed rations. Sorghum represents a genuine solution for animal nutrition.

Chains are being created locally, based around processing plants, bringing together all the links required, from growers to livestock farmers. Lidea is creating added value by working with partners to strengthen these chains. Through Eurosorgho*, our teams benefit from one of the largest research programmes in Europe. Our aim is to offer farmers and processors high-potential varieties, adapted to all climate conditions and all market segments. Our ambition? To grow and feed differently.

**Eurosorgho is a joint research venture between LIdea and Semences de Provence*

THE SORGHUM STRATEGY IS BASED ON INNOVATION, AGRONOMY, PRESERVATION OF WATER RESOURCES, AND USES. IN THIS REGARD, SORGHUM CULTIVATION HAS CLEAR BENEFITS.

Frederic GUEDJ,
Sorghum Market Development Manager,
Lidea Seeds

For several years, Frederic Guedj, Sorghum Market Development Manager at Lidea, has been criss-crossing Europe to meet farmers and feed producers who have adopted sorghum. Beyond the growing technical and agronomic interest in this cereal, he has identified a general lack of information on its use in animal feed.

In response to this observation, Lidea is offering you this informative brochure, to share our experiences, to provide an update on sorghum's nutritional qualities for farm animals, and to highlight its economic and agronomic advantages. Processors will then see for themselves the real quality benefits of sorghum in animal feed.

CHALLENGES

FEED PRODUCERS' EXPECTATIONS

ANIMAL FEED PRODUCTION SECTOR

BIG ADVANTAGES IN A SMALL SEED

As a result of its robustness, sorghum represents an excellent response to the challenges posed by climate change. Although sorghum production is still restricted in Europe, its development is based on high-performance genetics and cropping conditions adapted to the major consumption areas. The key to its success will be winning new market shares, particularly in animal feed.

EUROPEAN SORGHUM PRODUCTION (INCLUDING UKRAINE AND RUSSIA) IN 2021

1 MT HARVESTED

400,000 HA SOWN

80% OF VOLUMES DESTINED FOR ANIMAL FEED

Sorghum offers considerable benefits for agriculture in climate change situations where water resource management is crucial. It is not a thirsty crop and is therefore suitable for medium-deep, non-irrigable land where it is difficult to grow corn. It can therefore be an additional crop in rotation on 85% of the world's cultivated land that is not irrigable. In addition, sorghum has strong resistance to pests (Diabrotica, nematodes, etc.) and diseases, and consumes on average 30% fewer inputs than corn.

Opportunities to increase acreages and yields

Globally, despite over 40 million hectares and over 60 MMT of sorghum production, sorghum remains a poorly represented crop, far behind wheat, corn, and barley, although demand has increased by more than 10 MMT in 4 years, driven by use as animal feed.

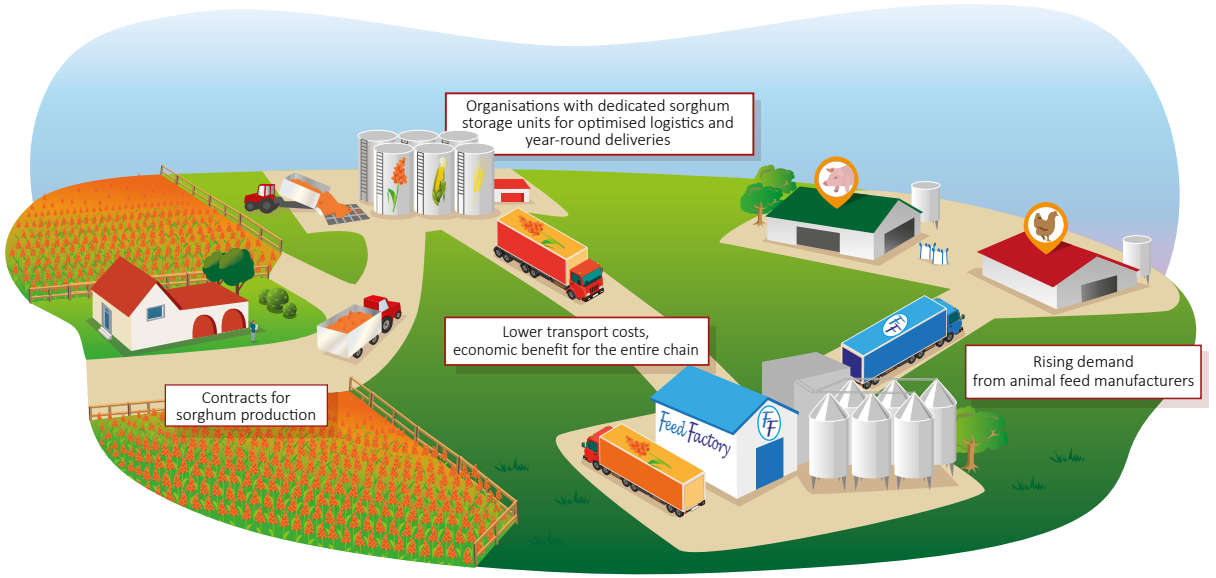
In 2021, Europe produced just over 1 MMT of sorghum. These volumes cover only 0.4% of cereal needs in Europe. Sorghum production is concentrated in the southern half of the continent, but it is gradually moving northwards, thanks to European early genetics. In terms of yields, France is far ahead, with average yields of 6.04 tonnes per hectare (t/ha) in 2021.

This performance is due to the use of hybrid seeds adapted to the latitudes, produced after years of research by seed companies in Western Europe (the first hybrid was registered in the 1960s).

In France, all fields are sown with this technology. Early hybrids in Europe provide more regular yields and perform well in climate variations and non-irrigated conditions. In addition, since the 1980s, grain has been of better quality and poor in tannins, the number one priority for animal feed, for better protein recovery and an energy value similar or even superior to other cereals.

CREATING A VIRTUOUS CIRCLE FOR SORGHUM

Optimised logistics, from farm to consumer



The development of sorghum cultivation areas throughout Europe provides security for the trade between all actors in the sector. Increased use of this cereal in animal feed facilitates the establishment of a reference price. Without this, prices, which are often based on maize minus a few euros, vary greatly between different intermediaries.

OPTIMISING DISTRIBUTION CHAINS

Much of the sorghum grown in Europe is not exploited locally but is exported to those countries which use it but, in general, produce little sorghum themselves. For example, this is the case in Spain, Europe's largest sorghum consumer, where nearly half of the sorghum required is grown in France. To improve stability and traceability, the sector must refocus the cultivation of this cereal within the areas it is used, developing shorter distribution chains between agricultural production, processing and feed users.

Gaining market share to provide security in the grain industry

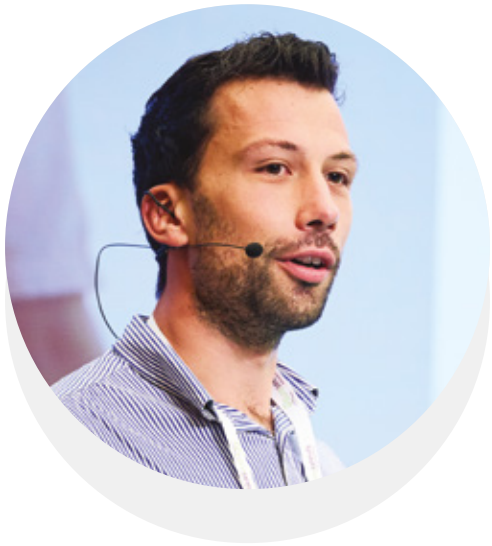
About 80% of the sorghum produced in Europe is intended for animal feed and, while volumes remain modest, there is growth potential. "If sorghum were to represent 5% of the market share of cereals consumed in the European Union by 2030, the harvest would represent 10 MMT, 2Mha and better preservation of our environment.

This objective is entirely achievable and would create a virtuous circle," explains Frédéric Guedj. Without compromising the primary grain market, this growth would ensure the security of the sector in the face of global warming.

In France, all fields of sorghum are sown with hybrid seeds. This technology contributes to reach an average yield of **5.8 tonnes per hectare** (over last five years), the highest in the world.

PROMOTING SORGHUM CULTIVATION AND EUROPEAN HYBRID GENETICS

To expand sorghum production in Europe, the Sorghum ID association brings together all the European actors in this sector. We interviewed Martin Gomez, International Promotion Officer at FNPSMS*, on the sorghum development strategy.



Martin GOMEZ,
International Promotion Officer at FNPSMS

What are the highlights of Sorghum ID's calendar in the next few years?

The members of the Sorghum ID association are committed to extending the production and use of sorghum during the coming years. To that end, Sorghum ID will continue to organise conferences and participate in trade shows to promote this crop. Visits and promotional events are planned in France, Spain, Italy, Romania, and Turkey.

Sorghum ID will also publish online the prices for sorghum undertaken by an independent company. This will promote trade in this commodity.

From 5 to 9 June 2023, Sorghum ID will participate in the International Sorghum Conference in Montpellier, France. This conference will allow us to share and learn about the latest developments in research, innovation, and industry.

What is the development strategy for sorghum in Europe, particularly in terms of demand creation, motivation of storage organisations, farmer training, and European early genetics?

To achieve an extensive and growing European Sorghum market, Sorghum ID aims to help more feed manufacturers to include this cereal in their formulas. This will contribute to a better understanding and management of the logistic chain, especially regarding storage organisations. Such organisations already manage massive grain volumes of various crops, and adding sorghum is not an easy decision. To better address the challenges, Sorghum ID will listen and promote exchange, by including the whole European sorghum sector in the solution-finding process.

Another key mission is the provision of technical information to farmers and technicians. Sorghum is a new crop for many producers. Technical skills have to be transmitted, especially regarding the choice of variety and management of the sensitive stages: sowing, flowering, identification of maturity level, harvest, and storage.

Have you seen interest increasing since the first European Sorghum Congress and the creation of the Sorghum ID association?

The first European Sorghum Congress was held in 2016 in Bucharest. This event contributed to raising the awareness of the people and organisations involved that they were not alone in their convictions and passion for the future of sorghum. This event founded the sector and gave great hope and ambitions to stakeholders.

**The FNPSMS - the French National Federation of Maize and Sorghum Seed Production*

DID YOU KNOW?

In 2022, a 4-year Casdar research project, NITROSORG, developped by INRAE, CIRAD, ITAVI and sorghum seeds companies, was launched to better understand and identify the quality of sorghum, in particular the content and digestibility of proteins and their suitability for poultry feed.

In comparison to corn, **sorghum has 2-3% more protein, 1% more starch, and more poultry energy.**

Today, the importance and benefits of sorghum for the future are understood. Crops diversification to face climate incidents, consumer expectation for cereals grown with fewer inputs, and the increasing need for gluten-free food are among the main factors driving the expansion of this crop.

Above all, diversification of use and product offer value are efficient and versatile ways to take advantage of the crop for both producers and the processing industry. Finally, genetic progress is flourishing. Areas of production are forever extending northwards. Productivity, digestibility, and earliness are upgraded every year.

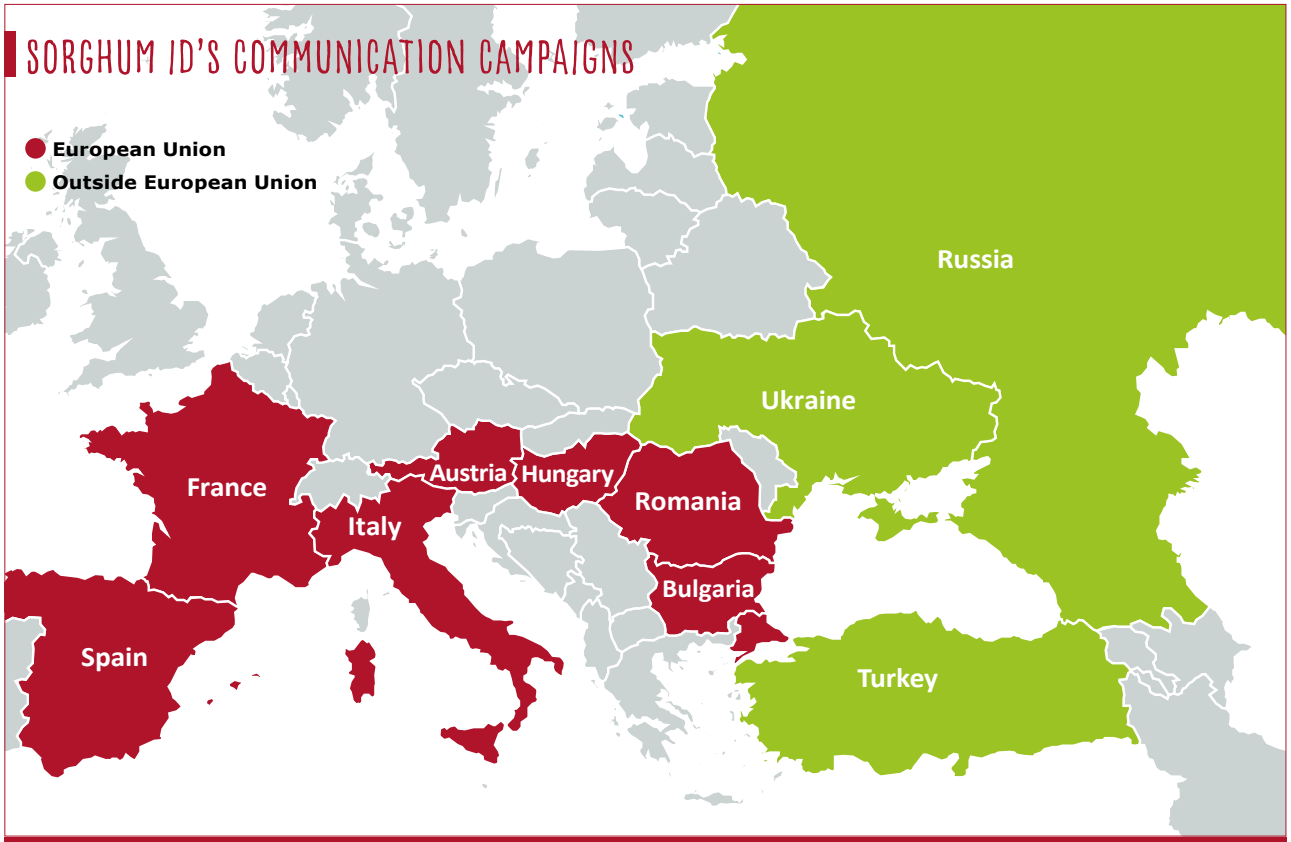
What is the future for sorghum in Europe? What are the keys to development in Europe?

In 2017-2018 Europe consumed more than 700,000 tons of imported sorghum, especially in the feed industry for swine nutrition.

We observed that the key to development is not only proving the relevance of sorghum. The main factors are volume and prices, regular and predictable availability of the commodity in both quantity and quality.

Once this has been achieved, sorghum has all the potential to become an opportunity for breeders, feed and food manufacturers, beverage producers, bakers, etc.

SORGHUM ID'S COMMUNICATION CAMPAIGNS



Sorghum ID conducts communication campaigns on sorghum in 11 countries, including three outside the European Union.

THE ASSOCIATION IN NUMBERS

27
MEMBERS, FROM SEED PRODUCERS TO PROCESSORS

10
NATIONALITIES REPRESENTED

250
PARTICIPANTS IN THE FIRST EUROPEAN SORGHUM CONGRESS

INTERVIEW

"SORGHUM HAS PLENTY OF ADVANTAGES FOR A MANUFACTURER LOOKING TO STAND OUT FROM THE CROWD"

The European Feed Manufacturers' Federation (FEFAC) brings together 23 national associations in Europe. We interviewed FEFAC's Deputy Secretary General, Arnaud Bouxin, to understand the challenges presented by sorghum for the European feed market.

Arnaud BOUXIN,

Deputy Secretary General of FEAC (European Feed Manufacturers Federation)

Have there been any changes in sorghum's image for livestock feed use in recent years?

In recent years the image of sorghum as a crop has undergone positive changes in Europe. The critical parameters were knowledge and availability. Thanks to Sorghum ID, knowledge of the product has improved and more information is available for feed manufacturers. In terms of availability, we are still far from the volumes necessary to reach a commodity level. There is some interest at the local level, but to attract more interest we need to set low prices for feed manufacturers, and farmers are not willing to do so.

There are two additional parameters that are relevant. First is quality chain development (non-GMO, organic). This is a positive factor in crops available in small volumes. Sorghum holds serious potential for Northern Europe because of its non-GMO nature.

Pricewise sorghum cannot compete with European corn or soybean but it can compete with non-GMO imported corn. This might promote an increased interest in sorghum.

Second, sorghum's fertilizer requirements are lower. Savings on inputs can potentially motivate farmers. The current situation presents opportunities for those who want to be pioneers in production or use.

The European Commission still does not consider sorghum to be a crop established as a sector. To obtain this recognition, we need food demand to act as a driver. Sorghum ID is developing a lot of food uses for sorghum. That's a good way to improve perceptions and establish the sustainability of the sorghum chain with farmers, EU institutions, and economic partners.

Why are sorghum volumes limited?

Volumes are considered sufficient above 1.5 M tonnes. When we start to include sorghum in feed formulations, we conduct simulations and we see how well it pays off. Using one feed material means no longer using another one.

"SORGHUM ID IS DEVELOPING A LOT OF FEED USES FOR SORGHUM"

Today's demand for sorghum comes from niche markets. Yet, the aim is for sorghum to go beyond niche markets. Here, volume makes the difference. The non-GMO market may hold the key to sorghum reaching the next level.

The organic market is currently another niche market, but it is not intended to be a niche market in the future. There is demand and intention expressed by public authorities to develop the organic market.

However, the European Commission action plan on organic farming for livestock products is yet to be adopted. While this is the case, there is a risk of a lack of political and economic support for organic livestock chains. Although there is a target of 25% for crops, the target for animal products is not visible.

We cannot have the same ambitions in terms of development of organic livestock products, nevertheless, there are developments. How big they will be, whether they will be enough to go beyond the niche market, remains to be seen.

What prevents sorghum from gaining in popularity?

If there were greater volumes available and the price was lower, sorghum could be more competitive than other crops.

To produce compound feed, an animal's requirements in energy, proteins, and nutrients must be met, the source itself does not matter. Animal nutrition aims to try to avoid changing the animals' diet too often. A switch from corn to sorghum would entail some changes in an animal's digestion and adaptation takes 2-3 days.

How do feed manufacturers decide on feed composition?

There is no special database. Feed manufacturers choose ingredients for an optimal diet. The ingredients depend on the respective prices. For example, in the north of Europe, they do not include corn, because, taking into account transport costs, the price of corn does not compete with barley. In the south, it is predominantly corn. It depends on the country and the scale of the food processing industry. Some coproducts are used as substitutes for cereals.

If we compare, for example, pig feed formulation in the north (Netherlands) and the south of Europe (Spain), in Spain it's 50% cereals, 40% corn, while in the Netherlands it's only 10% cereals, with 5% feed wheat and 5% barley, and the rest is a coproduct (bran from the milling industry, or corn gluten feed from the starch industry).

Such differences exist not only between countries but also from one feed manufacturer to another. Feed manufacturers are used to producing feed for different animal species. Optimisation of composition differs for pigs, dairy cows or chickens, because their nutritional requirements are not the same. If the feed manufacturers' main customers have chickens, and 50% of production is for chickens, the choice of 20 main ingredients will be driven by this.

But a feed meal manufacturer close by might specialise in pig feed, and they will select a range of feed that will be optimised for pig feed. Two manufacturing plants next to each other, with the same prices, won't use the same feed materials because of these conditions, so of course, the formulations will be different.

FORMULATION

SORGHUM IS A PRIMARY INGREDIENT OF A FEEDING RATION

Thanks to steadily improving energy and protein values over the past decade and a competitive cost per kg of dry matter, sorghum provides key advantages in animal feed. These nutritional and economic qualities are essential criteria for manufacturers when creating feed rations.

Feed manufacturers and farmers are unanimous in their view that sorghum can be an important component of animal rations. Sorghum seed concentrates energy and provides easily digestible protein. According to Alexandre Calendreau, in charge of feed formulation at Idena, near Nantes in western France, sorghum makes it possible to diversify the formula of feed rations as a supplement to wheat, corn and barley, or as the principal ingredient. "It's a cereal which ensures the quality of feed rations," he says.

"PROTEIN LEVELS IN SORGHUM GRAIN, AT BETWEEN 10 AND 11%, ARE IMPROVING YEAR ON YEAR"

The energy that sorghum provides is of interest to feed manufacturers, particularly for the development of table poultry, lactating sows and young animals. The latter consume small quantities of high-energy foods. Protein levels in sorghum seed, at between 10 and 11%, are improving year on year thanks to varietal research.

Economically interesting and secure supplies

In addition to its nutritional values, sorghum is also attractive because of its price, regardless of the destination of the feed ration: table poultry, layers, birds and pigs. "Sorghum should not be considered a substitute cereal, but rather a lever to improve the profitability ratios of industrial feed," explains Alexandre. Due to its high protein content, sorghum can limit dependence on soybean meal in feed rations. "It's a way to reduce expenditure on this imported protein and to boost the protein content provided by cereals in feed rations," adds Alexandre. Other criteria also interest feed manufacturers: ease of supply, limited risk of mycotoxin contamination and the consistent quality of sorghum seed produced in the same agricultural region.

Stable, high-quality yields

The presence of a local sorghum supply chain is prompting more manufacturers to turn to this grain, especially with a view to optimising logistical costs.

In countries where the existence of raw materials is an advantage - especially those which must meet specifications - sorghum is part of the logic of local production. And in countries where water resources are a problem, it's a crop which maintains its performance due to its suitable physiology. These are attributes to be highlighted and combat the conventional wisdom that European sorghum seeds still contain tannins. In fact, thanks to research, this has not been true for 20 years!

Alexandre CALENDREAU,
Head of Feed Formulation at Idena, based near Nantes in France

"By including sorghum, we can diversify the sources of energy and protein in feed and improve homogeneity. This factor improves animal performance."

Sorghum allows feed manufacturers to diversify their sources of protein and energy. The quality of the finished product is improved.

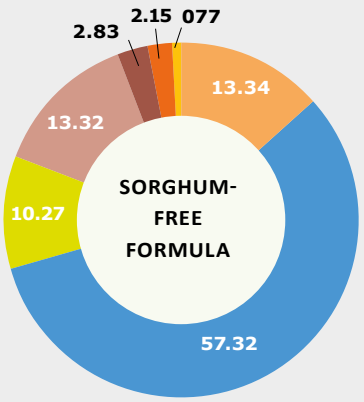
COMPLEMENTARITY BETWEEN CEREALS, AN ADVANTAGE FOR FEED MANUFACTURERS

Wheat: Feed pellets are well concentrated. The consistency is appreciated by poultry.

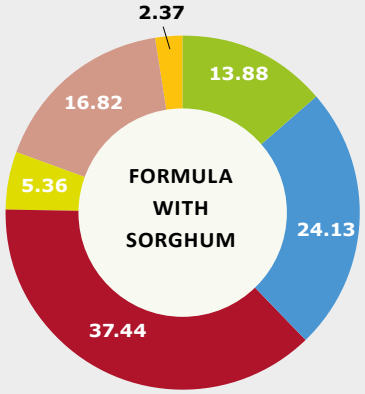
Corn: Rich in pigments to provide colour to poultry flesh and intensify the yellow of egg yolks.

Barley: Good fibre content which avoids health problems in pigs, especially young animals.

Sorghum: Low risk of mycotoxins, less linoleic acid and polyunsaturated fatty acid (improved meat quality), higher phytase activity.



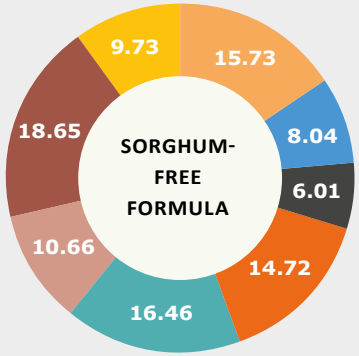
Wheat dominates the ration



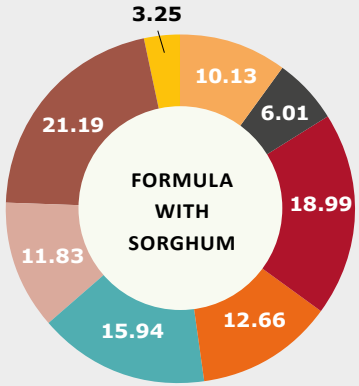
This formula reduces the proportion of wheat in favour of sorghum. It reduces the dependence on a single raw material (wheat), reduce oilseeds raw material and cost of the diet, while preserving the energy input needed for poultry growth.

Maize · Wheat · Rapeseed · Soybean meal · Rapeseed meal · Crude soybean oil · Sorghum · Others

Source: Idena



Cereals provide 30% of the ration's protein.



With the sorghum formula, cereals provide 35% of the ration's protein: managing the variability, a good amino acid digestibility and cost of the diet for adult pigs.

Maize · Wheat · Barley · Wheat middlings · Wheat-derived distillers dried grain · Sorghum · Soybean meal · Rapeseed meal · Others

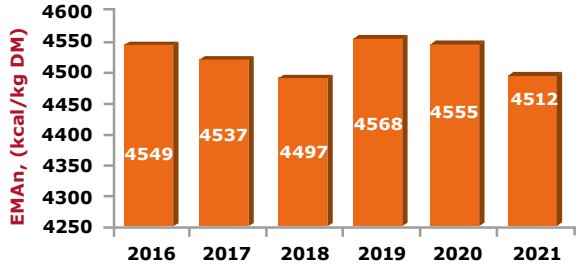
Source: Idena

NUTRITIONAL VALUES

	SORGHUM	CORN
Rooster energy value (Kcal/lg DM)	3796	3726
Protein value (% DM)	**10.7**	**8.2**
Starch value (% DM)	75.8	75.5
Fat value (% DM)	4.5	4
Fall (%DM)	8.5	9.4

Source: Arvalis Institut du Végétal - Qualit@lim collect pluriannual datas 2011-2021

EVOLUTION OF THE GROSS ENERGY VALUE OF SORGHUM



Source: FranceAgrimer/ARVALIS-Institut du végétal/ 2016-2021 collectors quality survey

These results, from the French technical institute Arvalis, show that when collection, drying and storage operations are properly conducted, sorghum should be a major player in the animal feed market.

The increase in energy values is interesting for the formulator because per kg of DM (dry matter), sorghum is progressively increasing in energy and protein points. The survey covered 10 departments accounting for about 85% of France's total sorghum collection.

PIGS

NUTRITIONAL POTENTIAL AND IMPROVED MEAT QUALITY

Ferenc Kurucz raises 120,000 pigs and cultivates 3,200 hectares of land, split between Romania and Hungary. According to the farm to fork principle, the field is devoted to crop cultivation, fodder preparation, breeding pigs, fattening and preparing meat, and producing premium meat products. He incorporated sorghum into his rotation for agronomic reasons as it allows him to better exploit land with low potential. He appreciates all the nutritional qualities sorghum has to offer in the production of pork pigs. The high nutritional value of this cereal has been proven.

"In both the growth phase and when finishing pigs, the average daily gain provided by sorghum is almost identical to that of corn," says Ferenc. As a producer of pork pigs in Hungary and Romania, Ferenc understands that sorghum has a place alongside corn, wheat and barley in his feed rations. "It has almost the same nutrient content: a little higher in amino acids, with a little less energy," adds the farmer, who raises 120,000 pigs. Indeed, this is exactly what the latest scientific studies say: sorghum has a high feed value in terms of its energy content and amino acid and fatty acid profiles.

"We use sorghum at every stage of production: during reproduction, growth and for finishing," says Ferenc. High in essential amino acids, the crop offers suitable amounts of threonine and tryptophan. On the performance side, average daily intake and gains range from 98% to 106% of the value of corn.

"In the feed rations of our 120,000 pork pigs, we have replaced some of the corn with sorghum because sorghum has almost the same nutritional composition as corn: a little higher in amino acids, a little lower in energy. In addition, sorghum is an economically attractive crop with agronomic qualities, because it grows on difficult land."

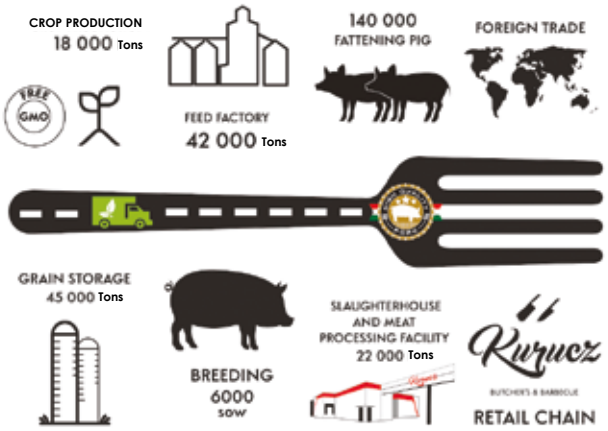
Grain preparation

Sorghum grain needs to be properly processed to unlock all its feed potential. The grain is small and very hard in comparison to corn, so sorghum grain must be broken into fine particles to improve its digestibility for animals. Ferenc explains the steps he takes after a wet harvest (grain with 30% humidity). "We mill corn and sorghum, then tread it with big tractors and cover it with plastic foil," he explains. "After lactic fermentation, this provides very high-quality feed for our pigs."

Ferenc KURUCZ,
Pork pigs producer in Romania and Hungary

"In the feed rations of our 120,000 pork pigs, we have replaced some of the maize with sorghum because sorghum has almost the same nutritional composition as maize: a little higher in amino acids, a little lower in energy. In addition, sorghum is an economically interesting crop with agronomic qualities because it grows on difficult land."

SHORT SUPPLY CHAIN



https://www.kurucz.eu/tartalom/29/szemleletmodunk

GOOD TO KNOW

Sorghum's societal benefits

Sorghum has nutritional qualities that meet the societal demand for a stronger link between food, health and the environment.

Less phosphorus released into the environment

Sorghum contains phosphorus in sufficient quantities, which can be directly assimilated by animals. This reduces purchases of inorganic phosphorus: the total concentration in the ration is lower and less phosphorus is released into the environment via urine too.

Benefits of good lysine content of sorghum for animal welfare

Better meat structure

Pigs fed a diet based on sorghum provide meat with firmer fat, containing less iodine, linoleic acid and polyunsaturated fatty acids.

An agronomic ally

However, sorghum is not only advantageous for the formulation of balanced and high-performance feed rations.

Depending on crop rotation, Ferenc produces 150 to 500 ha of sorghum from a total surface area of 3,200 hectares. Ferenc has found it to be a useful agronomic ally. “We cultivate 2,200 ha in Hungary and 1,000 ha in Romania,” he explains.

“In Hungary, half of our land is of poor agronomic quality, and we plant sorghum on the poorer land. Corn is not profitable in these fields, and we needed another crop in the rotation alongside sunflower, wheat and barley.”

So, in terms of agronomics, nutrition, environment and health, sorghum has it all!

TWO SORGHUM-BASED RATIONS

To take full advantage of sorghum’s nutritional value, it is recommended that sorghum-based diets be formulated based on a standardised ileal digestible amino acid as well as digestible phosphorus.

The first option contains greater amounts of crystalline amino acids and less soybean meal and monocalcium phosphate. It takes full advantage of grain sorghum’s highly digestible threonine, tryptophan and valine concentrations and allows for greater use of crystalline amino acids.

This reduces the amount of soybean meal in the diet and helps decrease nitrogen excretion in swine waste. The second option implies the addition of a little fat to a sorghum base in order to reach the same levels of energy as a corn-based ration.

Ingredients %	Maize	Sorghum (option n°1)	Sorghum (option n°2)
Sorghum	-	79.35	78.2
Maize	77.27	-	-
Soya-based feed	20.06	17.81	18.25
Choice with white fat	-	-	0.7
Monocalcium P, 21%P	0.6	0.53	0.53
Ground limestone	1.03	1.08	1.08
Salt	0.35	0.35	0.35
L-Lysine-HCl	0.29	0.385	0.385
DL-Methionine	0.03	0.09	0.095
L-Threonine	0.06	0.085	0.085
L-Tryptophan	0.005	0.013	0.013
Vitamin premix	0.15	0.15	0,15
Trace mineral premix	0.15	0.15	0.15
Total	100%	100%	100%
Standardised digestible ILEAL amino acids,%			
Net energy, Kcal/KG	2,495.63	2,466.97	2,495.63
Total lysine, %	1.02	0.99	1
Crude protein, %	16.3	16.4	16.5
Calcium, %	0.55	0.55	0.55
Total P, %	0.467	0.45	0.45
Digestible P, %	0.25	0.25	0.25

Example of a sorghum ration compared to maize

Source : www.sorghumcheckoff.com

Xavier ARTIGAS,
of Pinsos del Estany, a feed manufacturer for pig and veal farms in Spain

“Each month, we distribute 2,500 tonnes of feed throughout the Girona region, including 130 tonnes of sorghum. Since the appearance of new varieties, devoid of tannins, sorghum is mainly fed to pigs.

The animals find these new varieties more palatable than the old varieties, which they rejected. Pigs eat more and gain weight faster. The farmer improves farm productivity and also benefits from cheaper rations than those based on maize, wheat and soyabean meal. However, to provide the best balance between digestibility, palatability, and protein and energy intake, the ideal blend contains four cereals, including sorghum.”

Example of a typical ration:

Sorghum: 10 to 15% (around 15% is best)

Maize: 20%

Wheat: 30%

Barley: 15%

Soya protein, oilseed rape, amino acids: 10 to 15%

Others: 10%

Xavier Artigas incorporates between 10 and 15% of sorghum in the feed ration he makes. If he cannot find sufficient volumes of good quality sorghum on the market, he cannot increase the share of this cereal in the feed ration.

TABLE POULTRY AND FOIE GRAS PALMIPEDS

SORGHUM BOOSTS PERFORMANCE!

Combined with corn in poultry rations, sorghum guarantees better animal performance while maintaining the quality of the finished product. Sorghum's protein levels, and especially its energy content, make it an ingredient of choice for fast-growing poultry.

For poultry, a good balance between different amino acids is essential right from the start. It is impossible for chicks to catch up after a deficiency during their early days, which causes delays in growth and performance.

The essential amino acids for poultry are methionine, lysine, threonine, tryptophan, leucine, isoleucine, valine, serine, arginine, histidine and phenylalanine. It is difficult or even impossible for poultry to synthesise these amino acids, therefore they must form part of the diet.

To properly construct the ration, the digestibility coefficients of these amino acids are more important than their gross quantity in the grain.

These coefficients are generally lower for sorghum than for corn with equivalent protein content. However, with an average dry matter of 10.7%, sorghum's protein content is 2-3% higher than that of corn. The two cereals are equal in terms of the digestibility of their nutrients.

True digestibility coefficients (%) for selected Amino Acids in sorghum & maize (NRC,1994)

COMPOSITION	SORGHUM GRAIN (8.8%)	MAIZE GRAIN (8.8%)
Lysine	78	81
Methionine	89	91
Cystine	83	85
Arginine	74	89
Threonine	82	84
Valine	87	88
Isoleucine	88	88
Leucine	94	93
Histidine	87	94
Phenylalanine	91	91

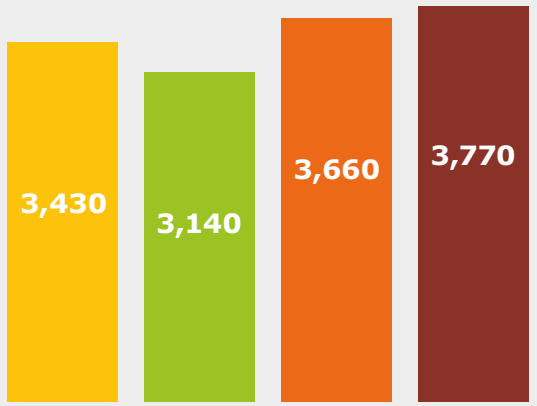
Tannins and enzymes are factors in digestibility

The digestibility of amino acids decreases significantly when tannins are present. Tannins are not found in cereals such as wheat and corn, but used to be present in traditional sorghum varieties. Today, all recent sorghum varieties have tannin thresholds of less than 0.3%. This means that feed manufacturers need have no concerns in this regard, as long as they are sure of the origin of their sorghum grain.

As with other cereals, the addition of enzymes in feed preparations increases nutrient availability. Studies show that a mixture of pectinases, glucanases and hemicellulases added to sorghum and soybean rations improves the ileal digestibility of amino acids by 3% and metabolizable energy by 6%.

SORGHUM: CHAMPION CEREAL FOR ENERGY IN POULTRY

Apparent metabolizable energy for poultry (AME) in kcal/kg DM)



Rougié

Protein level, energy content and digestibility of nutrients: sorghum shows good qualities for poultry and foie gras palmided formulations.

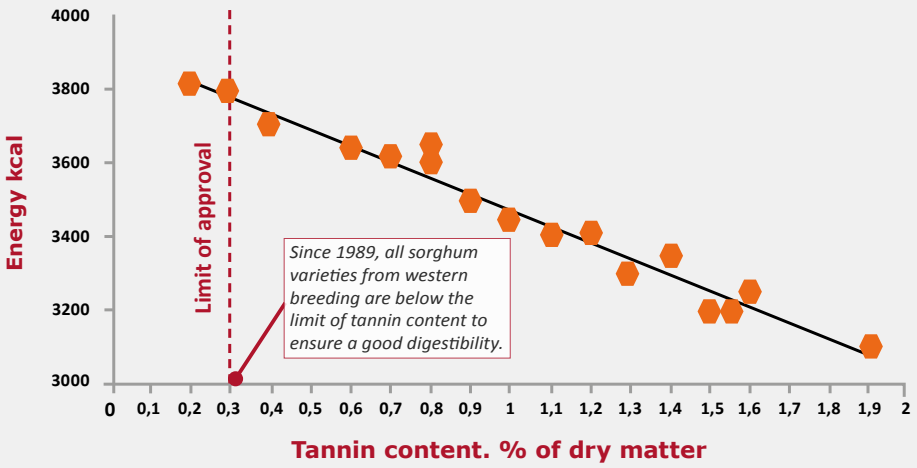
DID YOU KNOW?

"Goose or duck foie gras"

Sorghum i s rich in protein, particularly in protein with branched amino acids that help strengthen cell walls and therefore limit the livers melting.

These amino acids activate another fat storage pathway in the liver that can improve liver weight or reduce force-feeding time.

Sorghum as an ingredient is also recognized as a benefit to animal welfare at the time of fattening.



For poultry (Grosjean and Metayer, 1993), the presence of tannins linearly affects the energy value of sorghum. For adult cocks for example, 1% tannin reduces the energy value of sorghum by 11%.

Catalin FUDULU,
Technical Director of Nutrition and Formulation
at G-A Nutritie Animala (EVIALIS), Romania

"Sorghum provides an economical source of energy for poultry during their growth and production stages"

"We have been using sorghum for nine years in our poultry formulations. In our region, sorghum is systematically cheaper than corn, while being higher in protein, which helps make it more competitive. However, its main interest is its energy content, and this is particularly useful for poultry feed production where energy is one of the highest costs. It can be incorporated at up to 40% in poultry feed formulas at the growing or production stage, but for the starter phases, it is preferable to lower the maximum incorporation rate to 30%. Tannins influence the digestibility of protein, but varieties with low tannin content resolve this problem.

So it is important to be aware of the variety used for the feed. If chickens are late in starting their growth, it's impossible to catch up later! The only problem with this cereal is the break in supply, as volumes are available only a few weeks after harvest.

This is why manufacturers prefer not to use it to a great extent, so as not to have to change their formulations very often. If we had good availability of sorghum all year long, the approach could be different."

Industrial manufacturing: keeping processing to a minimum

Several studies have shown that poultry can properly digest sorghum, regardless of whether it is in the form of whole grains or milled. Unlike pigs, who assimilate finely ground grains more easily, poultry use their gizzards to reduce the size of the food they eat.

The distribution of whole grains is therefore the most economical way to feed poultry. For manufacturers wishing to incorporate sorghum in their formulations, the decision on whether to mill the grain is not based on the digestibility of nutrients, but on manufacturing constraints: suitable milling tools, desired quality of the final pellet, milling costs, etc.

The over-processing of sorghum grain, like excessive heat or moisture during feed production, may cause chemical cross-linking and reduce nutrient availability.

Feed type	Sorghum grain and flour	Maize grain and sorghum flour	Sorghum grain and maize flour
ZOONOTIC PERFORMANCE OF GEESE			
Feed conversion ratio (FCR) Gavage	4.81	5	4.87
Liver weight (kg)	1.07	0.98	1.03
LIVER COLOUR			
Luminance	64.8	66.5	64.5
DISTRIBUTION OF LIVERS ACCORDING TO COMMERCIAL GRADE			
Total number of livers	84	82	-
Extra	5	28	20
Premium	22	24	21
Grade C, large	35	20	34
All defects	20, of which 16 grey	7, of which 1 grey	2
Others	2	3	5

Animals received 13.2kg of feed, of which 42% was in the form of grain and 58% in the form of flour. Geese fed a mixture of maize grain and sorghum flour offer the best compromise between quality and quantity.

TABLE POULTRY AND FOIE GRAS PALMIPEDS

Colour, taste and texture: finding the right balance in feed rations

A diet including sorghum has little effect on the organoleptic qualities of finished products, whether it is foie gras, meat or poultry skin. Sorghum contains less xanthophyll than corn. This pigment is the cause of the yellow colouring in the final product.

Poultry fed on a diet rich in sorghum will provide meat which is less yellow than those fed on corn. The addition of natural xanthophyll corrects this loss of colour and is easily integrated into the feed manufacturing process.

However, some markets prefer plain meat and, while the colour of meat may be changed, there is no effect on its taste! A study has shown that the taste qualities of goose breasts are not influenced by the choice of cereal during the growth and finishing stages.

Boosting weight with the inclusion of sorghum

The mash used for the gavage of geese for foie gras production comprises water, additives and almost exclusively corn. Completely replacing corn with sorghum increases animal performance. This improvement may be explained by the amylopectin/amylose ratio, which differs between cereals and is generally higher in sorghum than in corn. In birds, amylopectin is more digestible than amylose.

Nevertheless, the feed conversion ratio and the yellow colouration of livers of sorghum-fed birds is lower, hence the regular commercial downgrading of these livers. The solution lies in balancing the two cereals.

Vigilance is required, however, as during the first five days of feeding, skipped meals are frequently observed for geese fed with mash containing sorghum grain rather than flour.

Ujvári SÁNDOR,

Deputy CEO of Tranzit-Ker Zrt. poultry processing company in Hungary

"Every year, we process 1,8-2 million geese, 8-9 million ducks and 15 million broiler chickens Our activity is focused on eastern Hungary and we have 70% market share in geese and 36% in ducks, making us market leaders in waterfowl. Our feed factory can produce nearly 150,000 tonnes, out of which we can produce approximately 100,000 tons of duck and goose feed mixes.

Our waterfowl feed has been non-GMO since 2016. In 100,000 tonnes of waterfowl feed, we use red grain sorghum to replace corn when it is available. Then, we do not include corn in our feed recipes and use sorghum at around 30 to 40% of the ration."

"We started to investigate the use of sorghum because near our feed factories the production areas have poor quality sandy soils with low water storage capacity. Also, we had to face the fact that due to climate change the quantity of water - rain - available in the vegetation phase is driving production towards drought-tolerant crops. Besides sorghum's better drought tolerance compared to corn, it also has a higher crude protein content which could help in avoiding the use of GMO soy in feed. We have had to establish sorghum's place in our feed recipes and to explore its profitability compared to corn given that lysine levels are not so high.

We haven't experienced any negative effect on meat quality during sorghum use. Quality has remained at the level we are used to. In addition, we don't have to worry about GMOs and toxins. If a feed producer already works with cereals, technically it shouldn't be any problem to include sorghum in the rotation.

We still have some challenges to integrate sorghum production at the farmer level though, since it is a 'new' crop and we have to convince farmers to include sorghum in their rotation and to ensure them that Tranzit-Ker will buy all of their production."

Sorghum can be integrated into poultry feed from the chick stage, maintaining the balance between essential amino acids.

Catalin FUDULU,
Technical Director of Nutrition and Formulation at G-A Nutritie Animala (EVIALIS), Romania,

includes sorghum in feed recipes at around 25% of the ration during poultry's growth stage.

"It is the main cereal in the ration. We start with lower inclusion rates to avoid digestibility risks, and we increase this rate as an animal gets older. Animals can digest it easily when they have a well-developed digestive system."

Industrial manufacturing: keeping processing to a minimum

In the initial stage, the priority for feed rations is the balance between the different amino acids and their digestibility for chicks.

Once the growth stage is reached, the goal is muscle gain. Energy becomes the priority while ensuring there is a balance of amino acids essential to good animal growth. As a result, a gradual increase in the proportion of sorghum in the diet becomes possible.

Broiler starters	Broiler grower	Replacement pullets	Laying hems	Breeding hems
30	40	40	40	35

**Maximum recommended inclusion levels in poultry feeds(%)*

András FARKAS
Managing Director,
Agroprodukt Kft, Hungary

"Our feed costs have decreased by 5-8% since introduction of sorghum in ration"

Raw materials (in %) \ Stage	Chick	Growth stage (10-20 days)	Growth stage (21-31 days)	Finishing (32 days - slaughter)
Maize	20	20	20	22,52
Wheat	25	25	25	15
Sorghum	18,91	24,56	28,47	35
Maize draff	1,19			
Soybean meal	28,01	26,05	19,96	18,16
Sunflower meal	1,96		2,96	5
Calcium carbonate	0,89	0,42	0,22	0,46
Dehydrated di-calcium phosphate	0,94	0,42	0,19	0,24
sodium bicarbonate	0,15	0,1	0,1	0,15
Sodium chloride	0,17	0,18	0,17	0,25
Crude soya oil	0,98	1,57	1,24	2
DL Methionine 99%	0,23	0,22	0,17	0,16
Liquid lysine 50 %	0,46	0,4	0,47	0,51
L-threonine 98%	0,11	0,09	0,06	0,05
Chick premix	0,5			
Growth premix		0,5	0,5	
Finishing premix				0,5
Premix	0,5	0,5	0,5	

Characteristics (in %) \ Stage	Chick	Growth stage (10-20 days)	Growth stage (21-31 days)	Finishing (32 days - slaughter)
Humidity	12,74	12,89	13,02	12,92
Crude fat	3,42	3,99	3,73	4,67
Crude cellulose	3,41	2,99	3,26	3,45
Mineral content	5,72	4,47	3,9	3,86
Starch	41,42	44,92	47,44	47,2
Crude protein A.	20,92	19,07	17,72	17,39

The percentage of sorghum gradually increases to 35% of the ration at the finishing stage, at which time animals need energy to gain weight.

© Rougié

LAYING HENS

AIMING FOR OPTIMAL EGG QUALITY WHILE OPTIMISING FEED COSTS

Florin Dumitru raises 112,000 laying hens on a 400 ha farm in Romania. He grows all the cereals used in his poultry rations. Sorghum makes up 18% of the whole ration, reducing the price of feed after manufacture. Pecked by hens, sorghum seeds contribute to their well-being.

Based in Romania, Florin has two large buildings housing his layer hens which produce 100,000 eggs per day. He pays close attention to both the cost and nutritional quality of feed because his eggs are appreciated not only by shoppers at a chain of supermarkets in Bucharest, but further afield in Italy and Austria, and, as diversification is a necessity, on the markets of eastern Romania: "I take the time to talk with my clients," he says.

"Healthy, dense yolks with a lovely colour are the indicators of good quality." Florin controls almost the entire production chain, from the raw material used to make the feed through to the distribution of eggs.

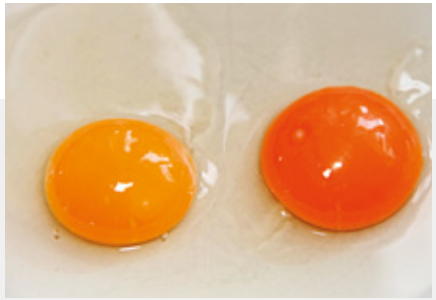
He keeps a very close eye on profitability ratios and traceability. The cereals that go into the feed formula for his hens are grown on the farm. The formula has been specially designed by nearby feed producer Combavipor SA Galati, which is the destination for his crops.

Feed costs were reduced by €11 per tonne thanks to sorghum

Thanks to sorghum, he has found an answer to the economic constraints of egg production. "My 112,000 hens consume 13.5 tonnes of feed every day and the slightest variation in price has a significant impact on the farm's profitability," he explains. Working with the feed manufacturer, he compared two formulations (see graph).

The first (entitled 'sorghum') contains 24% sorghum, 18% corn, 22.3% soybean meal, wheat, barley, sunflower meal and additives. The second (entitled 'corn') has the same ratios of barley, sunflower meal and additives but soybean meal is increased to 23.8%, corn to 38% and wheat to 10%. While the nutritional quality is similar, the sorghum formula is €11 per tonne cheaper. "I save €4,500 a month," he says.

This bonus allows him to employ 10 staff. The sorghum, both red and white-grained varieties, provides the same energy value as corn but with 2.5 points more protein. It, therefore, offsets some of the protein intake provided by soybean meals and the energy provided by corn.



"I'M IN CONTACT WITH THE IASI AGRICULTURAL UNIVERSITY AS PART OF A PHD ON THE FEEDING OF HENS AND EGG QUALITY. IN PARTICULAR, I WOULD LIKE TO CHECK WHETHER THE INCLUSION OF SORGHUM IN THE RATION AFFECTS THE THICKER CONSTITUTION OF THE YOLK AS WELL AS ITS IMPACT ON THE INTENSITY OF THE YOLK'S COLOUR."

Up to 70% of the rations fed to laying hens can be made up of sorghum. Hens particularly appreciate whole grains.

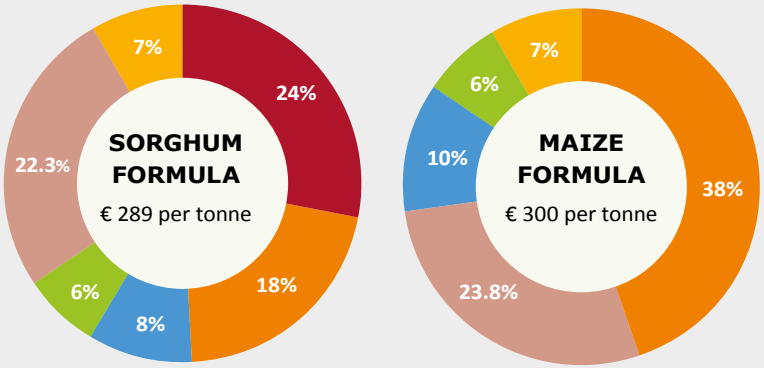
DID YOU KNOW?

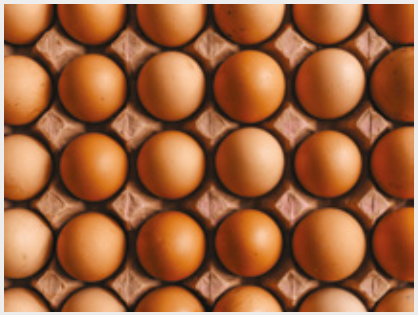
Sorghum and the intensity of yolk colour

Sorghum is low in xanthophyll, a carotene-derived yellow pigment which intensifies the colour of egg yolks, and this is offset by the inclusion of additives. These additives are either natural from the carotenoid family or synthetic and do not significantly affect the final cost of the feed.

ECONOMIC COMPARISON BETWEEN TWO FEED FORMULAS FOR LAYING HENS

Formulations composed for Florin Dumitru's laying hens





Sorghum **Maize** **Wheat** **Barley** **Soybean meal** **Sunflower meal and additives**

ECONOMIC BENEFITS: 11 € / t with sorghum formula

ROTATION: 120 ha wheat, 125 ha maize, 40 ha sorghum

FARM: 400 ha of land, one battery unit with 40,000 caged hens and one barn with 72,000 free-roaming hens, 100,000 eggs per day

Feed performs well

In addition to price, the performance of feed is an important criterion. "I have two feed systems," explains Cristian. "The first is a chain feeder system, which runs all along the building. The second consists of small trolleys but they do not work well if the feed gives off more dust."

Feed rich in sorghum has a better consistency, it "flows better". In addition, hens search out the small sorghum seeds and peck them. "They are kept busy," he smiles.

In terms of cropping, Florin has identified another advantage: sorghum performs well in times of drought and requires little treatment apart from weeding.

Provided sowing has been successful, it is an easy crop to grow. "The soil must be finely prepared for the seed to germinate properly," he explains. Having noticed an increase in the number of episodic droughts over the past decade, he plans to increase the area dedicated to sorghum by 15%.

Sorghum cultivation is advantageous in eastern Romania because it's a region where irrigation systems are not usually available and so crops rely only on rainfall.

BEEF CATTLE

SORGHUM NUTRITIONAL VALUE FOR BEEF CATTLE FEED

Sorghum is an important feedstuff for livestock. Barley, corn, sorghum and wheat are all potential sources of energy for beef animals. Depending on local climate conditions, one grain may be preferred over another.

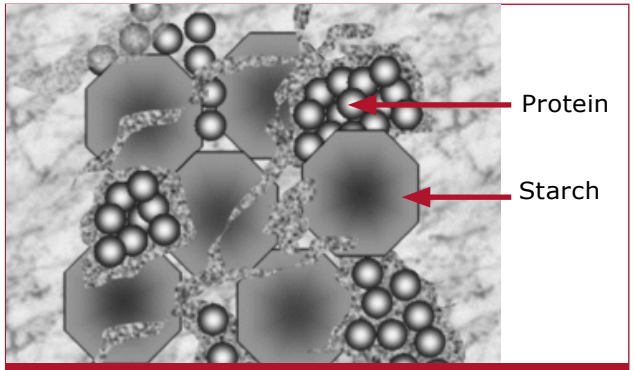
Sorghum and corn are highly comparable in terms of energy. A slight digestibility advantage for corn over sorghum may be observed in theory, but the difference is relatively small and may not be detected in animal trials.

Starch utilisation in the rumen is critical when increasing animal performance.

As a result, determining and understanding the ruminal fermentation patterns of various grain sources is important when attempting to achieve high levels of feed efficiency and increase average daily gain.

AVERAGE NUTRIENT VALUES

	Grain	Nutrient Requirements of Beef Cattle
Crude protein (%)	SORGHUM	12,60
	MAIZE	9,80
	BARLEY	13,20
	WHEAT	14,20



Protein starch interaction

Through grain processing, the protein digestibility for livestock animals can be optimised.

Journal of Food Science

3 DIFFERENT GRAIN PROCESSING METHODS

Different methods of processing with five different grains concluded that sorghum-based feed resulted in similar average daily gains to corn when fed to livestock animals.

Dry rolled | Humid (30% H_2O) | Steam roll (Flakes)

DRY MATTER INTAKE COMPARISON (KG/DAY)

Processing	Barley	Maize	Sorghum	Oat	Wheat
Dry-rolling	8,89	**9,45**	**10,47**	9,20	8,97
Humid (30% H_2O)		**8,72**	**9,15**		
Steam-flaking	8,25	**8,35**	**8,68**	9,12	8,10

FEED EFFICIENCY COMPARISON: WEIGHT GAIN (KG/DAY)

Processing	Barley	Maize	Sorghum	Oat	Wheat
Dry-rolling	6,25	**6,57**	**7,43**	6,01	6,59
Humid (30% H_2O)		**6,43**	**7,12**		
Steam-flaking	6,19	**5,87**	**6,33**	6,18	5,92

Steam-flaking can increase the nutritional value of sorghum by 12-15% compared to dry-rolling, by increasing starch digestibility in the rumen and throughout the digestive tract. It also contributes to improving the digestibility of the crude proteins contained in sorghum.

FEED/WEIGHT GAIN COMPARISON (KG)

Treatment	Maize	Sorghum
Dry-rolling	**3,13**	**3,31**
Steam-flaking	**2,86**	**2,95**

WEIGHT GAIN PER DAY COMPARISON (KG)

Treatment	Maize	Sorghum
Dry-rolling	**1,20**	**1,20**
Steam-flaking	**1,20**	**1,20**

FLAKED SORGHUM = LIVESTOCK YIELD SIMILAR TO MAIZE.

Sorghum grain with adapted processing is an alternative to corn. Steam-flaking is the most suitable grain processing treatment, but high moisture processing may be interesting due to its low cost.

OUTCOMES

- Appropriate processing method can increase the efficiency of sorghum grain for livestock.
- Early harvest at 30% H_2O vs. 16% H_2O (norm) guarantees a better quality of grain. A drying system is not required, and it can easily be stored in a silo or tube with no investment.
- Better digestibility of protein and increased performance.
- Consumption index records 5% improvement with sorghum-corn mixture.
- Sorghum promotes average weight gains similar to those obtained with corn rations fed to cattle in feedlots.
- Meat quality increases (lower acid linoleic and polyunsaturated fatty acid).
- Better level of lysine or amino acid in general.
- 30% fewer inputs for cultivation: pesticides and fertilisation (therefore, increased profit margin).
- Enhanced drought tolerance and early hybrid technology lead to yield performance.
- The good preceding crop can be managed as green manure for sunflowers.

Bernard ADER,
Vice-president of COPA COGECA* and farmer producing Limousin beef cattle in the South-West of France

"I have been growing conventional and organic sorghum for more than 30 years. In organic cattle meat production, sorghum allows me to vary the sources of energy, proteins, amino acids, and trace elements present in our cereal mix, which is composed of sorghum, corn and triticale, for Limousine beef production rations. Sorghum is also low in linoleic and polyunsaturated fatty acids for better quality meat produced.

We cultivate sorghum as an intermediate crop behind meslin because it is also a hardy plant, requiring little water and with lower input requirements. It is an easy plant to harvest at 15% H_2O, without drying costs and easy to store and therefore profitable."

"IN CATTLE MEAT PRODUCTION, SORGHUM ALLOWS ME TO VARY THE SOURCES OF ENERGY, PROTEINS, AMINO ACIDS, AND TRACE ELEMENTS PRESENT IN OUR CEREAL MIX."

**Copa (the Committee of Professional Agricultural Organisations) represents over 22 million European farmers and their family members.*

Cogeca (the General Confederation of Agricultural Cooperatives) represents the general and specific interests of European agri-food, forestry, and fishery cooperatives.

INTERVIEW

SORGHUM IN PET FOOD INDUSTRY

"I am surprised whenever I get the question why would you use sorghum in pet food. To me, it makes absolute sense. I've been dealing with sorghum for more than 25 years."

Greg ALDRICH,
Associate Professor at Kansas State University
in a grain science and industry department

Could you please tell us more about your department?

"Historically, we've been focused on the research and teaching of milling science, the idea of conversion of wheat seeds into wheat flour. Later it evolved into bakery science, and then, the last addition was to explore a feed science, livestock feed manufacturing. And I am the last addition, with my coming to the university in 2011, to introduce pet food science to our university.

Today our laboratory works on a number of different topics associated with pet food manufacturing and its nutritional value, so we look at the effects of the process and how that influences the nutrition, the shelf life, and overall food safety. And, of course, you can't make pet food without ingredients, so we bring ingredients into this equation.

I started my pet food career in 1995 and I've been dealing with sorghum in pet food for almost more than 25 years. I found it to be very acceptable as a starch source comparable to corn and a very effective ingredient."

Which studies did you carry out about sorghum?

«We have done a fair number of research studies here in our laboratory. During one of our first studies, we evaluated the process of milling sorghum into sorghum bran, sorghum germ, and sorghum flour. If we deconstruct the whole seed, there might be an added value. Sorghum flour may have other applications, the bran may be a very viable source of fermentable soluble fiber for gastrointestinal health, and germ might be another fraction that brings value in terms of high levels of essential fatty acids. Deconstruction brings more value to those separated fractions.

> "I FOUND SORGHUM TO BE VERY ACCEPTABLE AS A STARCH SOURCE COMPARABLE TO CORN AND A VERY EFFECTIVE INGREDIENT."

Those first studies were very effective and demonstrated that the use of sorghum flour could provide us with a superior digestibility to corn, wheat, or rice-based starch excluded diet.

Whole grain sorghum itself performs very much, the same as those combined cereals, and the thing that came out from a lot of work, even high levels in which we fed those diets, sorghum bran, or mill feed, the digestibility of those diets was slightly lower than the mainstream starches, but that could be an effective use in a weight loss diet.

And the other result was that the antioxidants circulating in the bloodstream of the dogs were about four falls than were in the controls. An idea here is that sorghum because of its seed coat contains a lot of polyphenolic compounds that are antioxidants. And they are not just antioxidants for the seed's protection while it's growing, they are antioxidants that are functional in animal circulation. That's why sorghum has an opportunity to advance itself beyond just being a starch source or fiber source, like other cereals, because of the content of polyphenolic acids."

POPULATION: MORE THAN 900 MILLION DOGS, 600 MILLION CATS WORLDWIDE

Top 10 Dog Populations By Country

COUNTRY	POPULATION
USA	69,929,000
China	27,400,000
Russia	12,520,000
Japan	12,000,000
Philippines	11,600,000
India	10,200,000
Argentina	9,200,000
United Kingdom	9,000,000
France	7,570,000
South Africa	7,400,000

Top 10 Cat Populations By Country

COUNTRY	POPULATION
USA	74,059,000
China	53,100,000
Russia	17,800,000
Brazil	12,466,000
France	11,480,000
Germany	8,200,000
United Kingdom	8,000,000
Italy	7,4000,000
Ukraine	7,350,000
Japan	7,300,000

https://www.simplyinsurance.com/pet-statistics/

DID YOU KNOW?

"SORGHUM IS BEING UTILIZED BY 15 PET FOOD COMPANIES IN USA IN MORE THAN 150 PRODUCTS"

https://www.sorghumcheckoff.com/consumers/pet-food/

In what form sorghum is introduced in pet rations?

"In addition to kibbles, we made sorghum crisps, it looks like puffed sorghum. It has a very natty taste and resilient structure. They look like granola bars, as we added pumpkin pepitas, coconut, and some other cereals, and we used soluble animal proteins, like gelatin, spray-dried plasma, and egg white, so we were able to construct those bars together. We compared them to rice-based granola bars.

There were no granola bars for pets as a treat, as we didn't need to use sugar or syrup, to bring the ingredients together. And dogs loved the taste! So it's a new sort of application. Instead of putting sorghum into a kibble, we were able to make a peace, that you could then turn into other confectionery products.

"IT'S ABOUT 50 DIFFERENT PRODUCTS ON THE MARKETPLACE THAT ARE USING SORGHUM TODAY IN PET FOOD."

The fun fact about sorghum crispies besides a flavor, that is the texture did not get mashy as you add syrup to it, sorghum crisps retain their shape inlike rice crisps. And I think it has to do with the amylose and amylopectin ratio and the level of potentially resistant starch in sorghum.

Whether or not, we can use sorghum to achieve the level of resistance of starch that escapes digestion and a small intestine from metabolism in a colon. And that would be good for gastrointestinal health. It's equal to other starches, but with polyphenolics we get antioxidants, and with this difference in the amylose and amylopectin ratio, we may shift the digestion of those starches to give us an advantage in fermentation.

We put sorghum whole ground and flour into bit treats. Those are primary forms to get into a formula. Sorghum is rarely used for canned food, we don't see it as a very acceptable application. But extruded, the croquettes and the bit dog treats looked like bones, those are particularly acceptable forms."

Is sorghum winning the increasing demand for feed formulations in the United States? Which other countries have adopted these cereals for the pet food industry?

"Today it's mostly North America that uses sorghum in pet food. All of the various things that have to come together to make sorghum a popular ingredient are here, in North America, but I think that other countries start to embrace the idea that it would be a good fair in crop rotations because of its hardiness, its decrease or low water requirement, its yield.

We have a fair number of pet food production companies that adopted using sorghum, so it is coming around in that category. It's about 50 different products on the marketplace that are using sorghum today in pet food."

What are the advantages and disadvantages of sorghum for pet food?

"The type of starch is another advantage and the opportunity to increase the resistance in a finished product. It doesn't have other functionalities beyond that from a processing standpoint. The seed coat is an interesting part, a pericarp with polyphenolic acids, antioxidants, and various flavonoids, that's where the real story comes out. They used to call them tannins, but they are not, they are condensed tannins.

The idea is that the color used to be described as bird resistance because it was bitter. But we didn't find any decrease in protein digestibility or palatability. And the most important point is that we cook our pet foods, so they've got through extrusion processing.

If we process them through extrusion, we've converted the starch and we've modified those flavor components, and most of those concerns go away, where they may still be evident in livestock feeds. The color, that everybody was worried about, is positive, it's a physiological benefit."

What proportion is sorghum in diets generally observed?

"There is no limitation on how much we should put in the formula for pet food. You can use it interchangeably with corn or rice in a pet food formula. It could be the sole starch, or the sole carbohydrate, without any digestive issues.

In the formula, we had to limit barley to 15-20%, and pulses to 20% because of high levels of oligosaccharides. Rice, corn, and sorghum we can put as much as we need as a single starch source. The rest of the equation comes from the market and regulations, the place of another product, and positioning with a consumer."

What are the motivations and main drivers for the pet food industry in the United States to introduce sorghum to the diet?

"The concept of sustainability, its lower agronomic costs to the environment. It doesn't require as much herbicides, pesticides, or fertilisers as corn or rice might. It is adapted to a lot more arid climates, it does not require as much irrigation and it can sustain higher temperatures.

Today sorghum is non-genetically engineered, so it's a very clean label and it should be acceptable to consumers."

DID YOU KNOW?

"PALATABILITY STUDIES HAVE SHOWN NO DIFFERENCES IN PETFOOD INTAKE BETWEEN EXTRUDED SORGHUM DIETS AND DIETS MANUFACTURED WITH OTHER GRAINS, SUCH AS CORN, WHEAT AND RICE."

DID YOU KNOW?

In Europe, Sorghum is also used in fish farming for its tolerance to mycotoxins compared to other cereals, but also its protein, starch, energy value, very low tannin (<0.12%, absence of anti-nutritional factors with early European genetics used), higher phytase activity (increases phosphorus digestibility and improved amino acid digestibility) and amino acids of interest.

Its fatty acid profile, like its lower content of linoleic acid and polyunsaturated acid, increases its interest for the quality of the flesh of the fish produced.

Sorghum is generally introduced at 40-50% in the ration.

Few examples of the introduction of sorghum in the ration for fish production: carp in Hungary, catfish in Vietnam, tilapia in Africa and Israel.

DID YOU KNOW?

Sorghum is an undemanding cereal, offering grain with high protein content, which provides energy to animals but it continues to be subject to certain misconceptions.

Among them are the belief that tannins are found in grain and that there is a difference in quality between red sorghum and white sorghum.

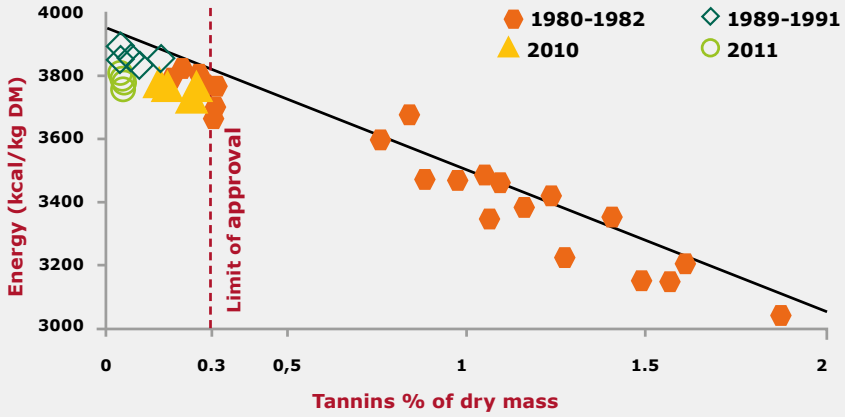
The new varieties marketed in Europe dispel these falsehoods by guaranteeing the health and nutritional quality of sorghum-based food and feed. And they are suitable for both conventional and organic farming systems.

TANNINS

A FEAR OF THE PAST

Responsible for reducing digestibility in livestock production, the presence of tannins in sorghum grain was long seen as a weakness. However, this fear is no longer relevant because seed companies have eradicated the molecule from new varieties since the mid-1980s!

For feed users and manufacturers, one of the main criteria for rejecting sorghum is high tannin content in the grain. As the concentration of tannins in the grain rises, the digestibility of sorghum's nutrients falls, particularly in monogastric animals. The mechanism which causes this is well understood: tannins, which are polyphenols, bind to grain proteins and form complexes that precipitate in the digestive tract of monogastric animals. Digestive enzymes then find it difficult to access the grain's nutrients.



Since the mid-1980s, all new sorghum varieties have tannin content below 0.3% of dry matter (DM). In 2011, France's Arvalis technical institute studied the tannin concentration of 23 samples from that year's harvest. Sorghum varieties averaged 0.05% DM, with variations ranging from just 0.01% to 0.18%. These values are well below the upper limit of 0.30% DM set by the European Union for the inclusion of new varieties in the official catalogue.

Plant breeding has solved the problem

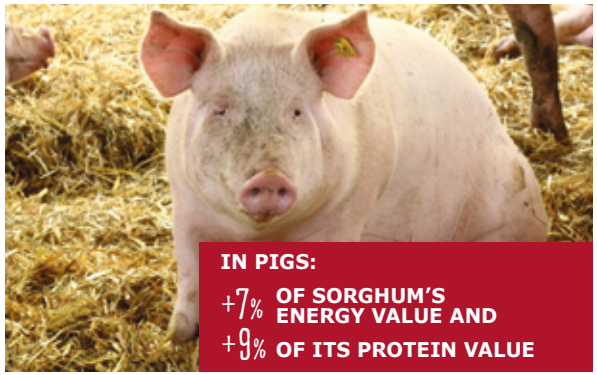
Seed companies have successfully tackled this problem. This weak point now only applies to so-called local or heirloom varieties. Since the mid-1980s, all new sorghum varieties entering the market have low tannin content. Along with increasing yields, reducing the tannin content of sorghum grain has been a central pillar in varietal improvement and a criterion for listing in seed catalogues. Nowadays, sorghum varieties can only be registered in the official French catalogue if they contain less than 0.14 % dry matter (DM). In the European Union, the upper limit for registration is 0.30%. However, farmers, especially in Eastern Europe, still rely on local varieties with high tannin levels. Hence the importance for manufacturers and feed users to investigate the origin of sorghum grain in order to ensure optimal quality.

IN FRANCE

9 **SAMPLES OUT OF**

10 **HAVE A TANNIN CONTENT OF UNDER 0.05%**

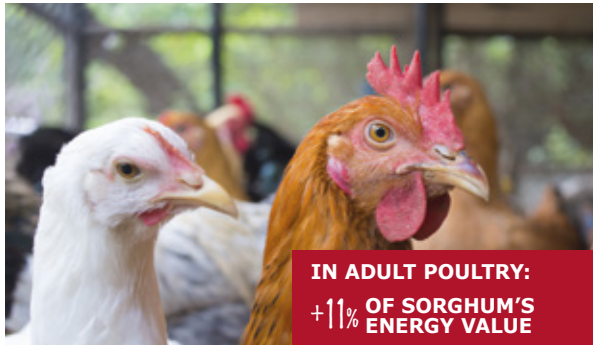
PRODUCTIVITY INCREASES WHEN TANNINS DECREASE BY 1% IN THE GRAIN.



IN PIGS:

+7% **OF SORGHUM'S ENERGY VALUE AND**

+9% **OF ITS PROTEIN VALUE**



IN ADULT POULTRY:

+11% **OF SORGHUM'S ENERGY VALUE**

DIVERSITY IN SORGHUM SEED

RED OR WHITE, THEY ARE ALL THE SAME!

The colour palette of sorghum seed swings between red and white, but the nutritional value of the grain is unrelated to this diversity in tones.

The diversity of colours and types of sorghum grain is very important. Farmers have a wide range of varieties to feed their animals.

Sorghum is classified according to colour: red seeds and white seeds. However, this binary classification masks a gradient of tones between these two colours.

Seed colour does not affect quality, nutritional value, yield potential or the precocity of plants, nor even the colour of the flesh of animals.

Contrary to popular belief, red grain does not contain tannins.

Differences between countries

While some countries grow more or less one type of sorghum, it is only out of habit. In France, Hungary, Romania and Bulgaria, 90% of cultivated species are red-grained. In Italy and Russia, the opposite is true. In the Ukraine, farmers opt for one colour as much as the other.

Red or white, seed companies work identically with their varieties, always trying to reconcile productivity and precocity, and resistance to cold and abiotic stress.

17 **RED GRAIN**

7 **WHITE GRAIN VARIETIES**

REGISTERED IN THE LIDEA CATALOGUE

Lidea sells both red and white seed varieties. Experimentation has demonstrated the diversity of colours existing in sorghum with no effects on grain quality.

MANUFACTURING PROCESS

OPTIMAL MILLING FOR GOOD FEED VALUES

Not too big, not too small…The nutritional quality of sorghum grain depends on the level of milling. This is achieved through the appropriate calibration of equipment in feed plants.

Milling is an important step in ensuring sorghum's digestibility in animal feed as it provides greater accessibility to starch and therefore energy. The finer the seed, the better it is exploited by animals. However, excessive milling can cause chemical cross-linkages, reduce the amount of nutrients available, or even provide a fermentation medium that can cause health problems. Everything is therefore a question of balance.

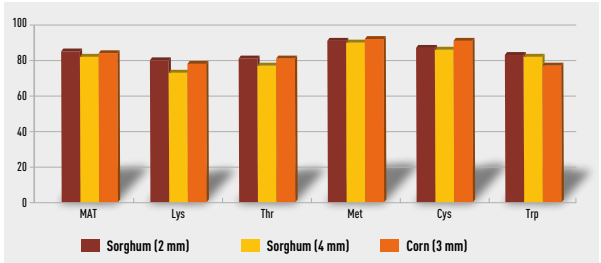
Two millimetres is a good compromise

The best results are provided by 2mm milling. This increases the digestibility levels of the main amino acids (including lysine, the first limiting amino acid for growth in pig feed) compared to milling at 4mm. It is easy to achieve this size through appropriate adjustments to the grills and speed of the milling equipment in feed plants. Sorghum grains are small so using grills of a diameter which is too large may see grains pass through without grinding. The result of milling is a homogenous texture which can be incorporated into the mix for the manufacture of animal feed.

Catalin FUDULU,
Technical Director Nutrition and Formulation
at G-A Nutritie Animala (EVIALIS) Romania,

"Sorghum grains are smaller than other cereals and protein crops. During the pellet and flour manufacturing processes, the grills must be specifically adapted to produce the correct fineness when the grain is ground. It is not complicated to implement this."

EFFECT OF MILLING LEVEL ON AMINO ACID DIGESTIBILITY IN ANIMAL FEED



An optimal result for feed digestibility is obtained by 2mm milling. Total nitrogenous content (MAT), Lysine, Threonine, Methionine, Cysteine, Tryptophan. Note Corn = maize

Adapting to species

Not all animals have the same sensitivity, so milling quality will have different effects according to the species and development stage. For ruminants it is less important, but it is essential, for example, in pig feed. Whether young or adult, monogastric animals cannot digest whole seeds. The opposite is true for poultry, which are granivores. However, for fast-growing poultry, milling provides faster nutrient uptake and increases farm performance. With this objective, all growing animals need to eat small quantities of quickly assimilated feed to meet their needs. The fineness of the milled product therefore plays a very important role.

GELATINISATION OF STARCH

In order for starch, a source of energy contained in all cereals, to be easily assimilated by animals, it must undergo gelatinisation. Starch granules dissolve in water after a rise in temperature.

The heating temperature required for sorghum is higher than other cereals: between 68.5°C and 75°C compared to between 62°C and 72°C for maize and 52°C to 53°C for wheat.

In feed plants, the desired particle size is obtained by adapting the grinding grills.

MYCOTOXINS

AN EASILY CONTROLLED RISK

Sorghum is a valuable ally in reducing the presence of mycotoxins in animal feed. By following good harvesting and storage practices, the risk is avoided and provides a healthy crop.

Mycotoxins can cause health and reproductive problems in animals so processors seek to limit their presence in feed. However, there is no major risk of these toxins developing in sorghum, providing a significant advantage for product quality. "The analyses we have been carrying out for 15 years on sorghum grains show that there is an absence or very weak presence of Fusarium mycotoxins likely to be produced in the field. The measured levels of deoxynivalenol, zearalenone and fumonisins are very low, and well below the target values recommended by the European Commission," explains Béatrice Orlando, sanitary quality specialist at France's Arvalis-Institut du Végétal technical institute.

Grains safe in the field

Why should this be? Sorghum grains are not attacked by corn borers, the damage of which is a gateway for Fusarium species. The panicle on sorghum plants remains in the open air. "So, in the event of an insect attack, the grain dries quickly, avoiding the moisture conditions favourable for the development of fungi," explains Jean-Luc Verdier, sorghum leader at Arvalis-Institut du Végétal. This means that if Fusarium species do attack, they are limited to the stem and do not affect the ear, in stark contrast to maize.

However, vigilance remains important. "Harvesting must not take place too late, during wetter periods which favour mycotoxins," warns Jean-Luc Verdier.

Bank on good storage practices

What about ochratoxin A? In Europe, its presence in cereal grains is due to excessive moisture during storage. Where grain water content exceeds 18%, drying before silo storage is required. A reasonable time between harvesting and grain drying must be respected. If these operations are properly performed, and the grain is stored in good conditions, the risk of ochratoxin is almost zero.

The inflorescence on sorghum plants is an open panicle, which leaves the grains in the open air. This avoids the overly moist conditions around the grain which are favourable to mycotoxin development.

https://www.sorghumcheckoff.com/

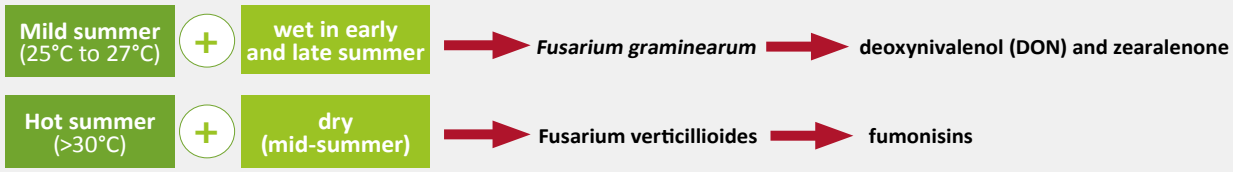
THE RIGHT HARVEST STAGE

Sorghum reaches maturity when grain humidity hits 35%, while harvesting can be done at between 16 (Norm) and 30% (wet grain use as for pork production). Normally, when grains are mature, the leaves stay green (plants are sustainable).

Waiting for a natural desiccation of leaves is unproductive as grain quality deteriorates and it causes germination on the panicle and grain discoloration.

FUSARIUM SPECIES AND MYCOTOXINS IN CEREALS: RISK FACTORS

Fungi of the Fusarium genus are responsible for the production of mycotoxins in the field. They develop under different humidity and temperature conditions.



Arvalis-Institut du Végétal

AGRONOMIC BENEFITS

IMPROVING THE ENVIRONMENT WITH SORGHUM

Thanks to its low water, plant protection product and fertiliser requirements sorghum is one of the most ecological crops available. Included in rotations, it also increases the cultivated diversity in agricultural areas.

Sorghum offers multiple environmental benefits. The crop offers the possibility of diversifying rotations and helps lengthen rotations in arable farming systems. Growing a succession of species in fields gradually reduces disease pressure and the development of insect and weed populations.

Reduced input needs

Sorghum is one of the most low-input crops. One or two herbicide treatments are sufficient at the beginning of the cycle.

Very often, the crop does not require the application of insecticides or fungicides. The risk of the development of Fusarium wilt, a cereal disease that can cause the development of mycotoxins in grain, is reduced. The addition of sorghum in a rotation with straw cereals breaks the life cycle of the fungus and helps to maintain the sanitary quality of grain.

Fertiliser inputs may be moderate due to the crop's high capacity for taking mineral nitrogen from the soil. Most of the nutrients are returned to the soil after harvest: 40% of nitrogen, 80-85% of potassium and 20-30% of phosphorus.

An answer for adapting agriculture to climate change

Thanks to its very dense root system and high photosynthetic efficiency, sorghum's water requirements are also very low. It's a crop which offers good resistance to water stress. It helps adapt cropping systems in climate change situations and where the preservation of water resources is a concern. In these contexts, sorghum is a good complement to maize cultivation, especially in areas which cannot be irrigated (85% of arable land in Europe).

SORGHUM'S ENVIRONMENTAL IMPACT TAKEN INTO ACCOUNT IN FEED PROCESSING

Western European experts in feed formulation take the environmental impact of ingredients into account in the creation of rations in order to improve farm environmental balance sheets. The French technical and research institutes have developed a database called Ecoalim for different production systems (pigs, poultry and cattle).

The database includes the price of raw materials, nutritional composition, environmental impacts, supply scenarios (distance and mode of transport) and transport costs and environmental impacts.

Regarding the environment, sorghum offers interesting advantages on phosphorus consumption, non-renewable energy, greenhouse gas emissions, acidification, eutrophication, saline soils, polluted soils etc.

WAXY SORGHUM

A waxy layer covers the entire surface of the plant which will limit its transpiration and therefore reduce water consumption (-40% compared to corn grain) but also allow it to withstand temperatures above 40°C (no stoppage of plant growth).

Low consumption of plant protection products

Treatment Frequency Index (TFI) in eight French departments from 2015 to 2017

	TFI
Sorghum	1.8
Hard wheat	3.9
Soft wheat	4.4
Maize	2.3
Barley	3.7
Triticale	2.4
Oilseed rape	6.2
Sunflower	2.3
Field bean	4.4
Pea	4.4

The Treatment Frequency Index (TFI) used in France accounts for the number of standard doses of plant protection products used per hectare during a cropping season. The lower the index, the less treatment the crop requires. Sorghum stands out as the most economical crop with 1.8 treatments, mainly herbicides applied at the beginning of the cycle. The TFI calculation was produced by the French technical institute, Arvalis-Institut du Végétal, as part of France's Ecophyto plan to reduce the use of plant protection products.

LIDEA, THE LARGEST SORGHUM PORTFOLIO IN EUROPE

Through its Eurosorgho* subsidiary, Lidea set up Europe's first sorghum research programme in 2009. We are constantly innovating in this crop, creating hybrids to meet all industrial and farming needs.

Our research team prioritised hybrid productivity, by enhancing genetic potential. However, in parallel, additional qualities are sought.

To improve agronomic performance and earliness, criteria such as the stability and rusticity of hybrids, diseases tolerance, resistance to Diabrotica, early vigour, lodging resistance, panicle clearance and behaviour in difficult conditions count. As for its destination, boosting grain quality is our strategic focus.

Lidea's grain sorghum offer is extremely comprehensive. It covers all maturity groups from very early (85-90 days) to late (more than 115 days), in both red and white grain ranges.

**Eurosorgho is a joint research venture between LIdea and Semences de Provence*

MATURITY	NAME	GRAIN	PANICLE	OUTLETS	CLIMATE PROFILE: HOT AND DRY	MEDIUM STRESS	NO STRESS	COOL AND WET
VERY EARLY *Day cultivation 85-90 days*	ARSKY				★★	★★★	★★	★★
	PONANT				★★	★★★	★★	★★
	NEW WILLY				★★	★★★	★★	★★
	ARMORIK				★★	★★★	★★	★★
EARLY – MID EARLY *Day cultivation 90-115 days*	NEW KALAHARI SU				★★★	★★★	★★	★
	NEW MARGO				★★★	★★★	★★	★
	NEW ARCANE				★★★	★★★	★★	★
	SHAMAL				★★★	★★★	★★	★
	NEW GIBSON				★★★	★★★	★★	★
	ALIZE				★★★	★★★	★★	★
	FOEHN				★★★	★★★	★★	★
	MONSOON				★★★	★★★	★★	★
MID LATE - LATE *Day cultivation more 115 days*	BOREAS				★★★	★★★	★★	
	NEW TANAMI				★★★	★★★	★★	

★★★ *Perfectly adapted* | ★★ *Adapted* | ★ *Little adapted* | *No adapted* | *Compact* | *1/2 Compact* | *1/2 Open* | *Open* | *Feed* | *Food* | *Bioethanol*

MATURITY	NAME	GRAIN	PANICLE	OUTLETS	CLIMATE PROFILE			
					HOT AND DRY	MEDIUM STRESS	NO STRESS	COOL AND WET
VERY EARLY *Day cultivation 85-90 days*	ARABESK				★★	★★★	★★	★★
	NEW SINAÏ				★★	★★★	★★	★★
EARLY – MID EARLY *Day cultivation 90-115 days*	NEW ZEALANDIA SU				★★★	★★★	★★	★
	ALBANUS				★★★	★★★	★★	★
	ARALDO				★★★	★★★	★★	★
	ARTISTA				★★★	★★★	★★	★
	KALATUR				★★★	★★★	★★	★

DID YOU KNOW?

The sorghum ingredient in animal feed for pigs, for example, reduces the risk of oxidation of the meat produced which is linked to the specific fatty acid profile (about 4.5%), with less linoleic acid and polyunsaturated fats.

A lower linoleic acid content contributes to the high-quality of pork fat if processed, and can also reduce the rancid taste.

Spain is the leading importer of sorghum in Europe with close to 1 MMT imported each year for pig production, principally in Catalonia for its famous ham.

FOR MORE INFORMATION ABOUT LIDEA'S SORGHUM RANGE

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Frederic Guedj
Sorghum Market
Development Manager, Lidea
frederic.guedj@lidea-seeds.com

www.lidea-seeds.com

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