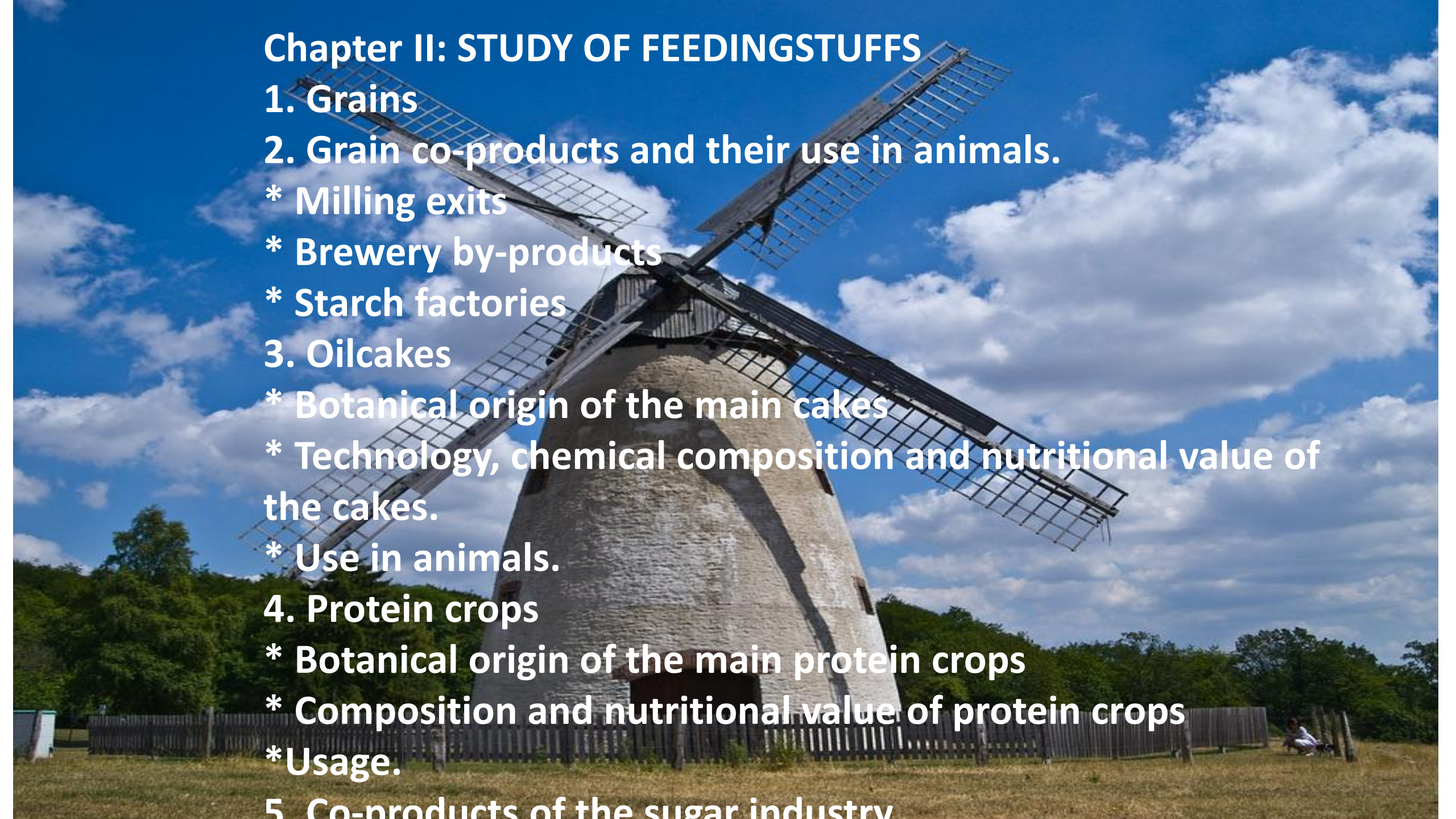

Chapter II: STUDY OF FEEDINGSTUFFS

1. Grains
2. Grain co-products and their use in animals.

* Milling exits
* Brewery by-products
* Starch factories

3. Oilcakes

* Botanical origin of the main cakes
* Technology, chemical composition and nutritional value of the cakes.
* Use in animals.

4. Protein crops

* Botanical origin of the main protein crops
* Composition and nutritional value of protein crops
*Usage.

5. Co-products of the sugar industry

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5. Co-products of the sugar industry

* Molasses / Candy pulp

8_ChapterII_LIVESTOCK FEEDS

- Introduction
- Livestock feed consists mainly of forages such as grass and hay, energy-rich cereals (such as maize) and protein supplements such as oilcake (soybeans, sunflowers).
- Other ingredients include agro-industrial by-products, minerals and vitamins, as well as products such as molasses and wheat bran, designed to balance the ration and ensure animal health and productivity.

Main types of feeds

- Forages: This is the basis of the diet.
- Grass: eaten fresh, constitutes a large part of the ruminants' diet.
- Hay: Dried grass for preservation.
- Silage: Forage fermented to preserve it, such as corn silage.
- Straw: Cereal stalks that are by-products of the fibre-rich harvest – threshing – bound boxing.

Concentrated feeds

- Cereals: Corn, barley, wheat, rich in starch (energy).
- Oilcakes: By-products of the extraction of oil from seeds, rich in protein (e.g. soybean meal, sunflower meal).
- Agro-industrial by-products: recover industrial residues.
- Wheat bran: Rich in fibre and others
- Beet pulp: A by-product of sugar production.
- Brewer's grains: Brewing residues.

1. Grains

- Grains (cereals such as corn, barley, wheat and oats) are an essential and inexpensive source of energy for livestock feed, especially for ruminants.
- Grains are an essential source of carbohydrates, mainly starch, but their protein content is lower and must be supplemented by other protein sources such as legumes or oilcake.
- The grains must be processed (ground, flattened, cooked) to improve their digestibility according to the animal species.

1.1. Nutritional importance and benefits

- Source of energy: Grains are rich in starch, a carbohydrate that provides easily digestible energy.
- Affordable: They are an inexpensive source of energy, especially for feeders.
- Mineral intake: Grains provide minerals like phosphorus and magnesium.
- Grains are often processed to improve their digestibility, especially raw starch that is poorly digested by some animals (such as domestic carnivores, but also to optimize the diet of ruminants).
- Usage Considerations
- The proportion of grain in the ration depends on the type of animal, its physiological stage and production objectives.
- The balance with forages (hay, silage) and other protein supplements is crucial to ensure a complete diet and avoid digestive disorders.

1.2. Food Processing and Use

- Grinding and flattening: Most grains must be ground or flattened before being incorporated into a ration to improve digestibility and the rate of degradation.
- Grinding/Milling: Reduces the size of the grains to facilitate consumption and digestion.
- Germination: Although more energy-intensive, sprouting can improve the dietary qualities of some grains.
- Cooking: For monogastric plants (such as suidae and poultry), heat treatment (flocking, extrusion) is necessary because they do not digest raw starch well.
- Heat treatment: Increases grain digestibility, especially for domestic carnivorous animals.
- Processes such as:
- Bottle: steaming followed by lamination.
- Extrusion: high-pressure baking.
- Storage: The grain can be kept whole at a high humidity level (grain silage) for the suidae, or on the contrary harvested and treated when the weather is dry.

Examples of use

- Dairy cows: Grains are often given as supplements to increase milk production.
- Poultry: They make up an important part of their feed, but often require heat treatment such as extrusion or flocking.
- Beef cattle: They are used for fattening, with barley and corn being particularly valued for their energy and starch content.
- Horses: They can be used for competition horses, but sprouted grains are often more expensive due to the loss of energy during germination.

Brewery by-products

- The main by-products of the brewery are
- Brewer's grains,
- Excess yeast and
- Wastewater (manufacturing)
- These by-products are increasingly being used, mainly in animal feed and the food industry, as well as for non-food applications

Les issues de meunerie

- Milling by-products, also known as milling by-products, refer to all products obtained during the milling of grains (mainly wheat) other than white flour intended for direct human consumption.
- They are made up of the husks of the grain and fragments of the kernel, and are rich in nutrients, including protein and fibre.

Main Types of Feed Mill Exits

- Although there is no rigorous regulatory classification, a distinction is generally made between:
- Bran: This is the outer shell of the grain (pericarp and integuments) separated during the milling process. It is rich in fiber.
- Remoulding: This is a mixture of small pieces of bran and cellulosic flour particles. It is somewhere between bran and pure flour in terms of fineness and composition.
- Low flours: These are higher types of flours (richer in minerals and fibre than white flours) recovered during the final stages of sieving.
- Recuts, irons, rebulets: Various terms to designate intermediate by-products or residues specific to the sieving process.
- Screenings and vetches: These are impurities (broken grains, foreign seeds, dust) removed during the initial stages of cleaning the wheat before milling.

Use and valorization

- Milling issues are important by-products of the milling industry:
- Animal feed: This is the main and historical outlet. Issues, thanks to their protein and fibre content, are widely used in the manufacture of compound feed for livestock (cattle, sheep, poultry).
- Human food: Some of the issues (including bran and high-type flours) can be used to produce wholemeal flours (type 150) or incorporated into bakery products to enrich their fibre content.
- Other applications: Industrial applications (fertilizer production, etc.) are also being explored.
- On average, about 22% of a wheat grain is processed into offset, the rest being white flour (type 45 to 80). The recovery of these outputs is a key element of the sustainability and economic efficiency of the milling sector.

Brewery by-products

- **Spent grains: made up of the husks of cereals after brewing, are used in animal and human food (flour, biscuits)**
- **Spent grains come from two main sources:**
- **Brewer's grains: These are the solid residues (mainly malted barley grain husks) that remain after the filtration stage (wort racking) of the beer brewing process. The starch was mainly extracted for fermentation, leaving a material rich in protein and fiber.**
- **Distillers' grains: These come from the production of ethyl alcohol (bioethanol) from cereals such as corn or wheat. After fermentation and distillation of the alcohol, the remaining components (proteins, fats, fibres) are concentrated, giving rise to distillers' grains with solubles (DDS).**

Brewers' grains

- Valorization:
- Animal feed: Mainly used fresh, ensiled or dehydrated for livestock, especially cattle and pigs.
- Human Food: Processed into flour for incorporation into baked goods, biscuits or meat alternatives.
- Innovative materials: Used to make furniture, cutlery or other objects by heat molding them.
- Forms: Can be used fresh, ensiled or in dehydrated form, sometimes granulated.

Yeast

- Description: Residue recovered by filtration after fermentation, rich in proteins and vitamins.
- Valorization:
- Food
- Cosmetic
- Pharmaceutical industry
- Other co-products
- Truns: Also called barley rootlets, they are a by-product of malting.
- Wastewater: The brewing process consumes a large amount of water. Although it is not a material co-product in the strict sense, their processing and recovery are essential for the environmental and economic efficiency of the brewery.
- The recovery of these by-products is part of a circular economy approach, reducing waste and offering new sources of income for the bra

- Yeasts: recovered by filtration can be used in human food, cosmetics or pharmaceuticals.
- They ferment sugars to produce alcohol and carbon dioxide. Outside the brewery, brewer's yeast is used as a source of vitamins (gpe B) and protein.

Starch factories

- Starch factories provide starch and its by-products for animal feed, mainly serving as a dense source of energy, especially for ruminants and poultry. Co-products such as gluten feed, gluten meal or corn germ are rich in protein and energy and are common ingredients.

The characteristics of starch and its derivatives

- The characteristics of starch and its derivatives can be adjusted to meet the specific needs of the animals, such as fat content for monogastric cows or balance with fibre for dairy cows.
- Importance and Use of Starch in Animal Feed Source of Energy: Starch is an important source of energy. Corn, for example,

- Specific products: Pure starch is often used in specific feeds such as milk substitutes for calves, lambs and piglets.

- Used in specific feeds to influence the fatty acid profile in carcasses, to avoid unsaturated fat.
- Ruminant case: In ruminants, starch is digested by fermentation in the rumen. The balance between starch digestibility and fiber content is crucial for the proper functioning of the rumen and to avoid acidosis.

Starch by-products

- Co-products: Co-products from starch processing, such as corn grains (gluten feed), gluten meal or corn germ, are valued for their protein and energy content, as shown by the study on corn germ for poultry.

- Adjustment of starch-based rations Starch content: It is advisable to target a starch level of around (22-25%) in the diet of dairy cows to optimize intake and digestion.
- Digestion speed: The rate of starch degradation can be adjusted.
- Slow-digesting starches may be safer in diets high in concentrates because they limit the risk of acidosis.

Structure change

- Starches can be processed to change their properties. Drying, roasting, cooking or chemical transformation can create modified starches, for example improving energy digestibility, as observed with the pelleting of poultry feed.

Cakes

- Oilcakes are residues obtained after oil extraction from oilseeds (such as soybean, rapeseed, sunflower) and are widely used in animal feed for their high protein content. They are the second most important class of feed after cereals and provide a source of essential nutrients, improving the quality of feed for livestock and poultry.

Role in animal feed

- Source of protein: Meal is the main source of vegetable protein in animal feed.
- Nutritional supplement: They are often mixed with grains and other foods to ensure a balanced intake of proteins, amino acids, minerals, and vitamins.
- Specific benefits: Rapeseed meal provides cellulose that is beneficial for ruminants and sunflower provides fiber for the intestinal transit of sows.
- Weight gain: Animals fed meal meals, such as "By Pass meal," can gain weight faster, reducing the time it takes to reach slaughter weight.

- Common Types
- Soybean meal: Widely used for their high nutritional value and digestibility, especially for poultry, pigs and calves.
- Rapeseed meal: Appreciated for its balance of amino acids and its richness in minerals.
- Sunflower cake: Rich in fibre, they are useful for digestion, especially in sows.

Botanical origin of the cakes

- The cakes come from the seeds of oilseed plants such as soybean, rapeseed, sunflower, but also from others such as peanuts, cotton, copra (coconut) and sesame.
- They are the solid residue obtained after the oil is extracted from these plants and are mainly used as livestock feed.

Main cakes by botanical origin

Legumes

Soybean: The most common meal, obtained from soybeans (\(Glycine~max\)).

Peanut: Produced from the peanut (\(Peanut~hypogaea\)).

Oilseeds (Brassicaceae):

Rapeseed: Obtained from rapeseed seeds (\(Brassica~napus\)).

Sunflower: Derived from the crushing of sunflower seeds (\(Helianthus~annuus\)).

Mustard: Mustard cakes are generally considered toxic.

Rapeseed: A hybrid of rapeseed and cabbage.

Oleaginous fruits

- **Coprah: Result of the extraction of oil from the coconut (Cocos~nucifera).**
- **Palm kernel: Grown from the kernels of oil palm trees (Elaeis~guineensis).**
- **Olive: Olive "pomace" is the residue after extraction of olive oil.**

Other plants

Flaxseed: Flaxseed meal is obtained after the extraction of flaxseed oil.

Sesame: Produced from the seeds of sesame (Sesamum~indicum).

Hemp: Obtained from hemp seeds.

Cotton: Residue from the extraction of oil from cottonseed.

Corn: Produced from corn germ.

Poppy: Oilette cake.

Castor oil: Very toxic, it is used against moles, but not for animal feed.

- The cakes are integrated into compound feeds or distributed in addition to the basic ration (forage). They act as balance concentrates to provide the protein and energy needed for growth, milk production or fattening.
- Incorporation must be gradual to allow the animal's digestive system to adapt.
- Some oilcakes (such as cottonseed) contain anti-nutritional factors (gossypol) that limit their use or require specific treatments.
- Rapeseed "varieties 00" meal (low in erucic acid and glucosinolates) is preferred in Europe for risk-free use.

- Protein crops
- * Botanical origin of the main protein crops
- * Composition and nutritional value of protein crops
- *Usage.

Protein crops.

- annual plants of the Fabaceae family (legumes),
- Grown specifically for their high protein content in their seeds, which are intended for livestock feed.
- Their use is a strategic lever for modern livestock farming.

- **The main aim of incorporating protein crops into the animal ration is to strengthen the protein autonomy of farms and territories, thus reducing dependence on imports**

Main protein crops used

- Protein peas, faba beans and lupin are the most commonly grown and used species in animal feed, at least in Europe.

  Peas are the most widely used of these protein crops.

Benefits

- Source of protein and energy: In addition to their high protein content (lupin can reach nearly 35% total nitrogen matter (MAT), pea about 20%), these seeds are also rich in carbohydrates, especially starch, thus providing a valuable source of energy.
- Amino Acid Profile: Protein protein proteins often have a good content of lysine, an essential limiting amino acid in cereals, making them an excellent supplement in the formulation of compound feeds.

Agronomy

As legumes, these plants fix atmospheric nitrogen, helping to improve soil fertility and structure, reducing the need for nitrogen fertilizers for future crops.

Limits and Precautions

- The use of protein crops may be subject to certain limitations related to the potential presence of anti-nutritional factors (tannins in some faba beans, vicine/convicine in lupin) which may affect digestibility and require heat treatments or the use of specific varieties.

In conclusion

Protein crops represent a strategic and sustainable alternative to imported proteins, playing a key role in diversifying feed sources and strengthening the sustainability of livestock systems.

Co-products of the sugar industry

- The main by-products of the sugar industry are beet pulp, molasses, and beet scum. These products are used as animal feed (pulp), fermentation for alcohol or yeast (molasses), and fertiliser (scum). Other co-products include washing water, sugarcane residues (bagasse), and fermentation CO2.
- bagasse, molasses and filter sludge (or defecation scum).

Main co-products and their uses

Coproduit	Matière première d'origine	Description	Utilisations principales
Bagasse	Canne à sucre	Résidu fibreux et pulpeux restant après l'extraction du jus. Principalement composée de cellulose.	**Énergie** (combustible pour alimenter l'usine en chaleur et électricité), **matériaux de construction**, **pâte à papier**, **emballages alimentaires biosourcés**.
Mélasse	Canne à sucre et betterave	Liquide visqueux et sombre, riche en saccharose (40-60%) et autres nutriments, qui reste après la cristallisation du sucre.	**Fermentation** pour produire de l'**éthanol** ou de l'**alcool**, **alimentation animale**, production de **levures** (notamment de boulangerie), **industries pharmaceutiques**.

Principaux coproduits et leurs utilisations

Pulpes de betterave	Betterave sucrière	Cossettes de betterave dont le sucre a été extrait par percolation avec de l'eau chaude.	**Alimentation du bétail**.
Boues de filtration / Écume de défécation	Canne à sucre et betterave	Résidus solides issus de la purification du jus (mélange de chaux, d'impuretés végétales).	**Amendement du sol** (améliore le pH et apporte des nutriments comme le phosphore et le potassium), **engrais**.

Importance of valorization

- The valorization of these by-products is essential to the circular economy of the sugar industry.
- Reduces the environmental footprint of factories by minimizing waste,
- Create added value by producing energy and raw materials for other sectors (agriculture, chemicals, energy).
- Factories recover steam and water from processes for reuse, optimizing the use of resources.


Thank you