

Measurement of Resilience of the Agricultural Producers and Food Consumers to War-Induced

Food Supply Chains in Ukraine



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Resilience of the
Agricultural Producers
and Food Consumers to
War-Induced Shocks in
Ukraine**

Supply chain schemes of cereals and meat production

Before the war, Ukrainian agriculture produced 10% of GDP, employed 14% of the labor force and accounted for 41% of total exports.

Ukraine has gradually become a major global supplier of agricultural commodities over the past two decades. Before the full-scale Russian invasion, Ukraine supplied about 50% and almost two-thirds of world exports of sunflower oil and meal respectively. The main destinations were China (48%), the EU (25%) and Turkey (7%). Ukraine was the world's third largest exporter of rapeseed and seventh largest exporter of soya beans. It was the fourth largest exporter of maize in the world, with the main destinations being China, the EU, Egypt, Iran and Turkey. Ukraine was the world's seventh largest exporter of wheat, with Egypt, Indonesia, Turkey, Pakistan and Bangladesh as its main destinations.

1. Poultry meat and eggs production

Poultry production takes place both at enterprises and at households, the main differences are access to technologies, cultivation technologies, finale consumers.

In 2022, poultry production reached 1.25 million tons, with 33.5% of it being exported. The production for breeding had a ratio of 90.5% for enterprises and 9.5% for households, whereas for poultry intended for slaughter, the ratio stood at 89% for enterprises and 11% for households. As of January 2023, total amount of chickens owned in all agricultural holdings was 165 mln, out of which 60% are owned by enterprises and 40% - by households (SSSU, 2022) and (SSSU, 2023).

Egg production was almost equally spread between enterprises and households, 48% and 52% respectively. The production in 2022 came to almost 12,000 mln pieces, while 12% of this number was exported. The majority of eggs produced by enterprises were from the Kyiv region, representing 38% of the total enterprise-based egg production. For households, the biggest production regions were Zhytomyr (10% of the total household production) and Lviv (8.5% of the total household production) (SSSU, 2022).

PrJSC MHP one of the biggest Ukraine's agro-industry with a fully integrated production cycle. It dominates the poultry market, MHP is a monopolist in the chicken market, producing about 64% of the entire chicken market and 86% of poultry meat exports (MHP, 2023).

Table 1. Production method of chicken and eggs households and enterprises

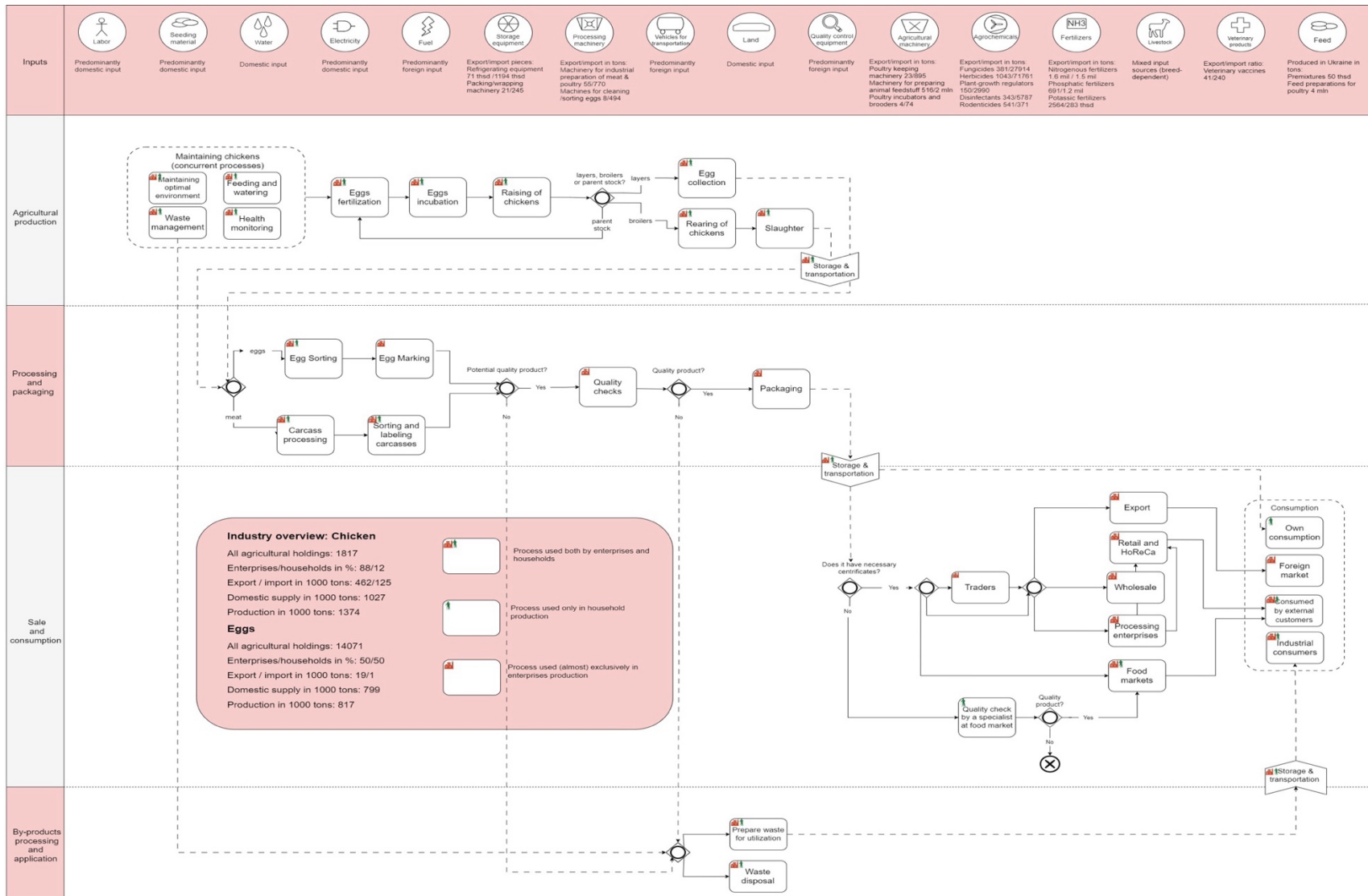
* For each input in parentheses indicated the local production + export to import ratio

Production stage	Details of the production in enterprises	Details of the production in households
1. Raising Chicks and Maintaining Adult Chickens	<ul style="list-style-type: none"> ▪ Housing for chickens, automatic equipment (cage systems, floor systems, deep litter systems): <ul style="list-style-type: none"> ○ Poultry-keeping machinery; ○ Haymaking machinery. ▪ Maintaining hygienic conditions (heating, humidity, ventilation, lighting) 	<ul style="list-style-type: none"> ▪ Housing for chickens, mostly not automatic and done manually ▪ Maintaining hygienic conditions (heating, humidity, ventilation, lighting); ▪ Veterinary care to prevent diseases (sanitation, immunization, and health measures); ▪ Feeding chickens;

	<ul style="list-style-type: none"> ▪ Veterinary care to prevent diseases (sanitation, immunization, and health measures) <ul style="list-style-type: none"> ○ Vaccines for veterinary medicine ▪ Feeding chickens (include whole grains: (wheat, barley, oats, grain by-products), crushed grains (corn, barley), and other ingredients like wheat bran, sunflower meal, fishmeal, herbal meal, precipitate, salt, and premix. <ul style="list-style-type: none"> ○ Drugs used for poultry feeding (excluding premixtures); ○ Premixtures for farm animal feeds (any); ○ Machinery for preparing animal feedstuffs. ▪ Access to clean drinking water; ▪ Forced molting of chickens (using zootechnical methods or hormones/chemicals); ▪ Labor 	<ul style="list-style-type: none"> ▪ Access to clean drinking water; ▪ Forced molting of chickens (using zootechnical methods or hormones/chemicals); ▪ Labor.
2. Egg Production	<ul style="list-style-type: none"> ▪ Egg collection; ▪ Sorting; ▪ Marking; ▪ Packaging and wrapping machinery; ▪ Machines for cleaning, sorting, or grading eggs 	<ul style="list-style-type: none"> ▪ Egg collection; ▪ Sorting; ▪ Marking; ▪ Packaging; ▪ Storage. <p>* Everything above are mostly manual processes.</p>
3. Meat Production	<ul style="list-style-type: none"> ▪ Fertilization of parent flock eggs for meat chickens (broilers); ▪ Incubation of eggs : <ul style="list-style-type: none"> ○ Poultry incubators and brooders (95 ▪ Rearing of meat chickens; ▪ Feeding and care; ▪ Slaughter; ▪ Carcass processing; ▪ Sorting and labeling carcasses by type, age, processing method, and quality of feeding; ▪ Packing and wrapping machinery (99); ▪ Portioning of meat; ▪ Meat processing <ul style="list-style-type: none"> ○ Machinery for the industrial preparation of meat or poultry (94). ▪ Storage in refrigerated chambers. 	<ul style="list-style-type: none"> ▪ Fertilization of parent flock eggs for meat chickens (broilers); ▪ Incubation of eggs; <ul style="list-style-type: none"> ○ Poultry incubators systems (mostly done manually) ▪ Rearing of meat chickens; ▪ Feeding and care; ▪ Slaughter; ▪ Carcass processing; ▪ Sorting and labeling carcasses by type, age, processing method, and quality of feeding; ▪ Packaging, manually; ▪ Portioning of meat; ▪ Meat processing;

4. Processing Production By-products	<ul style="list-style-type: none"> ▪ Using waste for, fertilizers production (powdered waste); ▪ Using eggs unsuitable for consumption as animal feed; ▪ Using slaughter waste as poultry feed; ▪ Using feathers for clothing and household items 	<ul style="list-style-type: none"> ▪ Using eggs unsuitable for consumption as animal feed; ▪ Using slaughter waste as poultry feed; ▪ Using feathers for clothing and household items.
5. Storage	<ul style="list-style-type: none"> ▪ Storage in warehouses or enterprises freezers 	<ul style="list-style-type: none"> ▪ Storage in refrigerators or freezers
6. Quality checks	<ul style="list-style-type: none"> ▪ An expert conclusion in accordance with the salmonellosis program from a state laboratory; ▪ An expert conclusion in accordance with the mandatory minimum list from a state laboratory; ▪ An operational permit and facility number; ▪ An expert conclusion on the examination of meat products for GMO content. 	-
7. Transportation	<ul style="list-style-type: none"> ▪ Vans and suitable machines for transportation of finished products; ▪ Labor (working-hours) 	<ul style="list-style-type: none"> ▪ Own car or a small truck to transport finished products to sales markets
8. Sales	<ul style="list-style-type: none"> ▪ Export; ▪ Domestic distribution channels and markets; ▪ Processing companies; ▪ Corporate retail networks; ▪ Franchise networks (branded and partnership retail trade); ▪ Other retail outlets (traditional trade) and HoReCa (hotels, restaurants, cafes); ▪ Agro-industrial markets. 	<ul style="list-style-type: none"> ▪ Sales at agricultural market.
9. Final Consumption	<ul style="list-style-type: none"> ▪ Domestic consumption; ▪ Consumption in the country of export; ▪ Consumption of sub-products or value-added products (sausages, cutlets, etc.). 	<ul style="list-style-type: none"> ▪ Own consumption.

Figure 1. Production scheme of chicken and eggs on households and enterprises



2. Beef and milk

Milk processing in Ukraine is carried out by 320 enterprises, but nearly 80% of the market is controlled by 55 factories, a significant portion of which are part of large holdings (Karpenko, 2020). Around 13 main companies account for 62% of the market. The rest of the market is divided among small companies and individual milk processing plants. Key enterprises such as "DP Lactalis Ukraine," "LLC Danone," "LLC Terra Food," "LLC Lyustdorf," "PJSC Milk Alliance," and "PJSC Vinnytsia Dairy Plant Roshen" together occupy more than half of the market (50%) (Karpenko, 2020).

In 2021, Ukraine produced **8.72** million tons of milk. Of these, agricultural enterprises produced 2.75 million tons, while household farms produced 5.97 million tons, in other words 30% produced by agricultural enterprises, while the remaining 70% is from household farms. This is a significant change compared to 1990 when the distribution was 76/24 (Agribusiness in Ukraine, 2021).

In 2022, 268 thousand tons of beef were produced, around 7% of this amount being exported. By the end of 2022, the total number of cows owned in all agricultural holdings was 1352 thsd heads, of which enterprises and 71% by households own 29% (SSSU, 2023).

In the beef and milk production in Ukraine employs 28,560 people, **5%** of the workforce in agriculture, forestry, and fishing, according to State Statistical Survey of Ukraine (SSSU, 2023).

Table 2. Production process of beef and milk enterprises and households

Production stage	Details of the production in enterprises	Details of the production in households
1. Cattle Maintenance	<ul style="list-style-type: none"> ▪ Creation and utilization of pastures ▪ Feeding cows <ul style="list-style-type: none"> ○ Types of Feed: <ul style="list-style-type: none"> (a) Herbaceous feeds (pasture grass, alfalfa, corn silage, alfalfa hay) (b) Grains (barley, corn) (c) Other feeds (barley straw, sunflower meal, fodder beets, molasses, beet pulp, chalk, mineral supplements) ▪ Preparations used for cattle feeding (excluding premixtures).¹ 	<ul style="list-style-type: none"> ▪ Creation and utilization of pastures ▪ Feeding cows: <ul style="list-style-type: none"> ○ Types of Feed: <ul style="list-style-type: none"> (a) Herbaceous feeds (pasture grass, alfalfa, corn silage, alfalfa hay) (b) Grains (barley, corn) (c) Other feeds (barley straw, sunflower meal, fodder beets, molasses, beet pulp, chalk, mineral supplements) ▪ Providing cattle with feed (feed mills, feed dispensers, feed transportation) ▪ Water supply ▪ Bedding material (straw)

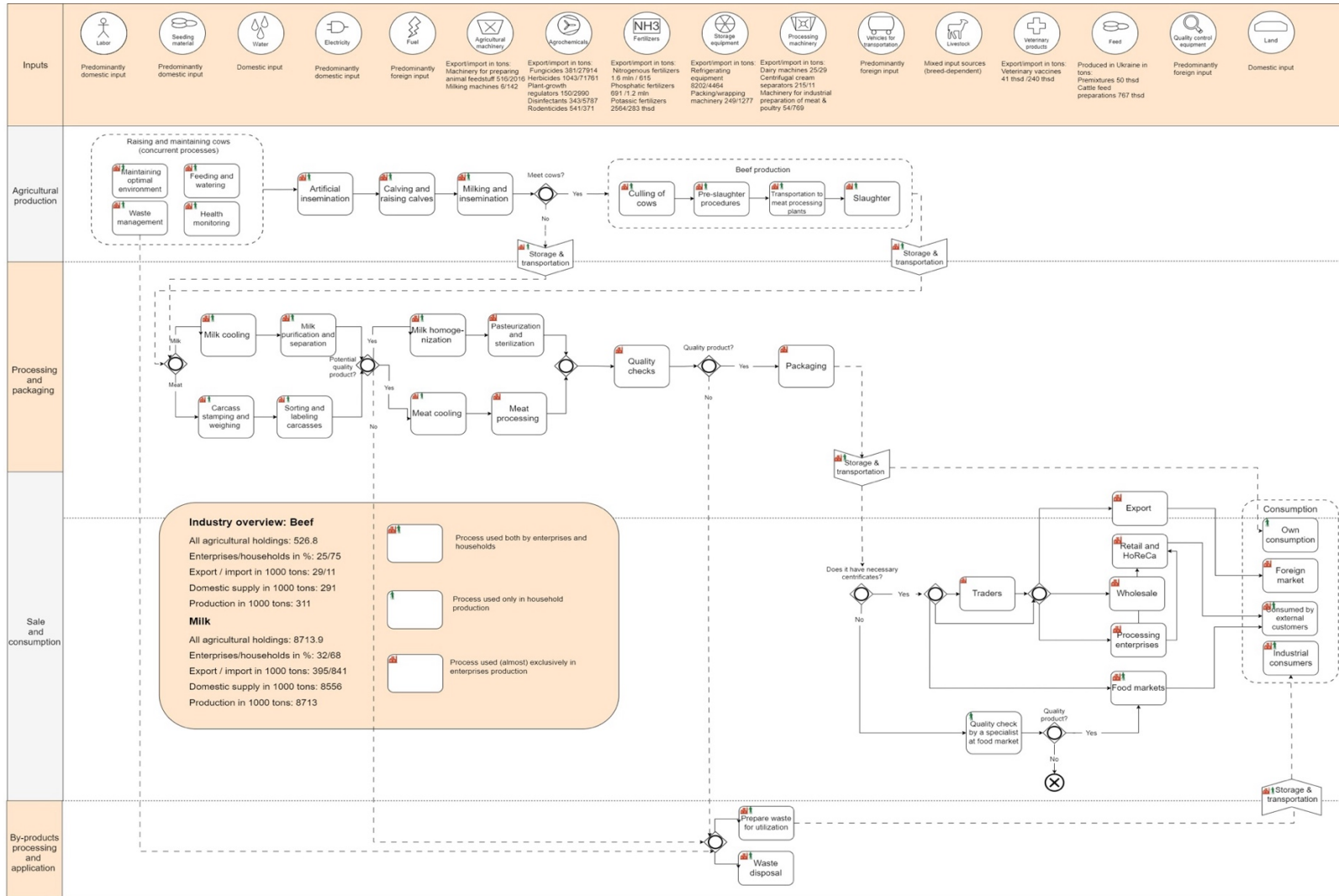
¹ According to the State Statistical Service of Ukraine in 2021 Ukraine produced 767 thsd tons, out of which 72 thsd ton from the customers raw materials (SSSU, 2022).

	<ul style="list-style-type: none"> ▪ Premixtures for farm animal feeds (any)². ▪ Machinery for preparing animal feedstuffs (80) ▪ Providing cattle with feed (feed mills, feed dispensers, feed transportation); ▪ Water supply ▪ Bedding material (straw) <ul style="list-style-type: none"> ○ Straw or fodder balers, including pick-up (87) ○ Haymaking machinery (55) ▪ Health monitoring <ul style="list-style-type: none"> ○ Vaccines for veterinary medicine (86) ▪ Creating an optimal microclimate (ventilation and heating systems) ▪ Waste utilization <ul style="list-style-type: none"> ○ Manure removal (conveyors, hydraulics, bulldozers, labor) ○ Manure storage in manure storages ○ Manure processing in biogas plants ▪ Labor (working-hours) 	<ul style="list-style-type: none"> ▪ Health monitoring ▪ Creating an optimal microclimate (ventilation and heating systems) ▪ Waste utilization <ul style="list-style-type: none"> ○ Manure removal (conveyors, hydraulics, bulldozers, labor) ○ Manure storage in manure storages ○ Manure processing in biogas plants ▪ Labor (working-hours)
2. Animal Reproduction	<ul style="list-style-type: none"> ▪ Artificial insemination ▪ Calving ▪ Raising calves ▪ Milking and insemination ▪ Weaning and grazing 	<ul style="list-style-type: none"> ▪ Artificial insemination ▪ Calving ▪ Raising calves ▪ Milking and insemination ▪ Weaning and grazing
3. Milk Production	<ul style="list-style-type: none"> ▪ Milking (using milking machines and labor) <ul style="list-style-type: none"> ○ Milking machines (96) ○ Labor ▪ Transportation (truckers, railroad) ▪ Milk processing: <ul style="list-style-type: none"> ○ Cooling (refrigerated tanks) ○ Milk purification (strainers and filters) ○ Separation into cream and skim milk 	<ul style="list-style-type: none"> ▪ Milking (using milking machines or labor); ▪ Milk processing; <ul style="list-style-type: none"> ○ Cooling (refrigerated tanks) ○ Milk purification (strainers and filters) ○ Separation into cream and skim milk ○ Normalization ○ Sterilization ▪ Storage.

² In 2021 Ukraine produced 4 mln tonne, out of which 50 thsd tonne from the customer's raw materials

	<ul style="list-style-type: none"> ○ Normalization ○ Homogenization ○ Pasteurization ○ Sterilization ▪ Dairy machines (54); ▪ Centrifugal cream separators (5); ▪ Storage: <ul style="list-style-type: none"> ○ Refrigerators, freezers and other refrigerating or freezing equipment, electric or other; heat pumps (95) 	
4. Beef Production	<ul style="list-style-type: none"> ▪ Culling of cows ▪ Pre-slaughter procedures (weighing, documentation) ▪ Transportation to meat processing plants (by road, rail, water transport; herding) ▪ Slaughter ▪ Carcass stamping ▪ Carcass weighing ▪ Sorting (meat, by-products, hide) ▪ Cooling (conveyor transportation to cooling chambers) ▪ Meat processing <ul style="list-style-type: none"> ○ Machinery for the industrial preparation of meat or poultry (94) ▪ Storage 	<ul style="list-style-type: none"> ▪ Culling of cows ▪ Pre-slaughter procedures (weighing, documentation) ▪ Transportation to meat processing plants (by road, rail, water transport; herding) ▪ Slaughter ▪ Carcass stamping ▪ Carcass weighing ▪ Sorting (meat, by-products, hide) ▪ Cooling (conveyor transportation to cooling chambers) ▪ Meat processing ▪ Storage
5. Quality checks	<ul style="list-style-type: none"> ▪ Inspection of finished products by an in-house veterinarian 	-
6. Product Transportation	<ul style="list-style-type: none"> ▪ Vans and suitable machines for transportation of finished products; ▪ Labor (working-hours) 	<ul style="list-style-type: none"> ▪ Own car or a small truck to transport finished products to sales markets
7. Sales of meat and dairy products	<ul style="list-style-type: none"> ▪ Wholesale trade ▪ Retail trade ▪ Food Services (production of meat products and semi-finished beef products) ▪ Export 	<ul style="list-style-type: none"> ▪ Sales on the market ▪ Sales for the processing industry ▪ Sales to the dairy product enterprise (milk)
8. Final Consumption		

Figure 2. Production scheme of beef and milk on enterprises and households



3. Pork

In 2022, the pig population was 5.6 million heads, more than 1.5 years of war, the pig population decreased by almost 12% and in 2023 it is accounting 4.95 million heads. In recent years, Ukrainian pig farming has gained enterprises importance. Currently, the share of enterprises in the total pig population is **64%**, and in the households, **36%**, respectively (SSSU, 2023).

According to the UPF (Ukrainian Pig Farmers) the following top 5 regions with the largest livestock pork populations 2022/2023 years: Kyiv Oblast: 14.8%, Lviv Oblast: 9.4%, Ivano-Frankivsk Oblast: 7.1% Ternopil Oblast: 5.2%, Dnipropetrovsk Oblast: 5.1. The companies with the largest market share in the industry: SP Top Nyva Pereyaslavshchyna **10.1%**, TzOV Hudvely Ukraine **7.1%**, Pap. AgroprodService **5.2%** (PigUa, 2023).

Table 3. Pork production process enterprises and households

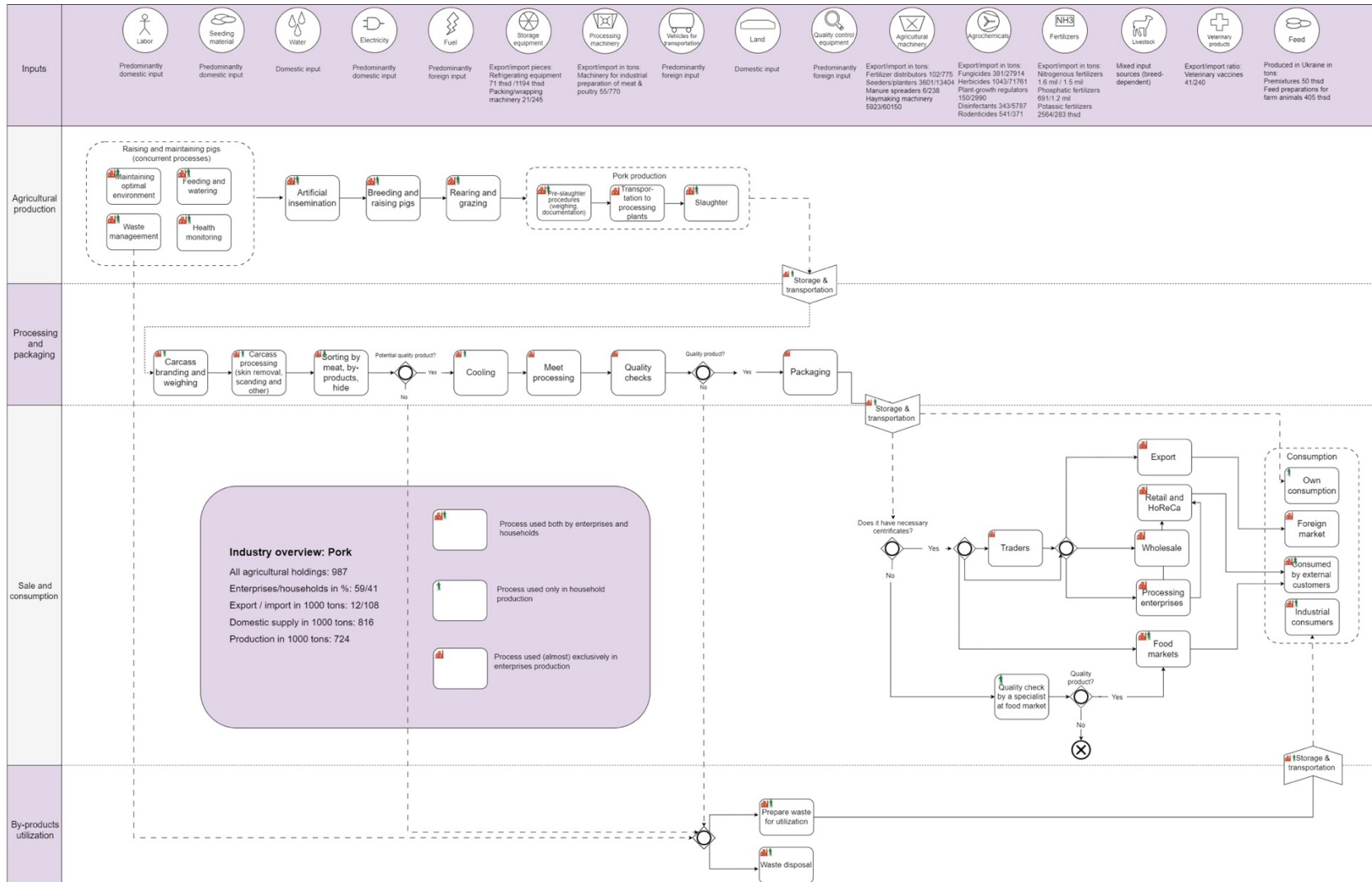
Production stage	Details of the production in enterprises	Details of the production in households
<p>1. Maintaining pigs</p>	<ul style="list-style-type: none"> ▪ Utilization of production facilities ▪ Outdoor areas for swine ▪ Feeding of swine and feed production: <ul style="list-style-type: none"> ○ Compound feed concentrate: (barley, wheat, oats, peas, wheat bran, sunflower meal, fish meal, grass meal, precipitate, salt, premix – 1%) – Compound feed typically consists of 50% to 90% root and tuber crops. The compound feed should contain essential amino acids such as lysine, methionine, tryptophan, arginine, histidine, leucine, isoleucine, phenylalanine, threonine, and valine, as well as vitamins. ○ Rations for replacement young stock should consist of concentrated feeds (75-87%), succulent and green feeds (12-20%), and feeds of animal origin (3-5% in terms of nutrition). 	<ul style="list-style-type: none"> ▪ Utilization of production facilities ▪ Outdoor areas for swine ▪ Feeding of swine and feed production, mainly; <ul style="list-style-type: none"> ▪ Ensuring animal feed supply (feed mills, feed dispensers, feed transportation to feeding sites) ▪ Feeding compound feed concentrates mixed with root and tuber crops or green legume mass in the form of moist mixtures, depending on the adopted technology. ▪ Water supply <ul style="list-style-type: none"> ○ Input data: (water, automatic waterers, water electric heating). ▪ Bedding (straw from cereal crops, wood shavings, and other organic materials with high moisture absorption capacity); ▪ Health monitoring, veterinary and sanitary measures; ▪ Creation of an optimal microclimate (ventilation and heating systems); ▪ Waste utilization: <ul style="list-style-type: none"> ○ Manure removal (conveyors, hydraulic

	<ul style="list-style-type: none"> ○ Sample Composition of Compound Feed Concentrate: ○ For gilts: barley – 30%, oats – 30%, sunflower meal – 8%, meat and bone meal – 6%, high-quality alfalfa meal – 23.5%, chalk – 1%, salt – 0.5%, premix – 1%. ○ For boars: barley – 57.4%, oats – 10%, peas – 6%, soybean meal 163 – 4%, yeast fodder – 4%, fish meal – 0.4%, high-quality alfalfa meal – 15%, dicalcium phosphate – 1%, chalk – 0.7%, salt – 0.5%, premix – 1%.³ ▪ Drugs used for cattle feeding; ▪ Premixtures for farm animal feeds (80) ▪ Ensuring animal feed supply (feed mills, feed dispensers, feed transportation to feeding sites) ▪ Feeding compound feed concentrates mixed with root and tuber crops or green legume mass in the form of moist mixtures, depending on the adopted technology. ▪ Water supply <ul style="list-style-type: none"> ○ Input data: (water, automatic waterers, water electric heating); ▪ Bedding (straw from cereal crops, wood shavings, and other organic materials with high moisture absorption capacity) <ul style="list-style-type: none"> ○ Straw or fodder balers, including pick-up balers (87) ○ Haymaking machinery (55) 	<p>systems, bulldozers, labor);</p> <ul style="list-style-type: none"> ○ Manure storage in manure storages; ○ Manure processing or utilization.
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	<ul style="list-style-type: none"> ▪ Health monitoring, veterinary and sanitary measures: <ul style="list-style-type: none"> ○ Vaccines for veterinary medicine (85) ▪ Creation of an optimal microclimate (ventilation and heating systems) ▪ Waste utilization <ul style="list-style-type: none"> ○ Manure removal (conveyors, hydraulic systems, bulldozers, labor); ○ Manure storage in manure storages; ○ Manure processing or utilization. 	
2. Animal reproduction	<ul style="list-style-type: none"> ▪ Insemination ▪ Breeding ▪ Raising pigs ▪ Rearing and grazing 	<ul style="list-style-type: none"> ▪ Insemination ▪ Breeding ▪ Raising pigs ▪ Rearing and grazing
3. Pork Production	<ul style="list-style-type: none"> ▪ Pre-slaughter procedures: weighing, document preparation ▪ Transportation to meat processing plants ▪ Slaughter ▪ Carcass branding ▪ Carcass weighing ▪ Carcass processing (skin removal, scalding with straw or soldering lamp, scalding with boiling water) ▪ Deboning ▪ Sorting (meat, by-products, hide) ▪ Cooling (conveyor transportation to cooling chambers) ▪ Meat processing <ul style="list-style-type: none"> ○ Machinery for the industrial preparation of meat or poultry (94) ▪ Storage 	<ul style="list-style-type: none"> ▪ Pre-slaughter procedures: weighing, document preparation ▪ Transportation to meat processing plants ▪ Slaughter ▪ Carcass branding ▪ Carcass weighing ▪ Carcass processing (skin removal, scalding with straw or soldering lamp, scalding with boiling water) ▪ Deboning ▪ Sorting (meat, by-products, hide) ▪ Cooling (conveyor transportation to cooling chambers) ▪ Meat processing ▪ Storage
4. Quality checks	<ul style="list-style-type: none"> ▪ Inspection of finished products by an in-house veterinarian 	-
5. Product Transportation	<ul style="list-style-type: none"> ▪ Vans and suitable machines for transportation of finished products; ▪ Labor (working-hours) 	<ul style="list-style-type: none"> ▪ Own car or a small truck for transporting finished products to sales markets

6. Sales	<ul style="list-style-type: none"> ▪ Wholesale Trade ▪ Retail Trade ▪ Food Services (production of sausages, meat products and semi-finished pork products) 	<ul style="list-style-type: none"> ▪ Retail sales at markets in villages or large cities; ▪ Sales at the markets on the amalgamated hromada.
7. Final consumption		

Figure 3. Production scheme of pork on enterprises and households



4. Sugar and sugar beet

In the 2021/22 marketing year, Ukraine produced approximately 1.45 million tons of sugar, according to the (SSSU, 2023). According to preliminary results, sugar production in Ukraine for the 2022/23 marketing year will decrease by 120,000 tons. In 2021, almost 10.8 million tonnes of sugar beet were produced, with 95% of the beet produced by enterprises and the remaining 5% going to households (SSSU, 2023).

In 2022, sugar beets were grown in 14 regions throughout Ukraine, with the majority of cultivation focused in six key regions accounting for more than 70% of the total crop. The regions of Vinnytsia, Khmelnytskyi, Poltava, and Ternopil specifically experienced the highest levels of sugar beet cultivation. The collective land area allocated for sugar beet cultivation in 2022 amounted to 178,000 hectares (SSSU, 2023).

In 2022, a total of 23 sugar factories processed sugar beets, which is a reduction from previous years. According to a report by (Latifundist, 2023), the three leading sugar producers were:

"Radekhivsky Sugar" - 340,000 tons of sugar;

"Astarta-Kyiv" - 282,000 tons of sugar;

"UKRPROMINVEST-AGRO" - 250,000 tons of sugar.

Table 4. Sugar production process enterprises and households

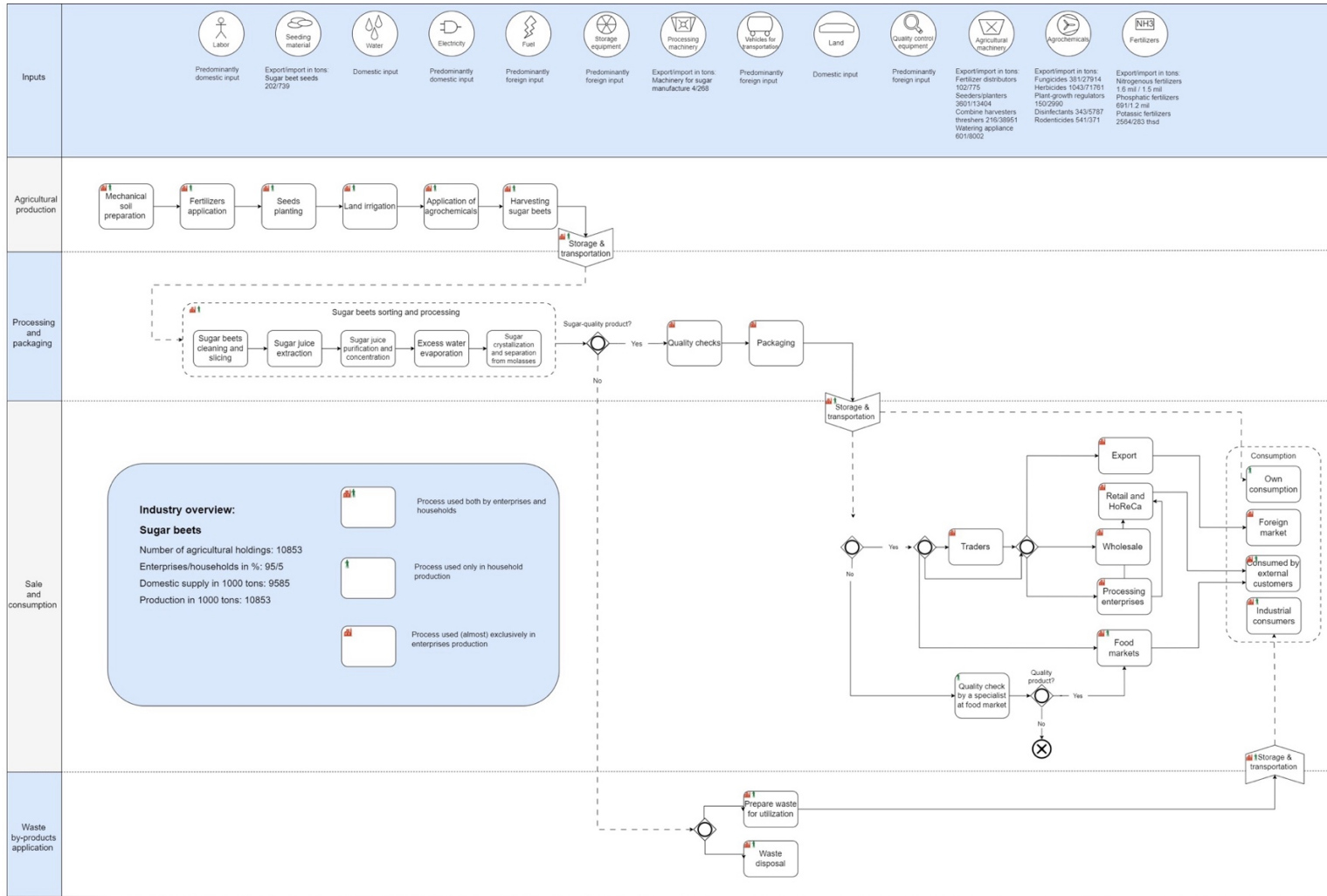
Production stage	Details of the production in enterprises	Details of the production in households
1. Fertilizer Application in Autumn	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production <ul style="list-style-type: none"> ○ Manure spreaders, excl. sprayers (99); ○ Fertilizer distributors, excl. sprayers and manure spreaders (93); ○ Animal or vegetable fertilizers (69); ○ Nitrogenous fertilizers (44); ○ Phosphatic fertilizers (100); ○ Potassic fertilizers (99.9). ▪ Water ▪ Gas ▪ Electricity ▪ Labor ▪ Delivery of raw materials and finished products ▪ Fuel 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production ▪ Water ▪ Gas ▪ Electricity ▪ Labor ▪ Delivery of raw materials and finished products ▪ Fuel
2. Mechanical Soil Preparation	<ul style="list-style-type: none"> ▪ Machinery (seeders and harvesters) 	<ul style="list-style-type: none"> ▪ Machinery (seeders and harvesters) ▪ Fuel

(Plowing and Deep Cultivation)	<ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines (57) ○ No-till direct seeders, planters and transplanters (87.5) ▪ Fuel ▪ Labor 	<ul style="list-style-type: none"> ▪ Labor
3. Land Access, Input Materials	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis 	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis
4. Planting, Input Materials	<ul style="list-style-type: none"> ▪ Seeds and planting materials: <ul style="list-style-type: none"> ○ Sugar beet seed, for sowing (79) ▪ Relevant machinery (seeders) <ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines; ○ No-till direct seeders, planters and transplanters. ▪ Fuel ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Seeds and planting materials ▪ Relevant machinery (seeders) ▪ Fuel ▪ Labor (working hours)
5. Irrigation, Input Materials	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems <ul style="list-style-type: none"> ○ Agricultural or horticultural watering appliances, whether or not hand-operated (93) ▪ Water ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems ▪ Water ▪ Labor (working hours)
6. Application of Necessary Agrochemicals for Crop Yield and Pest Control	<ul style="list-style-type: none"> ▪ Crop protection products and agrochemicals (fungicides and herbicides, which, like fertilizers, may need to be produced using the same production factors) <ul style="list-style-type: none"> ○ Insecticides (96) ○ Fungicides. (99) ○ Herbicides, anti-sprouting products and plant-growth regulators (98.5); ○ Just Plant-growth regulators (95); ○ Disinfectants (68.7); ○ Rodenticides (40). ▪ Water ▪ Relevant machinery (harvesters) <ul style="list-style-type: none"> ○ Combine harvester-threshers (99.5) ○ Threshing machinery (19) 	<ul style="list-style-type: none"> ▪ Crop protection products and agrochemicals (fungicides and herbicides, which, like fertilizers, may need to be produced using the same production factors) ▪ Water ▪ Relevant machinery (harvesters) ▪ Fuel ▪ Labor

	<ul style="list-style-type: none"> ○ Mowers, incl. cutter bars for tractor mounting (86) ○ Other harvesting machinery, including pick-up balers, combine harvester-threshers, other threshing machinery and root or tuber harvesting machines (67) ▪ Fuel ▪ Labor 	
7. Harvesting Sugar Beets, Input Data (Own or Imported Harvesting Machines)	<ul style="list-style-type: none"> ▪ Harvesting machinery ▪ Beet-topping machines and beet harvesters ▪ Trucks ▪ Fuel ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Harvesting machinery ▪ Trucks ▪ Fuel ▪ Labor (working hours)
8. Storage and Transportation to Processing Plant Warehouses	<ul style="list-style-type: none"> ▪ Storage in warehouse facilities ▪ Transportation by trucks ▪ Fuel ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Storage in warehouse facilities ▪ Transportation by trucks ▪ Fuel ▪ Labor (working hours)
9. Sugar Beet Processing, Input Materials	<ul style="list-style-type: none"> ▪ The sugar production process consists of several stages, including: <ul style="list-style-type: none"> ○ Sugar beets go through a processing line where they are cleaned and sliced. ○ Part of the beets is crushed to obtain sugar juice, which contains sugars. ○ The obtained sugar juice undergoes purification and concentration. ○ Excess water is evaporated from the sugar syrup using evaporators, resulting in syrup with a high sugar content. ○ Sugar crystallizes from the sugar syrup and is separated from molasses. ○ Molasses are used in the production of compound feed. ▪ Machinery for sugar manufacture (99) ▪ Drying in specialized facilities ▪ Water, gas, electricity 	<ul style="list-style-type: none"> ▪ The sugar production process consists of several stages, including: <ul style="list-style-type: none"> ○ Sugar beets go through a processing line where they are cleaned and sliced. ○ Part of the beets is crushed to obtain sugar juice, which contains sugars. ○ The obtained sugar juice undergoes purification and concentration. ○ Excess water is evaporated from the sugar syrup using evaporators, resulting in syrup with a high sugar content. ○ Sugar crystallizes from the sugar syrup and is separated from molasses. ▪ Drying in specialized facilities; ▪ Water, gas, electricity; ▪ Labor (working hours); ▪ Fuel

	<ul style="list-style-type: none"> ▪ Labor (working hours) ▪ Fuel 	
10. Quality checks	-	-
11. Transportation to Export Terminals or Retail Stores	<ul style="list-style-type: none"> ▪ Trucks ▪ Fuel ▪ Labor (working hours) ▪ Warehouse facilities 	-
12. Sales	<ul style="list-style-type: none"> ▪ Wholesale trade to general markets; ▪ Retail trade, sales to store; ▪ Food services; ▪ Export ▪ Sale of molasses for further compound feed production; ▪ Sale of compound feed made from sugar production waste (molasses); ▪ Sales of sugar to undertakings producing confectionery products; ▪ Sales of sugar to enterprises producing alcohol; ▪ Sales of sugar to enterprises producing juices and carbonated drinks. 	<ul style="list-style-type: none"> ▪ Sale of sugar beet for processing in factories
13. Final Consumption	<ul style="list-style-type: none"> ▪ Consumption of sugar by individuals who purchased it in stores, markets, or directly from the sugar plant; ▪ Consumption of sugary products. 	

Figure 4. Production scheme of sugar on enterprises and households



5 Sunflower oil

Ukraine, as a major global producer and exporter of grains and sunflower oil. For the first time in many years, in 2022, Ukraine became a major exporter of sunflower - under the conditions of general uncertainty, farmers preferred to sell their harvest stocks as soon as possible and not depend on the situation with the production of sunflower oil and export routes (Share UA Potential, 2023).

In 2021, Ukraine harvested 16.5 million tons of sunflower, with 86.7% of the production volume contributed by enterprises and the remaining 13.3% attributed to households (SSSU, 2022). Approximately 85% of the total volume of sunflower oil produced was exported.

Moreover, the top five regions in the country (Kirovohrad, Dnipropetrovsk, Kharkiv, Zaporizhzhia, and Mykolaiv) accounted for more than 40% of the total sunflower cultivation area in the same year. The full-scale Russian invasion in 2022 had a significant impact on the sunflower cultivation areas and overall yield in Ukraine. The total cultivation area dropped from 6.6 million hectares in 2021 to 4.8 million hectares in 2022 (SSSU, 2022).

Kernel is the largest sunflower processor, processing about 2.2 million tons of sunflower and producing 1 million tons of oil in the 2021/22 season. Kernel's market share in the 2021/22 season was 22%. International companies like Cofco and Cargill's assets remained in the occupied territory, Bunge suspended its plant in Mykolaiv due to the blockade of Ukrainian ports, and ADM (whose plant is in Chornomorsk) was affected as well. In the 2020/21 season, among international companies, Bunge had the highest market share at 11%, but it should decrease in 2021/2022 due to the suspended plant and terminal in Mykolaiv. In 2022, MHP used significant supply of sunflower on the domestic market and increased processing. MHP's market share among Ukrainian sunflower processors in the 2021/22 season was about 6% (Share UA Potential, 2023).

Table 5. Sunflower Oil Production Process enterprises and households⁴

Production stage	Details of the production in enterprises	Details of the production in households
1. Pre-Season Fertilizer Application	<ul style="list-style-type: none"> ▪ Application of nitrogen, phosphorus, and potassium micro-fertilizers, as well as magnesium, boron, and sulfur. ○ Chemical components for fertilizer production <ul style="list-style-type: none"> (a) Manure spreaders, excl. sprayers (99) (b) Fertiliser distributors, excl. sprayers and manure spreaders (93) (c) Animal or vegetable fertilizers (69) 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production <ul style="list-style-type: none"> ○ Manure spreaders, excl. sprayers (99) ○ Fertilizer distributors, excl. sprayers and manure spreaders (93); ○ Animal or vegetable fertilizers (69); ○ Nitrogenous fertilizers (44); ○ Phosphatic fertilizers (100); ○ Potassic fertilizers (99.9). ▪ Water (domestic production) ▪ Gas

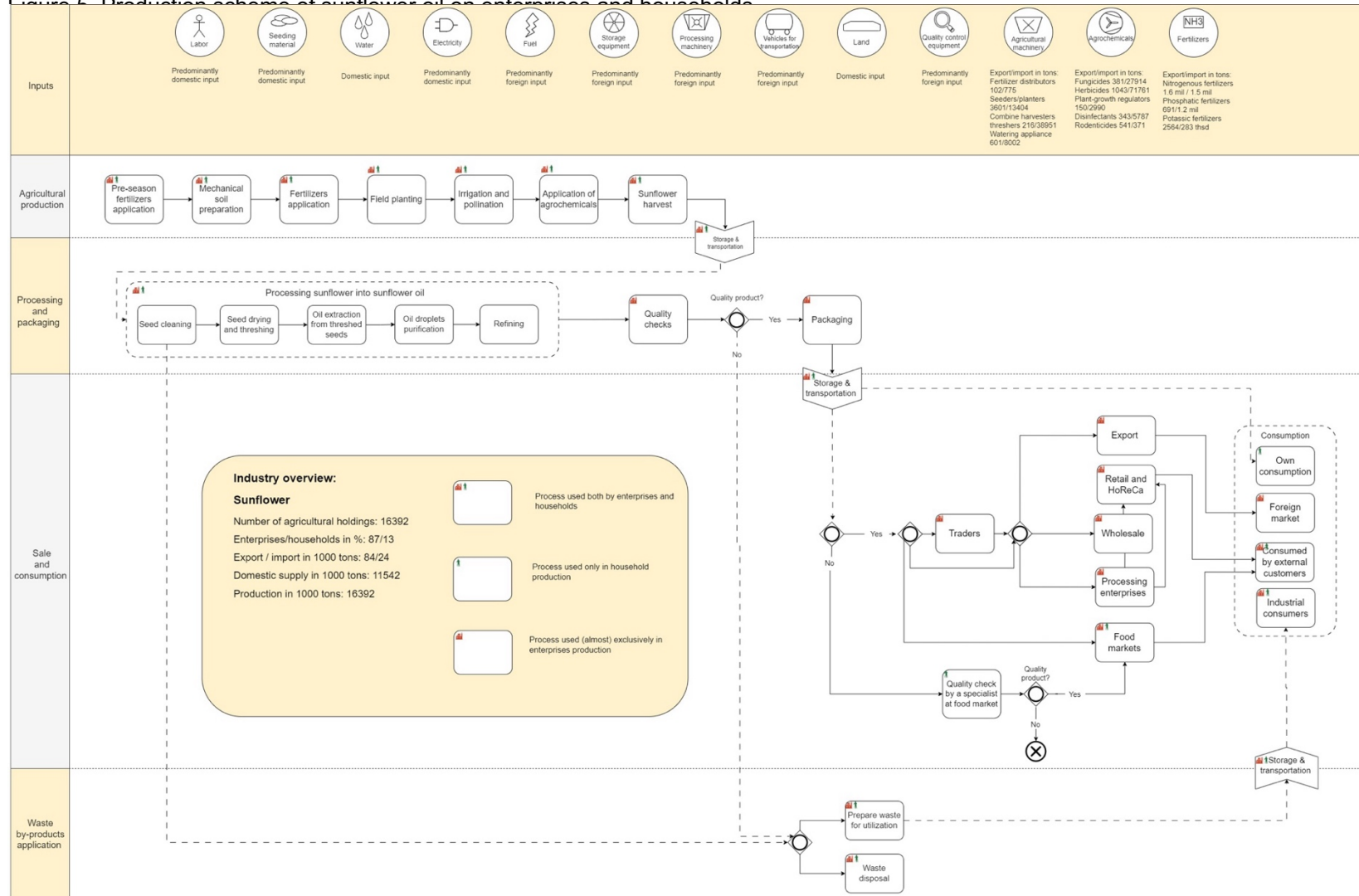
⁴ According to agricultural producers, sunflowers contribute 120 kg of nitrogen, 45 kg of phosphorus, and 235 kg of potassium per ha

	<p>(d) Nitrogenous fertilizers (44)</p> <p>(e) Phosphatic fertilizers (100)</p> <p>(f) Potassic fertilizers. (99.9)</p> <ul style="list-style-type: none"> ▪ Water (domestic production) ▪ Gas ▪ Electricity ▪ Labor ▪ Transportation of both raw materials and finished products 	<ul style="list-style-type: none"> ▪ Electricity ▪ Labor ▪ Transportation of both raw materials and finished products
<p>2. Mechanical Soil Preparation (surface soil treatment or double-layer plowing depending on the region and moisture levels)</p>	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines) <ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines (57) ○ No-till direct seeders, planters and transplanters (87.5) ▪ Fuel ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines) <ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines (57) ○ No-till direct seeders, planters and transplanters (87.5) ▪ Fuel ▪ Labor (working hours)
<p>3. Land Access</p>	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis 	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis
<p>4. Field Planting</p>	<ul style="list-style-type: none"> ▪ Seeds or planting materials <ul style="list-style-type: none"> ○ Sunflower seeds (23); ▪ Appropriate machinery (combines); ▪ Fuel; ▪ Labor (working hours). 	<ul style="list-style-type: none"> ▪ As seeds or planting materials ▪ Appropriate machinery (combines) ▪ Fuel ▪ Labor (working hours)
<p>5. Irrigation and Pollination</p>	<ul style="list-style-type: none"> ▪ Ground or other irrigation systems; ▪ Water; ▪ Labor (working hours); ▪ Beehives with bees, which are exhibited during the flowering period of the crop. 	<ul style="list-style-type: none"> ▪ Ground or other irrigation systems; ▪ Water; ▪ Labor (working hours); ▪ Beehives with bees, which are exhibited during the flowering period of the crop.
<p>6. Application of Necessary Agrochemicals</p>	<ul style="list-style-type: none"> ▪ Desiccation; ▪ PPE + agrochemicals (fungicides and herbicides, with the same production functions as fertilizers): <ul style="list-style-type: none"> ○ Insecticides (96); ○ Fungicides (1/99); ○ Herbicides, anti-sprouting products and plant-growth regulators (99); 	<ul style="list-style-type: none"> ▪ Desiccation; ▪ PPE + agrochemicals (fungicides and herbicides, which, like fertilizers, must be produced using the same production factors) ▪ Water; ▪ Appropriate equipment (harvesters); ▪ Fuel;

	<ul style="list-style-type: none"> ○ Plant-growth regulators (95); ○ Disinfectants (95); ○ Rodenticides (40). ▪ Water; ▪ Appropriate equipment (harvesters); ▪ Fuel; ▪ Labor (working hours) 	<ul style="list-style-type: none"> ▪ Labor (working hours).
7. Sunflower Harvest	<ul style="list-style-type: none"> ▪ Combines with special attachments (headers); ▪ Trucks; ▪ Fuel; ▪ Labor (working hours); 	<ul style="list-style-type: none"> ▪ Combines with special attachments (headers). ▪ Trucks. ▪ Fuel. ▪ Labor (working hours)
8. Storage and Transportation to Processing Plant Warehouses	<ul style="list-style-type: none"> ▪ Storage of sunflowers in fabric bags with necessary air circulation and moisture removal; ▪ Storage in warehouse facilities; ▪ Transportation by trucks; ▪ Fuel; ▪ Labor (working hours). 	<ul style="list-style-type: none"> ▪ Storage of sunflowers in fabric bags with necessary air circulation and moisture removal. ▪ Storage in warehouse facilities. ▪ Transportation by trucks; ▪ Fuel; ▪ Labor (working hours).
9. Sunflower Processing into Sunflower Oil	<ul style="list-style-type: none"> ▪ The process of sunflower oil production includes several stages: <ul style="list-style-type: none"> ○ Seed cleaning before drying and threshing. ○ Oil extraction from the threshed seeds, resulting in oil droplets and meal. ○ Purification of oil droplets. ○ Treatment of extracted oil. ○ Refining if necessary. ▪ Packaging; ▪ Water; ▪ Gas; ▪ Electricity; ▪ Labor (working hours); ▪ Fuel. 	<ul style="list-style-type: none"> ▪ The process of sunflower oil production consists of several stages, including: <ul style="list-style-type: none"> ○ Seed cleaning before drying and threshing. ○ Oil extraction from the threshed seeds, resulting in oil droplets and meal. ○ Purification of oil droplets. ○ Treatment of extracted oil. ○ Refining if necessary. ▪ Packaging. ▪ Water. ▪ Gas. ▪ Electricity. ▪ Labor (working hours) ▪ Fuel.
10. Production of Animal Feed from Intermediate Products	<ul style="list-style-type: none"> ▪ After oil extraction, intermediate products such as oil cake and meal remain; ▪ Packaging; ▪ Transportation of feed to consumers and specialized agricultural enterprises specializing in the cultivation of domestic animals, poultry, and fish; ▪ Feed sales. 	<ul style="list-style-type: none"> ▪ After oil extraction, intermediate products such as oil cake and meal remain. ▪ Packaging; ▪ Transportation of feed to consumers and specialized agricultural enterprises specializing in the cultivation of domestic animals, poultry, and fish.

		<ul style="list-style-type: none"> ▪ Feed sales.
11. Transportation to Export Terminals or Retail Stores	<ul style="list-style-type: none"> ▪ Trucks. ▪ Fuel. ▪ Labor. ▪ Warehousing facilities. 	-
12. Quality checks	-	-
13. Sales	<ul style="list-style-type: none"> ▪ Wholesale trade <ul style="list-style-type: none"> ○ Sales of sunflower oil for local consumption; ○ Sales of sunflower oil for export to foreign markets (85% of all production). ▪ Retail trade, sales in store; ▪ Food services. 	<ul style="list-style-type: none"> ▪ Wholesale trade
14. Final consumption		

Figure 5. Production scheme of sunflower oil on enterprises and households



6. Corn

Ukraine, along with the United States, Brazil, and Argentina, is among the world's largest corn sellers, accounting for 85% of exports. Annually, 75-85% of Ukrainian corn is sold on international markets. Of the remaining quantity for domestic consumption, 90% is used in feed production.

In 2021, corn production in Ukraine was largely dominated by enterprises, accounting for 90% of total production, while households produced only 10%, likely for broiler feeding and other purposes (SSSU, 2022). The country's total corn production for the 2021 sowing year was 42.2 million tons, with 87.4% produced by enterprises and 12.6% by households. The main regions leading in corn cultivation were the Poltava, Chernihiv, Sumy, Vinnytsia and Cherkasy oblast. The crop harvesting area decreased by 25.8% in 2022 compared to the pre-war year, resulting in 4.07 million hectares being harvested as opposed to 5.48 million hectares in 2021. The gross harvest in 2022 declined by almost 39%, yielding only 25.6 million tons (SSSU, 2022).

Table 6. Corn production process enterprises and households⁵

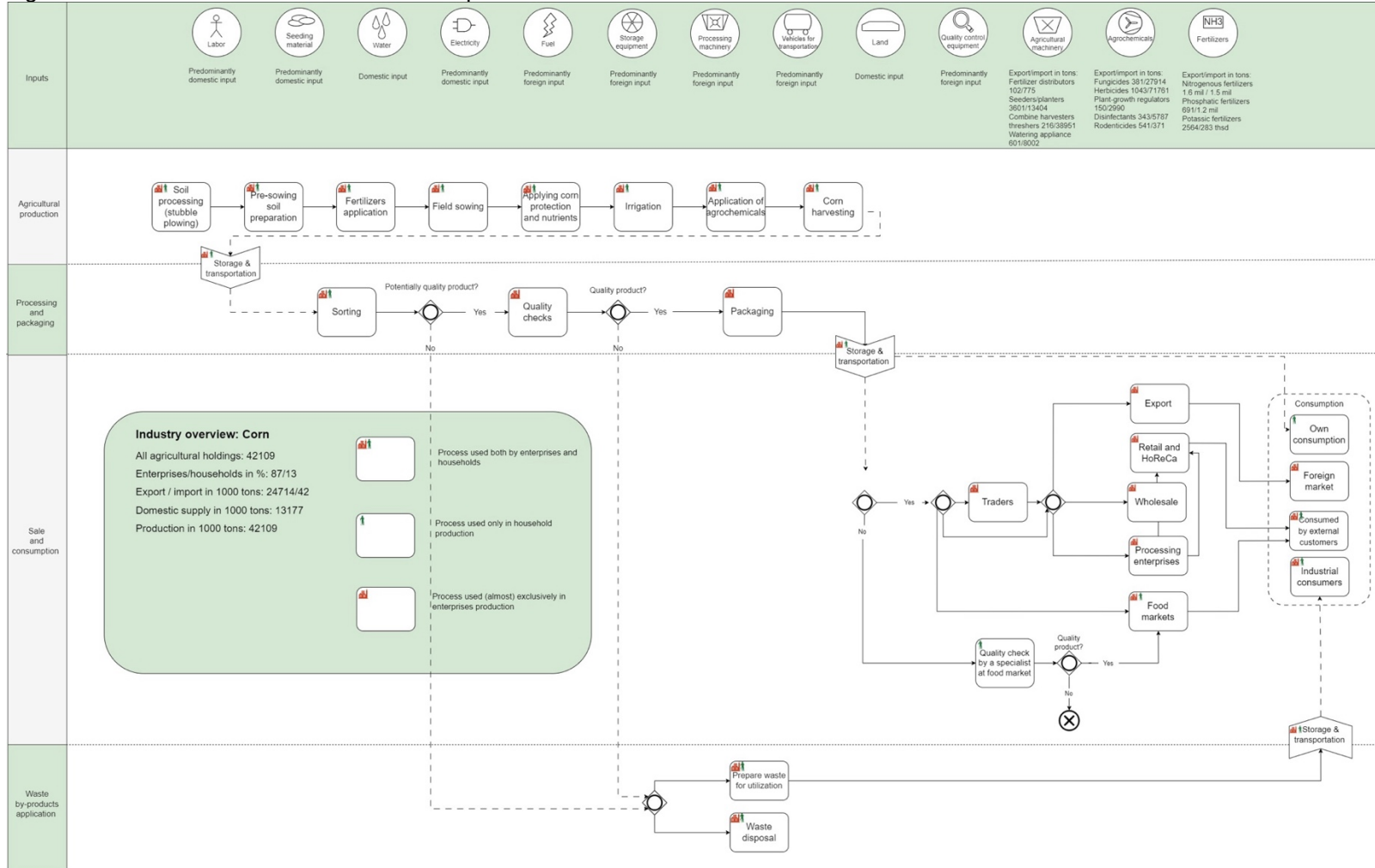
Production stage	Details of the production in enterprises	Details of the production in households
1. Soil Processing Immediately After Harvesting the Previous Crop (Stubble Plowing in One or Two Passes)	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines). <ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines (57) ○ No-till direct seeders, planters and transplanters (87.5). ▪ Fuel. ▪ Labor. 	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines). ▪ Fuel. ▪ Labor.
2. Pre-sowing Soil Preparation (Surface Soil Cultivation or Double-layer Plowing Depending on the Region and Moisture Level)	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines). <ul style="list-style-type: none"> ○ Scarifiers and cultivators (95); ○ Disc harrows (45); ○ Harrows, excl. disc harrows (10); ○ Ploughs (36). ▪ Fuel; ▪ Labor. 	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines). ▪ Fuel; ▪ Labor.
3. Application of Fertilizers Before Planting, Including Nitrogen, Phosphorus	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production; <ul style="list-style-type: none"> ○ Manure spreaders, excl. sprayers (99); ○ Fertilizer distributors, excl. sprayers and manure spreaders (93); 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production. ▪ Water. ▪ Gas; ▪ Electricity; ▪ Labor (working hours); ▪ Delivery of both raw materials and finished products;

⁵ To produce one ton of grain harvest, "corn consumes such amounts of nutrients: nitrogen 25-30 kg, phosphorus 10-15 kg, potassium 30-40 kg, calcium 6-10 kg, magnesium 6-10 kg. **Invalid source specified.**

	<ul style="list-style-type: none"> ○ Animal or vegetable fertilizers (69); ○ Nitrogenous fertilizers (44); ○ Phosphatic fertilizers (100); ○ Potassic fertilizers (99.9). <ul style="list-style-type: none"> ▪ Water; ▪ Gas; ▪ Electricity ▪ Labor. ▪ Delivery of both raw materials and finished products. ▪ Fuel. 	<ul style="list-style-type: none"> ▪ Fuel.
4. Land Access	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis 	<ul style="list-style-type: none"> ▪ Land lease ▪ Land purchase ▪ Emphyteusis
5. Sowing the Field, Input Materials	<ul style="list-style-type: none"> ▪ Seeds and/or planting materials. ▪ Appropriate machinery (seeders). <ul style="list-style-type: none"> ○ Seeders, planters and transplanters, excl. no-till machines (57) ○ No-till direct seeders, planters and transplanters: (87.5) ▪ Fuel. ▪ Labor (working-hours). 	<ul style="list-style-type: none"> ▪ Seeds and/or planting materials. ▪ Appropriate machinery (seeders). ▪ Fuel. ▪ Labor (working hours).
6. Corn Nutrition	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production. ▪ Water. ▪ Gas; ▪ Electricity; ▪ Labor. ▪ Delivery of both raw materials and finished products. ▪ Fuel. 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production. ▪ Water. ▪ Gas; ▪ Electricity; ▪ Labor. ▪ Delivery of both raw materials and finished products. ▪ Fuel.
7. Protection of Corn Crops	<ul style="list-style-type: none"> ▪ Appropriate machinery (combines) with toothed rollers. ▪ Fuel. ▪ Labor (working-hours). 	<ul style="list-style-type: none"> ▪ Appropriate machinery (combines) with toothed rollers. ▪ Fuel. ▪ Labor (working hours).
8. Irrigation, Input Materials	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems. ▪ Water. ▪ Labor (working hours). 	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems. ▪ Water. ▪ Labor (working hours).
9. Application of Necessary Agrochemicals for Crop Yield Preservation and Pest Control, Input Materials	<ul style="list-style-type: none"> ▪ Pesticides and agrochemicals (fungicides, herbicides, insecticides), which, like fertilizers, need to be produced using the same production factors. <ul style="list-style-type: none"> ○ Insecticides (96); ○ Fungicides. (99); 	<ul style="list-style-type: none"> ▪ Pesticides and agrochemicals (fungicides, herbicides, insecticides), with almost the same production process and production factors as fertilizers. ▪ Water.

	<ul style="list-style-type: none"> ○ Herbicides, anti-sprouting products and plant-growth regulators (98.5); ○ Just Plant-growth regulators (95); ○ Disinfectants (68.7); ○ Rodenticides (40). <ul style="list-style-type: none"> ▪ Water. ▪ Appropriate machinery (combines). ▪ Fuel. ▪ Labor. 	<ul style="list-style-type: none"> ▪ Appropriate machinery (combines). ▪ Fuel. ▪ Labor (working hours).
10. Corn Harvesting	<ul style="list-style-type: none"> ▪ Combines with special attachments. ▪ Trucks. ▪ Fuel. ▪ Labor (working - hours). 	<ul style="list-style-type: none"> ▪ Combines with special attachments. ▪ Trucks. ▪ Fuel. ▪ Labor (working hours).
11. Storage		-
12. Quality checks	<ul style="list-style-type: none"> ▪ Quality control before export to other countries 	<ul style="list-style-type: none"> ▪ Quality control before export to other countries ▪ Quality control by grain traders who buy products from households and then export these products
13. Transportation to grain terminal for further export or to consumer	<ul style="list-style-type: none"> ▪ Trucks. ▪ Fuel. ▪ Labor (working - hours). 	-
14. Sales	<ul style="list-style-type: none"> ▪ Retail sales; ▪ Export; ▪ Animal feed production: <ul style="list-style-type: none"> ○ Separate feeds. ○ Part of compound feeds. ▪ Food services. 	<ul style="list-style-type: none"> ▪ Animal feed production: <ul style="list-style-type: none"> ○ Separate feeds. ○ Part of compound feeds. ▪ Sales to exporters
15. Final consumption		

Figure 6. Production scheme of corn on enterprises and households



2.7 Wheat and wheat flour

Ukraine is one of the largest agricultural producers in the world, and wheat is one of its most important crops. In recent years, Ukraine has become a significant player in the global wheat export market, competing with traditional exporters such as Russia, the United States, Canada, and France.

In 2021, Ukraine produced 32.2 million tons of wheat, with 80% produced by enterprises and 20% by households (SSSU, 2022). The top regions for wheat cultivation were Kharkiv, Dnipropetrovsk, Zaporizhia, Odesa, and Mykolaiv. Given the geographical locations of these regions and the Russian Federation's attack directions, the leading wheat-producing regions were likely the most impacted by the attack. Given Ukraine's focus on winter wheat production (97.5% of its total wheat output), the sowing campaign occurred prior to the full-scale invasion. However, the harvested areas differed greatly. As a result, the actual harvesting land area in 2022 was 26% less than that of the pre-war year, equating to 5.22 million hectares in 2022 compared to 7.09 million hectares in 2021. Gross harvest in 2022 also substantially decreased, plummeting by 36% to a total of 20.5 million tons (SSSU, 2022).

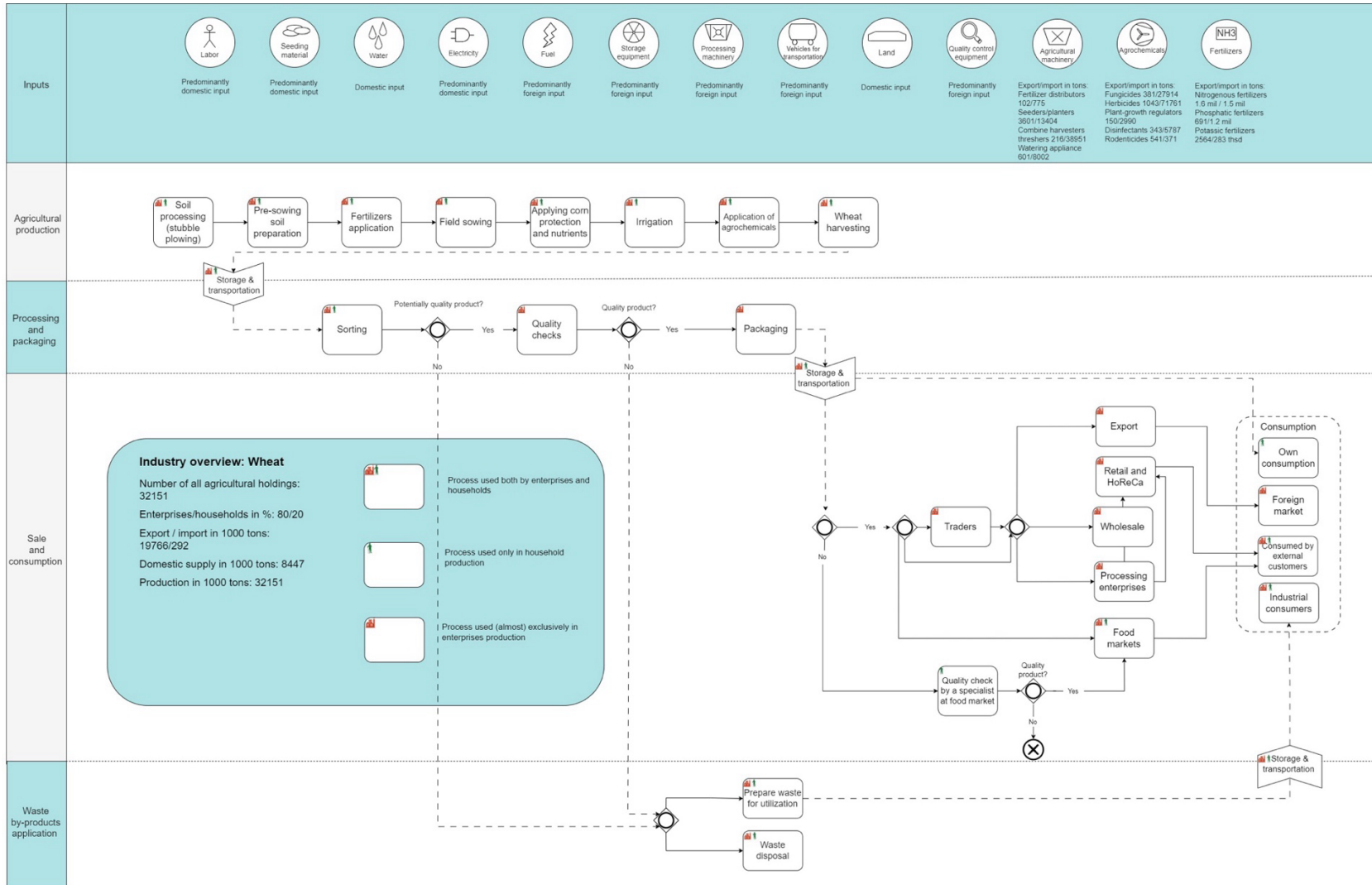
Table 7. Wheat production process enterprises and households

Production stage	Details of the production in enterprises	Details of the production in households
1. Soil Processing	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines). ▪ Fuel; ▪ Labor. 	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines); ▪ Fuel; ▪ Labor.
2. Pre-sowing Soil Preparation	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines); ▪ Fuel; ▪ Labor. 	<ul style="list-style-type: none"> ▪ Machinery (seeders and combines); ▪ Fuel; ▪ Labor.
3. Application of Fertilizers Before Planting	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production; ▪ Water; ▪ Gas; ▪ Electricity; ▪ Labor; ▪ Delivery of both raw materials and finished products; ▪ Fuel. 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production; ▪ Water; ▪ Gas; ▪ Electricity; ▪ Labor; ▪ Delivery of both raw materials and finished products; ▪ Fuel.
4. Land Access	<ul style="list-style-type: none"> ▪ Land leasing; ▪ Land purchase; ▪ Emphyteusis. 	<ul style="list-style-type: none"> ▪ Land leasing; ▪ Land purchase; ▪ Emphyteusis.
5. Sowing the Field	<ul style="list-style-type: none"> ▪ Seeds and/or planting materials; ▪ Appropriate machinery (seeders); ▪ Fuel; ▪ Labor (working-hours). 	<ul style="list-style-type: none"> ▪ Seeds and/or planting materials; ▪ Appropriate machinery (seeders); ▪ Fuel; ▪ Labor (working-hours).
6. Wheat Nutrition	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production; 	<ul style="list-style-type: none"> ▪ Chemical components for fertilizer production;

	<ul style="list-style-type: none"> ▪ Water; ▪ Gas; ▪ Electricity; ▪ Labor; ▪ Delivery of both raw materials and finished products; ▪ Fuel. 	<ul style="list-style-type: none"> ▪ Water; ▪ Gas; ▪ Electricity; ▪ Labor; ▪ Delivery of both raw materials and finished products; ▪ Fuel.
7. Protection of Wheat Crops	<ul style="list-style-type: none"> ▪ Appropriate machinery (combines) with toothed rollers; ▪ Fuel; ▪ Labor (working-hours). 	<ul style="list-style-type: none"> ▪ Appropriate machinery (combines) with toothed rollers; ▪ Fuel; ▪ Labor (working-hours).
8. Irrigation	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems; ▪ Water; ▪ Labor (working-hours). 	<ul style="list-style-type: none"> ▪ Surface or other irrigation systems; ▪ Water; ▪ Labor (working-hours).
9. Application of necessary agrochemicals for crop yield preservation and pest control	<ul style="list-style-type: none"> ▪ Pesticides and agrochemicals (fungicides, herbicides, insecticides), which, like fertilizers, need to be produced using the same production factors; ▪ Water; ▪ Machinery (combines); ▪ Fuel; ▪ Labor. 	<ul style="list-style-type: none"> ▪ Pesticides and agrochemicals (fungicides, herbicides, insecticides), which, like fertilizers, need to be produced using the same production factors. ▪ Water; ▪ Machinery (combines); ▪ Fuel; ▪ Labor.
10. Wheat Harvesting	<ul style="list-style-type: none"> ▪ Combines with special attachments; ▪ Trucks; ▪ Fuel; ▪ Labor (working-hours); 	<ul style="list-style-type: none"> ▪ Combines with special attachments; ▪ Trucks; ▪ Fuel; ▪ Labor (working-hours).
11. Storage	<ul style="list-style-type: none"> ▪ Storage in elevators ▪ Storage in grain terminals ▪ Storage in special bags ▪ Pallets 	<ul style="list-style-type: none"> ▪ Storage in special bags ▪ Pallets
12. Quality checks	<ul style="list-style-type: none"> ▪ Quality control before export to other countries 	<ul style="list-style-type: none"> ▪ Quality control before export to other countries ▪ Quality control by grain traders who buy products from households and then export these products
13. Transportation	<ul style="list-style-type: none"> ▪ Trucks. ▪ Fuel. ▪ Labor (working - hours). 	-
14. Sales	<ul style="list-style-type: none"> ▪ Export; ▪ Domestic distribution channels and markets; ▪ Processing companies; ▪ Flour production; ▪ Supplements production; 	<ul style="list-style-type: none"> ▪ Animal feed production: <ul style="list-style-type: none"> ○ Separate feeds; ○ Part of compound feeds. ▪ Sales to exporters or other market participants with appropriate export licenses;

	<ul style="list-style-type: none"> ▪ Alcohol production; ▪ Gluten production; ▪ Animal feed production: <ul style="list-style-type: none"> ○ Separate feeds; ○ Part of compound feeds. ▪ Wholesale networks; ▪ Retail networks; ▪ Food services. 	
15. Final consumption		

Figure 7. Production scheme of wheat on enterprises and households



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