



Regional Office for Europe and Central Asia

**FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS**

## **FOOD LOSSES AND WASTE IN ARMENIA**

### **COUNTRY REPORT**

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2013

## **Acknowledgement**

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This paper carries the name of the author and should be used and cited accordingly. The findings, interpretations and conclusions are the authors' own and should not be attributed to the Food and Agriculture Organization of the UN, its management, or any member countries.

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More information on the Agrarian Structures Initiative and its projects is available at <http://www.fao.org/europe/agrarian-structures-initiative/en/>

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## 1. Summary

The issue of food losses and waste is incredibly important, because if it can be prevented it can contribute to increasing incomes and improving food security in the world's poorest countries. Food losses and waste affect the food security of vulnerable groups, as well as food quality and safety, economic growth and the environment.

Armenia is a small landlocked country located in the South Caucasus. It is in a conflict with neighboring Azerbaijan and has no economic relations with Turkey. Limited resources and production capacity make eliminating food losses and waste an important priority.

This study concentrates on revealing volumes of food losses and waste, as well as how they can be prevented in all five steps of the supply chain; namely:

- Agricultural production;
- Post-harvest handling and storage;
- Processing and packaging;
- Distribution;
- Consumption.

The Commodity groups that were addressed are:

- Cereals;
- Roots and tubers;
- Oilseeds and pulses;
- Fruits and vegetables;
- Meat;
- Fish and seafood;
- Milk and eggs.

In order to reveal actual food waste across the supply chain we:

- ✓ Conducted interviews with farmers to determine product waste during harvesting and post-harvest handling and storage;
- ✓ Contacted cold storage facilities and wholesalers to obtain data on FLW during post-harvest handling and storage;
- ✓ Contacted selected dairy processors and canneries to find out about FLW during processing and distribution (since most dairy products are returned to processing plants if spoiled in the retailing stage or brought back to the retailer by consumers);
- ✓ Interviewed several wholesalers to reveal FLW during post-harvest handling, storage and distribution;
- ✓ Interviewed eight supermarkets, eight medium size grocery stores, 36 small shop holders, two butcher's outlets and 15 fruit and vegetables resellers on two open markets<sup>1</sup> to reveal FLW at the distribution stage;
- ✓ Interviewed 506 customers in Yerevan to get information on FLW during the consumption stage.

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<sup>1</sup> See the detailed FLW weights allocation among different distribution agents in Appendix 4.

The survey results revealed the following FLW percentages across the supply chain.

**Table 1. FLW percentages in each step of the supply chain**

	Ag. production	Post-harvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	15%	5%	6%	7%	5%
Roots and tubers	19%	6%	0%	3%	1%
Fruit and vegetables	6%	4%	3%	4%	3%
Meat	1%	0.1%	1%	1%	1%
Fish and seafood	20%	0.1%	0.2%	3%	1%
Milk	2%	0.1%	4%	2%	1%
Eggs	23%	1%	0.1%	0.1%	0.1%

Source: Own data

As an average low income country, FLW in Armenia is much higher at the beginning of the supply chain (agricultural production stage) than at the end (in distribution or consumption steps).

Main suggestions and recommendations on FLW reduction are:

- Educating and providing technical assistance to farmers in the process of harvesting;
- Training all supply chain actors to implement post-harvest handling and storage procedures and create infrastructure for delivering fresh food to consumers;
- Improving processing and packaging procedures and technologies;
- Advocating the creation of farmers' cooperatives;
- Developing or changing traditional marketing systems;
- Providing cold storage facilities and improving hygiene conditions at the distribution stage, especially on open markets;
- Improving storage conditions and promoting food purchase planning at household level.

## 2. Introduction

### 2.1 Study objectives

The issue of food losses is incredibly important, because if it can be prevented it can contribute to increasing incomes and improving food security in the world's poorest countries. Food losses affect the food security of vulnerable groups, as well as food quality and safety, economic growth and the environment. Reasons for FLW differ throughout the world and depend on the situation and certain conditions of particular countries. Food losses are influenced by crop production choices, the availability of infrastructure and facilities for transporting and preserving food, marketing chains and channels for distribution, and the purchasing and food use practices of individual households.

Economically preventable food losses have a direct impact on the income of farmers and consumers. Since many small farmers live on the boundaries of food insecurity, a reduction in food losses could have a direct and considerable impact on their livelihoods. For vulnerable members of society the main concern is to have access to nutritious, safe and affordable food products. Improving the efficiency of the food supply chain and reducing losses in this process will help to bring down the cost of food to the consumer, which is a very big issue in countries like Armenia, where poor families spend most of their income on food. Moreover, agriculture is the main source of family income in rural areas, where poverty levels are much higher. Armenia's dependency on agricultural products is quite high, so it is very important to minimum waste and loss throughout the value chain.

One of the main findings of previous studies was that in low income countries food is mostly lost during the agricultural production and postharvest handling and storage stage, while in high income countries it is mostly wasted at the consumption stage (Gustavsson et al., 2012).

If we take a closer look at the volumes of agricultural production in Armenia, we will see that fruit and vegetables account for the highest production volumes. Fruit and vegetables also play a vital dietary role for consumers. This makes both the production and consumption of fruit and vegetables increasingly important. However, this sector suffers greatly from postharvest losses. Some estimates suggest that in countries like Armenia about 30–40 percent of fruit and vegetables are lost during the harvest and postharvest stages of the value chain<sup>2</sup>. Some products are highly seasonal and may not be sold on the local markets for profit, while international markets may reject fruit and vegetables containing unauthorized pesticides and with inadequate labeling and packaging.

The aim of this research is to find and analyze data on food losses and waste as it goes through different stages of the food supply chain, starting from harvesting and ending with consumption. The commodity groups covered are cereals, roots and tubers, fruit and vegetables, meat, fish and seafood and milk. The steps in the food supply chain included are agricultural production, postharvest handling and storage, processing and packaging, distribution and consumption.

The following questions were addressed for each commodity group and for each step in the food supply chain:

- ✓ How much food is produced?
- ✓ What percentage of food is lost and wasted in each step of the food supply chain?

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<sup>2</sup> Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region, Edited by Dr. Rosa S. Rolle, APO 2006, ISBN: 92-833-7051-1 (joint APO/FAO publication).

- ✓ What are the causes of food losses and waste?
- ✓ How can food losses and waste be prevented?

Within the framework of specific task, the study addresses the following aspects:

- Introductory overview of volumes produced for each commodity group;
- Identification of economic importance of particular product groups for people in terms of food security, employment generation, impact on smallholders, and contribution to foreign exchange;
- Identification of importance of the domestic market concerning the demand for specific products;
- Identification of value chains for a product within a commodity group of interest;
- Assessment of food losses and waste during harvesting, postharvest handling and storage, processing, distribution, and consumption of the selected products;
- Identification of critical loss points within the product supply chain and recommendations for loss minimization across the supply chain.

## 2.2 Study methodology

### 2.2.1 Definition of food waste and loss

Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain (Parfitt et al., 2010)<sup>3</sup>. Food losses occurring at the end of the food chain (retail and final consumption) are known as food waste, which relates to the behavior of retailers and consumers (Parfitt et al. 2010).

### 2.2.2 Types of food waste and loss in Armenia

FAOSTAT (2010a) FAO Statistical Yearbook 2009 - Agricultural Production, defines possible areas of food waste and loss<sup>4</sup>.

In Armenia, food losses and waste throughout the supply chain have been revealed during surveys and interviews with the main participants in each stage of the supply chain.

Vegetable commodities and products:

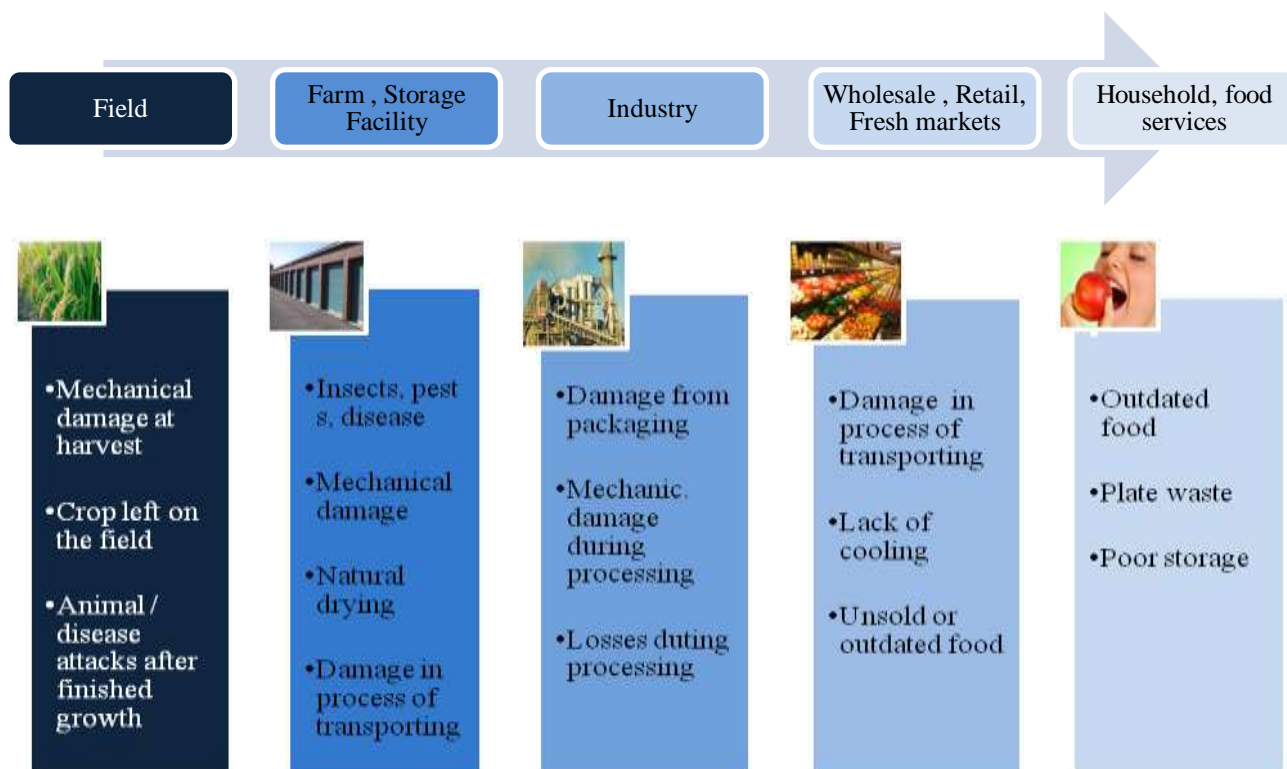
**Figure 1. Stages in value chain and FLW elements in each stage for vegetable commodities and products in Armenia**



<sup>3</sup> Parfitt, J., Barthel, M. & Macnaughton, S. Food - 2010, waste within food supply chains: quantification and potential for change to 2050, *Phil. Trans. R. Soc.*, vol. 365

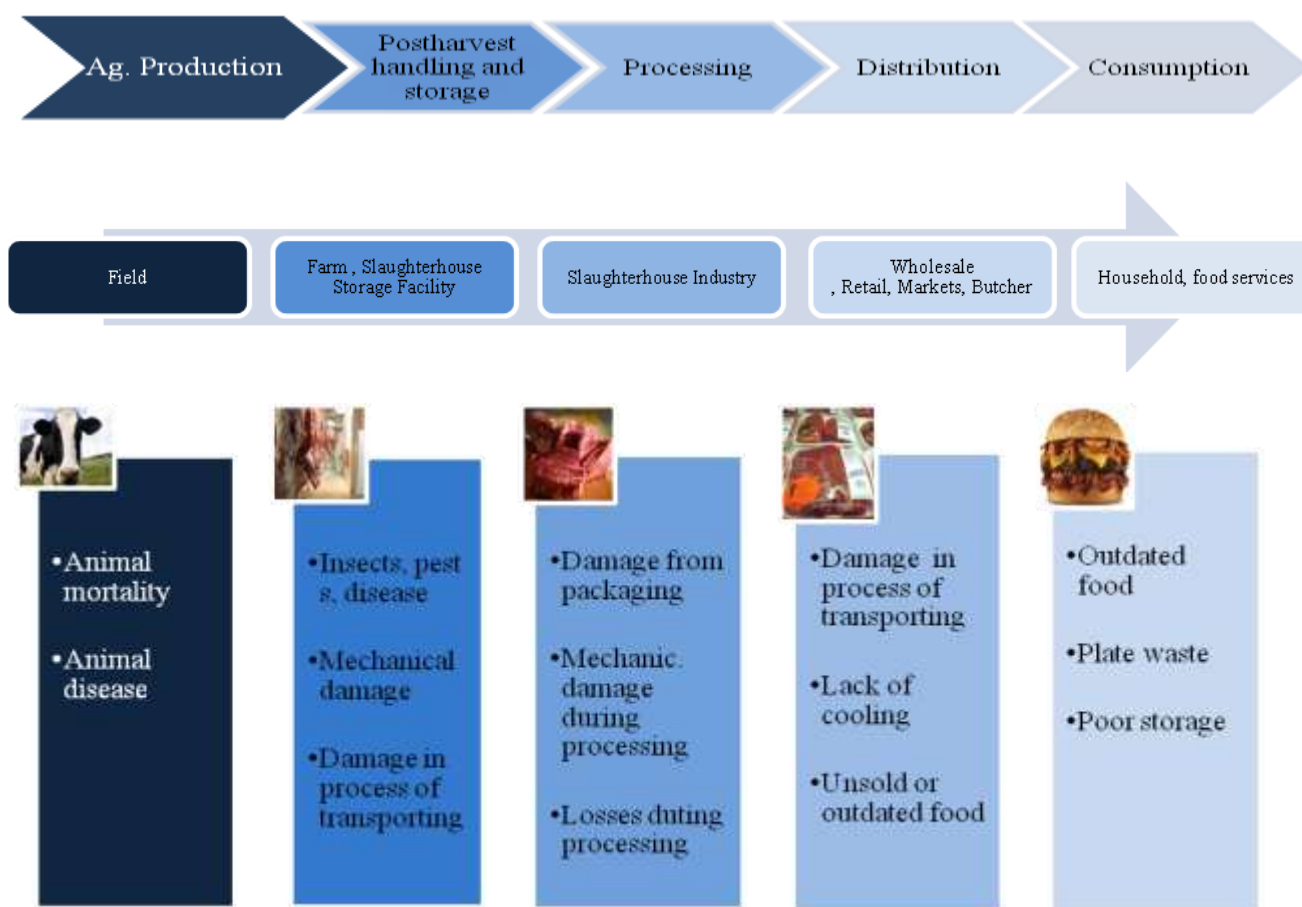
<sup>4</sup> FAOSTAT (2010a) FAO Statistical Yearbook 2009 - Agricultural Production, available at: <http://www.fao.org/economic/ess/publications-studies/statistical-yearbook/fao-statistical-yearbook-2009/b-agriculturalproduction/en/>





Animal commodities and products:

**Figure 2. Stages in value chain and FLW elements in each stage for animal commodities and products in Armenia**



### 2.2.3 Data collection and data sources

For the current study we used the following primary and secondary sources of data:

➤ **Primary information sources:**

- Consumer surveys;
- Interviews with business support organizations;
- Interviews and surveys with value chain actors (farmers, supermarkets, storage facilities, wholesalers, traders on fresh markets);
- Interviews with Ministry of Agriculture experts.

➤ **Secondary information sources:**

- FAOSTAT data;
- Official statistics published by Armenian Statistical Service;
- UNDP, CARD and FAO reports;
- Ministries of Agriculture, Economy and Trade reports;
- World Bank reports;
- Customs service's reports;
- Previous studies of ICARE.

### 2.3 Assessment of food waste and losses

The volumes of food produced in the given commodity groups were identified based on official statistical data available on the websites of state agencies and international organizations. Several products were selected from each commodity group, based on the economic significance of a particular product for region or marz in terms of employment generation, contribution to foreign exchange, largest impact on smallholder producers, or food security for vulnerable groups.

In order to quantify food losses, we collected information on amount of food lost and wasted at each step of the value chain for each commodity, and then applied conversion factors provided by the FAO 2011 Global Food Losses and Food Waste<sup>5</sup> report. In order to reveal actual food waste across the supply chain we:

- ✓ Conducted interviews with farmers to determine product waste during harvesting and post-harvest handling and storage;
- ✓ Contacted cold storage facilities and wholesalers to obtain data on FLW during post-harvest handling and storage;
- ✓ Contacted selected dairy processors and canneries to find out FLW during processing and distribution (since most dairy products are returned to processing plants if spoiled in the retailing stage or brought back to the retailer by consumers);
- ✓ Interviewed several wholesalers to reveal FLW during post-harvest handling, storage and distribution;
- ✓ Interviewed eight supermarkets, eight medium size grocery stores, 36 small shop holders, two butcher's outlets and 15 fruit and vegetables resellers on two open markets<sup>6</sup> to reveal FLW at the distribution stage;
- ✓ Interviewed 506 customers in Yerevan to get information on FLW during the consumption stage.

### 2.4 Food balance sheets

In order to achieve results that are compatible with previous FAO studies we used the same model to show the flow of commodity in FBS<sup>7</sup> (See Appendix 1). The only difference is that within the utilization elements we

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<sup>5</sup> FAO Global Food Losses and Food Waste, 2011 <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf>

<sup>6</sup> See the detailed FLW weights allocation among different distribution agents in Appendix 4.

<sup>7</sup> FAO Global Food Losses and Food Waste, 2011 <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf>

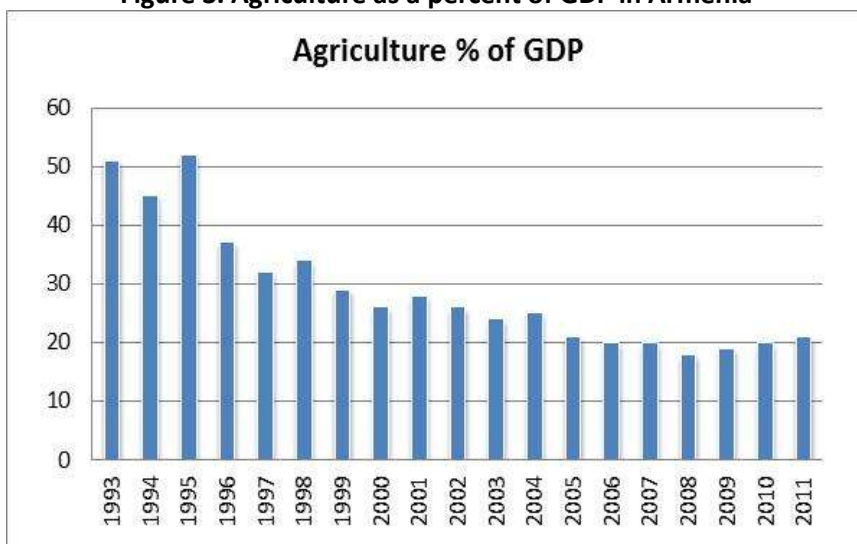
have omitted “waste”, since the data on waste was obtained directly from supply chain participants. For the detailed FLW calculations we used 2009 data from FAOSTAT.

### 3. Commodity groups that have the greatest impact on food security and food availability

#### Agricultural production overview

Armenia has a territory of 29 000 m<sup>2</sup> and an estimated population of 3.04 million (according to the 2012 census). As a part of the Soviet system, Armenia was a rather industrialized country, where agriculture was the second largest industry, accounting for 21 percent of GDP and 27 percent of employment<sup>8</sup>.

Figure 3. Agriculture as a percent of GDP in Armenia



Source: NSS RA

In the transition period and during war in Nagorno-Karabakh, Armenia's economy suffered a major recession. People were not able to find any employment in the cities and started cultivating land for their own subsistence. As a result of this, Armenia's dependency on agriculture increased. In the early 1990s Agricultural output accounted for about 50 percent of GDP. After independence previous production volumes could not be achieved, since the major supplier for animal feed and fertilizers, as well as the main customer for fruit and vegetables market was Russia. Very soon, agricultural equipment and machinery became obsolete and individual farmers were not able to replace it. From 1991-1992 land privatization led to the creation of about 350 000 small farms and Armenian agriculture came to be characterized as a low productive and subsistence-oriented.

Agriculture's impact on the economy is significant, given that during the last five years 60 percent of income of the rural population, which constitutes 36 percent of the total population, is provided through agriculture, and 61.6 percent of the land area is agricultural. The majority of workers in Armenia's regions are engaged in self-employment or unpaid work, such as agriculture and subsistence farming (The World Bank, 2011). Agriculture is one of the most critical sectors, providing 44 percent of employment in the country. Nonetheless, according to the sample study of the National Statistics Service for 2001-2006 on actual employment in agriculture, the actual number of people employed in agriculture constituted about 24.3 percent of the population or 240 000 people (NSS, 2006).

<sup>8</sup>Avestisyan S. (2010) *Agriculture and Food processing in Armenia*, Yerevan, p22.

Today, agriculture is still among the larger branches of the economy (in terms of contribution to the total country output) and contributes slightly more than 21 percent of the GDP<sup>9</sup> (See Figure 3).

Agriculture has one of the lowest productivity levels of any branches of the economy (EV Consulting, 2012). Over the last decade the Armenian Government implemented several projects aimed at supporting agriculture. However, field performance is still far lower than it should be. The main challenges in the field are caused by the lack of infrastructure in rural areas, an underdeveloped irrigation system, the low quality and high price of input supplies, and lack of skilled human labour in many branches of agriculture.

Armenia has 2.97 million ha of land, of which 2.05 million ha is considered agricultural land. More than 60 percent of the agricultural land in Armenia is pastures and meadows and most of the arable land is concentrated in the Ararat valley. Agricultural production volumes and crop types vary greatly by marz.

According to the State Cadastre the total area of arable land is 448 000 ha.<sup>10</sup> Around 33 percent of cultivable land is not utilized for various reasons. After independence, Armenia passed a land privatization law according to which all state owned farms, orchards and vineyards became the property of smallholders. Consequently, each of the 340 000 small farms received around 1.4 hectares of land which hindered its economically efficient exploitation. Currently, farms with 10 hectares or more comprise only 6-7 percent of total farmland. Under such conditions it is necessary to improve agricultural production and the service infrastructure. Currently, more than 98 percent of the gross agricultural output is supplied by the private sector.<sup>11</sup> The problem of small and fragmented farms is a big challenge for the development of agriculture, because small farms cannot exploit economies of scale, do not exercise efficient production technologies and cannot utilize modern market techniques.

Stone fruits are grown mostly in Ararat and Armavir marzes, apples are grown in Kotayq and Aragatsotn marzes, and figs are cultivated in Syunik and Tavush marzes. Cereals and leguminous crops are mostly grown in Gegharkunik and Shirak marzes. Most animal husbandry takes place in Shirak and Gegharkunik marzes. The distribution of Agricultural production by Marz is presented in Table 2 below.

As stated in the UNDP Comparative Analysis of Agriculture in South Caucasus, today Armenia produces about twice as much crops as it does meat. Over the last decade production volumes for both meat and crops have gradually increased. If we look at sub categories of agricultural products by years, it is easy to notice that, a stabilized irrigation system as well as the import of high-productivity seeds has increased fruit and vegetable productivity across the country. Fruit and vegetable exporting companies, as well as wine producers in Armenia are starting to sign long-term contracts with farmers, which helps in planning sales and creates incentives for better use of inputs.

**Table 2. Agricultural production volumes by Marzes in 2012<sup>12</sup>**

	Gross Production (bill. drams)	Weight, %
Yerevan	7.5	0.9
Aragatsotn	82.0	9.8
Ararat	124.0	14.8

<sup>9</sup> NSS, Armenia in figures, 2012, [http://www.armstat.am/file/article/armenia\\_12\\_2.pdf](http://www.armstat.am/file/article/armenia_12_2.pdf)

<sup>10</sup> [www.cadastre.am](http://www.cadastre.am)

<sup>11</sup> Ministry of Agriculture Report “Armenian rural and agricultural sustainable development strategy 2010-2020”

<sup>12</sup> Socio-Economic Situation in RA, January-December 2012  
[http://www.armstat.am/file/article/sv\\_12\\_12a\\_122.pdf#page=1&zoom=auto,0,179](http://www.armstat.am/file/article/sv_12_12a_122.pdf#page=1&zoom=auto,0,179)

Armavir	144.0	17.1
Gegharkunik	160.6	19.1
Lori	59.7	7.1
Kotayk	52.7	6.3
Shirak	97.8	11.6
Syunik	52.7	6.3
Vayots Dzor	18.2	2.1
Tavoush	41.2	4.9
<b>Total RA</b>	<b>840.4</b>	<b>100.0</b>

Source: NSS RA

Grains and legumes are planted on more than half of the country's farmland, wheat being the most essential crop, which satisfies 36 percent of total need with the rest being imported. Growing wheat is less profitable than growing fruit and vegetables, particularly at lower elevations (below 1 500 meters), where irrigation is necessary for the cultivation of the crops and adds to the production cost.

The fruit and vegetable areas have slightly increased in recent years. Land areas covered by vineyards decreased significantly after land privatization, due to the collapse of the downstream industry (wineries). However, in recent years grape production has been restored, and grapes are produced not only by individual, small-scale farms but also by large farms.<sup>13</sup> Livestock production underwent some big fluctuations due to numerous animal disease outbreaks, but in the long run the production patterns did not change much.

Over the period from 2004 till 2008, the average annual growth in agriculture was about 7.4 percent. This helped improve food self-sufficiency, which in 2008 increased up to 60 percent. The local demand for plants, potatoes, main fruits, grapes, and veal is 98 percent satisfied by local production, whereas the self-sufficiency level is quite low for wheat (40 percent), other grains (50-55 percent), poultry (15-17 percent), and pork (50-55 percent). Cereals (mainly wheat and rice) are imported from Russia and Kazakhstan, frozen meat (used by processing plants) is imported from India and Brazil.<sup>14</sup>

Therefore, it should be mentioned that all these numbers highlight again that agriculture is critical for Armenia. Specifically, improving agriculture could lead to poverty reduction, food security, increase in the quality of life especially in rural areas, stability, and strategic improvement of the other sectors.

The commodities addressed within the scope of the research have been grouped according to FAOSTAT's Food Balance Sheet:

- Cereals (excluding beer): Wheat, rice (milled), barley, maize, rye, oats, millet, sorghum, other cereals.
- Roots and tubers: Potatoes, sweet potatoes, cassava, yams, other roots.
- Oilseeds and pulses (including nuts): Soybeans, groundnuts (shelled), sunflower seeds, rape and mustard seed, cottonseed, coconuts (including copra), sesame seeds, palm kernels, olives, other oil crops.
- Fruit and vegetables: Oranges and mandarins, lemons and limes, grapefruit, other citrus, bananas, plantains, apples (excluding cider), pineapples, dates, grapes (excluding wine), other fruit, tomatoes, onions, other vegetables.

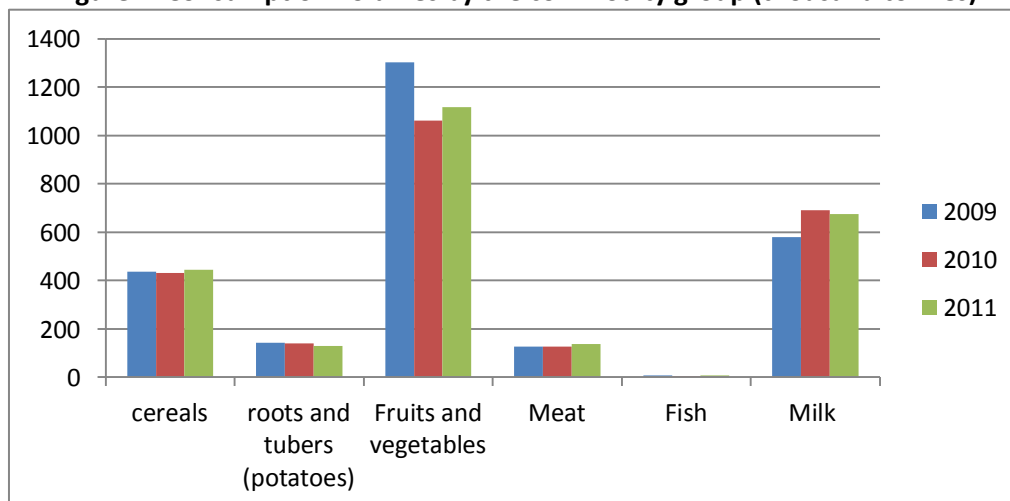
<sup>13</sup> The World Bank Report "Armenia, Agriculture and Rural Development Policy Note" pp. 25-26

<sup>14</sup> RA customs service's statistics. Imports by the product-country  
<http://www.customs.am/Content.aspx?itn=csCIImportStatistics>

- Meat: Cattle meat, mutton/goat meat, pig meat, poultry meat, other meat, offal.
- Fish and seafood: Freshwater fish, demersal fish, pelagic fish, other marine fish, crustaceans, other mollusk, cephalopods, other aquatic products, aquatic mammal meat, other aquatic animals, aquatic plants.
- Milk and eggs: Milk and eggs.

Out of the commodity groups mentioned above oilseeds and pulses do not apply to Armenia. The data on consumption and production volumes for the remaining commodity groups during recent years is presented in the figures below.

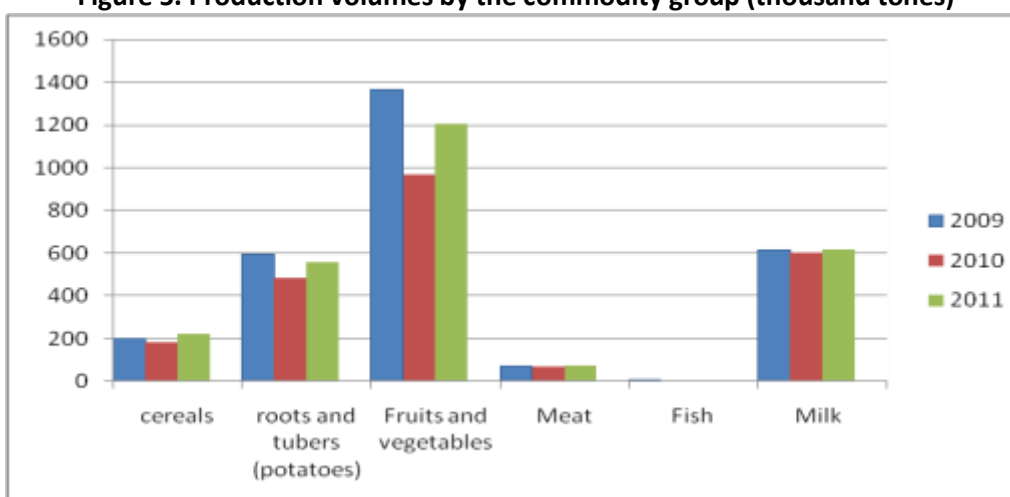
**Figure 4. Consumption volumes by the commodity group (thousand tonnes)**



Source: NSS RA Food Balance Sheet.

Armenia possesses high level of self-sufficiency in potatoes, vegetables, fruits, milk, eggs and lower levels in terms of wheat, meat, pork (NSS, 2011).

**Figure 5. Production volumes by the commodity group (thousand tonnes)**



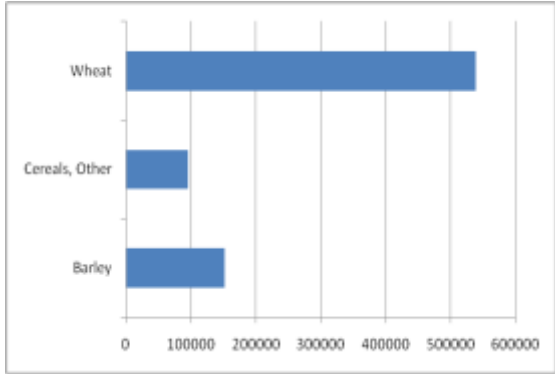
Source: NSS RA Food Balance Sheet.

Because of some specifics in climate, soil and food preferences, some commodity groups and products mentioned in the list are not relevant to agriculture in Armenia. Within the scope of the study we will discuss

several agricultural products from commodity groups of interest to evaluate those from the prospective of importance for Armenia. So commodity groups and separate products are defined as follows:

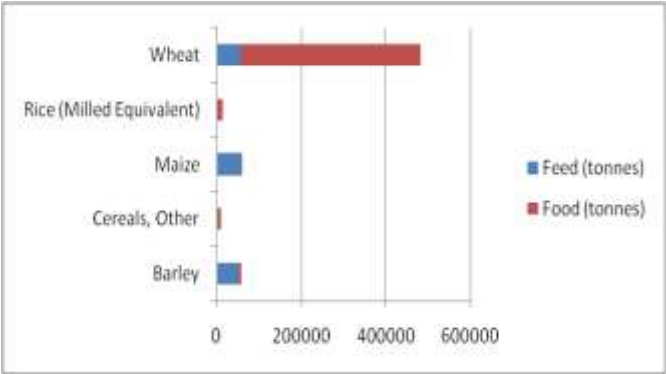
**Cereals: Wheat.** Within total supply of cereals (787 400 tonnes in 2009), the share of the wheat was about 70 percent (see Figure 6).

**Figure 6. Domestic supply of cereals in 2009 (tonnes)**



Source: FAOSTAT.

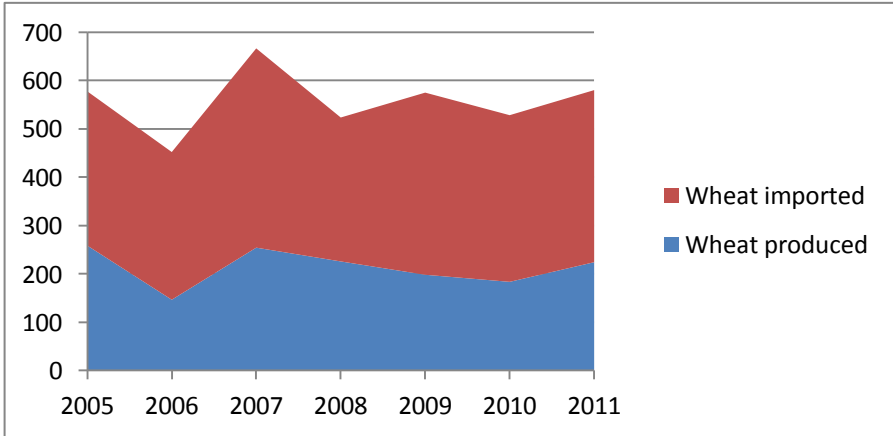
**Figure 7. Volumes of cereals used for feed and food, 2009 (tonnes)**



The next biggest category is barley (almost 20 percent of the total cereal supply), which is mostly used for animal feed and beer (see Figure ). Barley is not included in the FLW study. Maize, rice, rye and other types of cereals add up to little more than 10 percent of the total supply of cereals. Taking into consideration this factor, the study uses **wheat** as the only product in the cereals category.

There are concerns about food security in Armenia, since it is a land locked country that has no relations with two of its neighbors. Wheat is one commodity that is vital for a nation in a blockade. That is why many economists consider it necessary for Armenia to be self-sufficient in the production of the wheat. On the other hand limited land resources can be used for crops with higher yields and higher value added (Avetisyan, 2010). Volumes of the local production of wheat have been slightly lower than imports of wheat.

**Figure 8. Sources of wheat in Armenia (thousand tonnes)**



Source: NSS RA.

Figure 8 above shows that the self-sufficiency ratio of wheat was 33 percent. Since 2005, the highest average yield of wheat from one hectare was 2.8 tonnes, which was achieved in 2011. This indicator is rather low compared to wheat yields in exporting countries, but given the geographic location of most wheat fields and the fact that there may not be alternative crops to be sown in some areas of Armenia, these yields can be



considered acceptable. Statistics of wheat production by marz show that the Gegharkunik and Shirak marzes produce more wheat than any other marz (see Table 3).

Wheat yields from one hectare of sown land is the highest in Ararat marz (3.8 tonnes), but there is not much land under wheat in Ararat Valley as many other crops with higher value added are cultivated there. The lowest per ha yield is in Syunik marz (2.4 tonnes)<sup>15</sup>, although its area under wheat is the fourth largest due to altitude, soil quality and irrigation issues, which make cultivation of other crops impossible.

**Table 3. Wheat production volumes by Marz (thousand tonnes)**

	2007	2008	2009	2010	2011
Yerevan	0.9	1	6	0.3	0.2
Aragatsotn	27.4	19.3	20.7	17.1	23.5
Ararat	21.7	15.9	15.6	12.9	13.9
Armavir	22.2	22	22.4	14.1	13.6
Gegharkunik	46.5	50.4	4.6	55.7	52.9
Lori	21.2	14.7	11.8	10.7	16.4
Kotayk	25.1	14.7	11.8	10.7	16.4
Shirak	61.8	52.8	44.4	48.7	53.4
Syunik	30.2	29.7	19.9	9.8	23.3
Vayots Dzor	1.4	2.3	3	2.5	3.5
Tavush	5.4	6	5.9	4.5	9.9

Source: NSS, 2012, Food security and poverty. Availability of food.

The average price for wheat in 2009 was AMD 125 per kilogram.<sup>16</sup> Production volumes were 198 100 tonnes, and the share of sales of wheat in agricultural GDP was 4.5 percent (AMD 552 098 000 000). The average price of bread in 2009 was AMD 350 per kilogram; the yearly average per capita consumption was 145 kg and bread accounted for about 15 percent of the industrial GDP (AMD 664 523 000 000).

**Roots and tubers:** The only root or tuber widely consumed and produced in Armenia is the potato so this study only considers this crop.

**Table 4. Potato production volumes by Marz (thousand tonnes)**

	2007	2008	2009	2010	2011
Armenia	579 571	647 215	589 985	481 855	556 887
Yerevan	944	126	139	169	160
Aragatsotn	33 560	34 034	34 215	34 273	42 418
Ararat	25 740	31 989	28 739	24 181	24 504
Armavir	50 228	62 946	49 772	32 297	42 418
Gegharkunik	271 302	277 979	254 302	233 069	255 506
Lori	56 952	54 491	55 031	31 804	38 943
Kotayk	18 191	17 333	16 075	14 054	15 851
Shirak	68 055	104 902	89 740	69 348	90 956
Syunik	31 282	33 300	32 371	23 646	27 617
Vayots Dzor	3 495	3 518	2 865	2 957	3 092
Tavoush	19 822	25 470	25 485	14 533	20 176

Source: National Statistical Service of Armenia.

<sup>15</sup> Source: NSS, 2012, Food security and poverty. Availability of food.

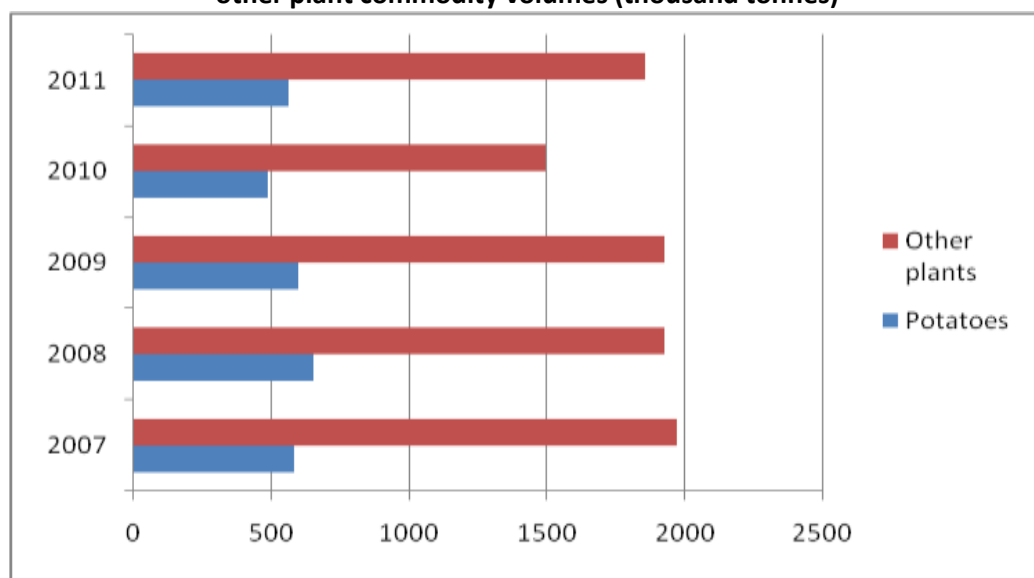
<sup>16</sup> ICARE, 2012 Assessment of wheat, barley and emmer wheat value chains in Armenia

Potato production has experienced growth over the last decade, as it is one of the essential crops in Armenia in terms of food security. Gegharkuik and Shirak Marzes are main suppliers of potatoes to the market (See Table 4). Most potato producers are smallholders (less than 1.4 ha farms) and incomes from potato sales can help to reduce poverty in these marzes. Improved seeds had a big impact on the productivity of potato varieties in recent years.

About 28 665 ha (which is 6.4 percent of the total arable agricultural area in the country)<sup>17</sup> of land is used for growing potatoes. According to the latest statistics from NSS, Armenian potato production totalled 557 000 tonnes. The gross volume of potatoes produced in Armenia in 2011 accounted for 11.2 percent of total agricultural output for that year. Production volume covers 98.2 percent of domestic demand.

The importance of potatoes as an agricultural commodity is illuminated by comparing the volume of potato production with the volumes of other plant commodities produced in Armenia. Potato production accounts for about one third of all plant commodity production. Needless to say, that vast majority of potato producers are smallholders, and potatoes serve as a main crop for household consumption throughout the year.

**Figure 9. Comparison of potato production volumes to other plant commodity volumes (thousand tonnes)**



Source: FAOSTAT

The self-sufficiency ratio for potatoes was 100.7 percent. Traders exported a small volume of potatoes to Georgia. The average price for potatoes in 2009 was AMD 150 per kilogram.<sup>18</sup> Production volumes were 593 600 tonnes and the sale of potatoes accounted for 15 percent of agricultural GDP (AMD 552 098 000 000).

**Oilseeds and pulses: None.** Bean and pea production in Armenia is insignificant, which together with exported products in this category comes up to roughly 0.2 percent of the total volume of food supply in Armenia<sup>19</sup>. Nuts have been included in the same commodity group as fruits. This commodity group is insignificant in terms of quantities involved and is not covered by this research.

<sup>17</sup> NSS of RA

<sup>18</sup> ICARE, 2013 - Value chain analysis of the selected farm food products in Armenia.

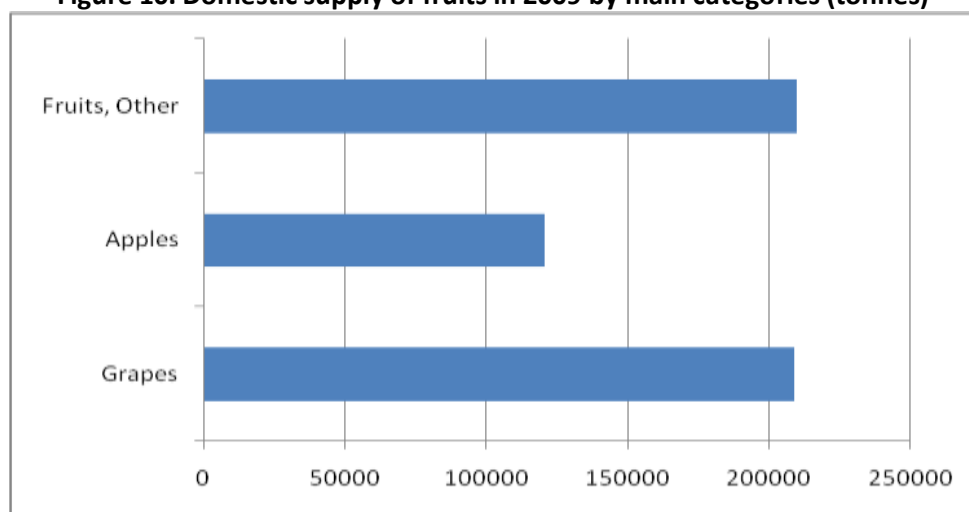
<sup>19</sup> National Food Balance of the RA identified main agricultural product categories used for food. Within this list total one year food supply in the country for 2011 was more than 5,400 thousand tonnes, while the volume of leguminous crops is only 14 thousand tons.

**Fruit and vegetables:** This category includes all possible types of vegetables and fruit (excluding grapes for wine), as well as nuts, since data on Armenian nut production and export/import was coupled with dried and fresh fruit data. If we take a closer look at the volumes of agricultural production in Armenia, we see that fruit and vegetables are the agricultural commodities that are produced in the highest volumes. They also have a vital role in terms of consumer diets. This makes both the production and consumption of fruit and vegetables increasingly important.

Within total output of fruits in 2009 the highest share was with grapes (38 percent), but grapes are mostly used in wine production, which is excluded from the scope of this study by the methodology. The product group with the next highest share in total output of fruits is apples (21 percent) (See Figure 10).

Apples are also important in terms of food security; it is the only fruit that is available throughout the year and does not have very high value added, since every farmer can store them in cool basements and the storage rooms in their own houses. Some varieties are perishable and are sold to processing plants straight after the harvest, while some are stored in commercial storages to be sold during the winter months at a premium price. There is almost no export of apples (some to Georgia). There are also some imports of fresh apples from Iran, as well as imported apple juices from Ukraine, Russia and Bulgaria. Fruit and vegetables are widely distributed throughout the country and are found in abundance on fresh markets, in numerous small shops and in big supermarkets.

**Figure 10. Domestic supply of fruits in 2009 by main categories (tonnes)**



Source: FAOSTAT

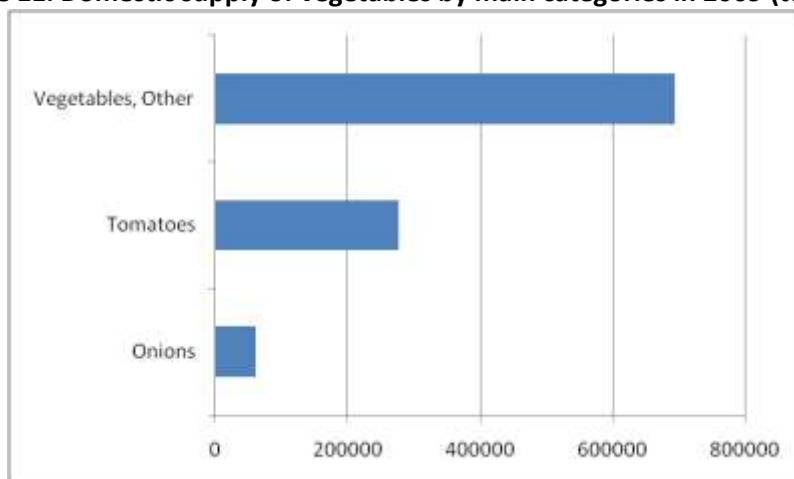
The average price of apples in 2009 was AMD 150 per kilogram<sup>20</sup>, production volumes were 278 600 tonnes and they accounted for 6 percent of agricultural GDP (AMD 552 098 000 000).

In terms of the total output of vegetables (potatoes excluded) in 2011 tomatoes accounted for the highest share (28 percent) (See Figure 11). The average price for tomatoes in 2009 was AMD 120 per kilogram.<sup>21</sup> Production volume was 120 800 tonnes, and accounted for 3.3 percent of agricultural GDP (AMD 552 098 000 000).

<sup>20</sup> ICARE, 2013 - Value chain analysis of the selected farm food products in Armenia.

<sup>21</sup> ICARE, 2013 - Value chain analysis of the selected farm food products in Armenia.

**Figure 11. Domestic supply of vegetables by main categories in 2009 (tonnes)**

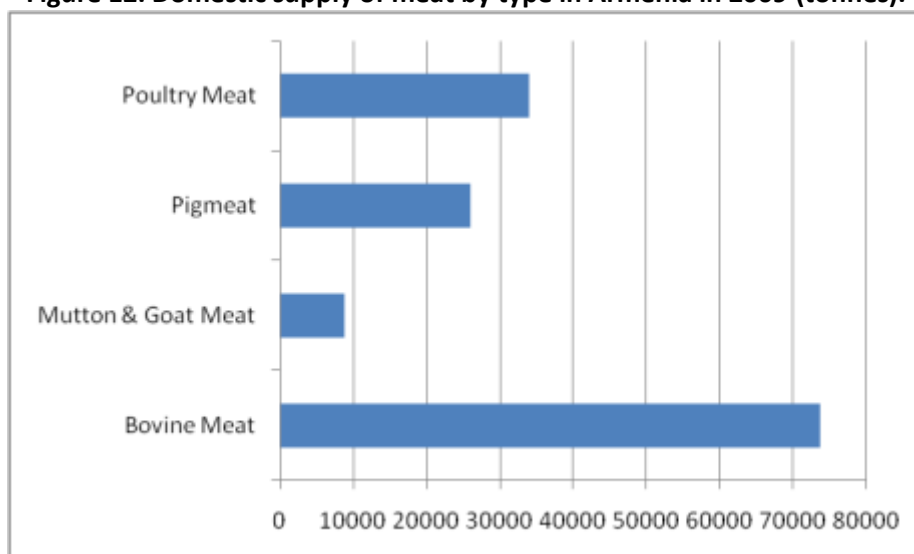


Source: FAOSTAT

Proceeds from the sale of tomatoes also account for the main income of farmers in the Ararat valley. This explains why detailed FLW calculations were conducted for apples and tomatoes.

**Meat:** Meat includes beef, pork, poultry, goat and mutton. However, based on 2009 FAOSTAT data, beef is the meat that is sold in the highest volumes in Armenia (See Figure 12 below) so the meat waste and loss was calculated on example of beef.

**Figure 12. Domestic supply of meat by type in Armenia in 2009 (tonnes).**



Source: FAOSTAT

Meat consumption patterns are highly impacted by animal diseases. Over the last decade the meat industry has been through an outbreak of Swine fever and several avian influenza panics, which could have distorted the consumption patterns for 2009.

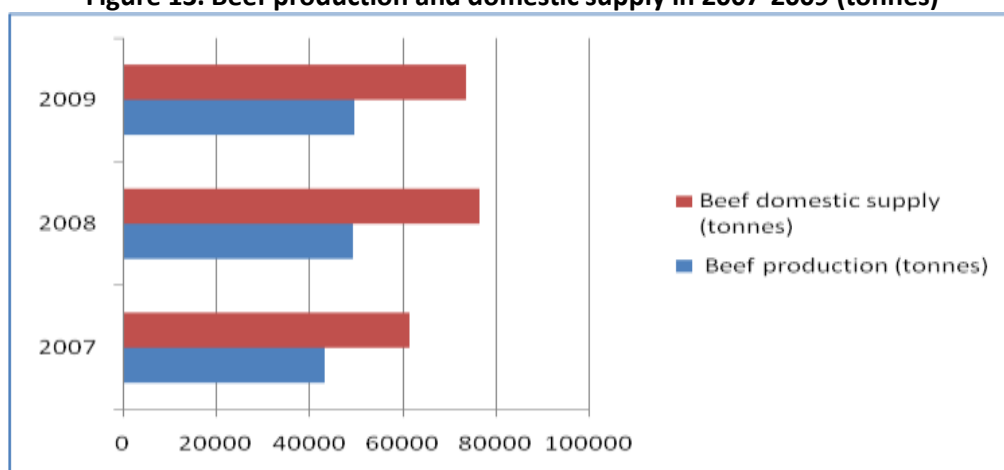
Table 5 provides meat consumption patterns over four years from 2007 to 2010. Clearly, within this commodity group beef has been the market leader in terms of consumption.

**Table 5. Per Capita Consumption of Meat in Armenia, 2007-2010 (kg/year)**

Meat Type	2007	2008	2009	2010
Beef	16.8	22.4	20.8	18.6
Pork	8.1	7.9	6.9	6.5
Poultry	11.3	15.9	11.7	14.6
Mutton	2.4	2.4	2.9	2.8

Source: NSS, 2012

Beef production also has increased since 2000, and now accounts for about 70 percent of all meat produced in Armenia. The Armenian beef processing value chain is notable in that fresh and processed meat markets can be considered separate value chains. Almost all fresh meat consumed in Armenia is of local origin, while all processed meat products (sausages, hams, etc.) are made from imported meat. This is because processed meat production requires large volumes of homogeneous meat, which cannot be found on the local market. Also, imported frozen meat is cheaper, which justifies its economic usage. The only exception to this rule is the owner of “Syunik Meat”, who uses his own beef to produce sausages.

**Figure 13. Beef production and domestic supply in 2007-2009 (tonnes)**

Source: FAOSTAT

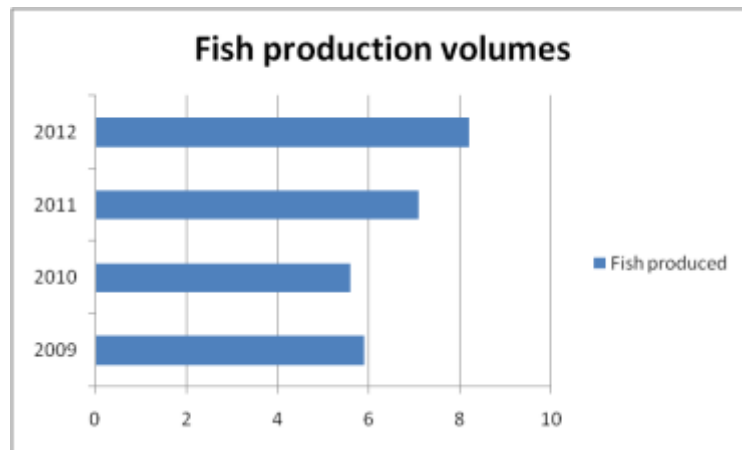
Figure 13 shows that Armenia is not self sufficient in beef production (the self-sufficiency ratio in 2009 was 78.4 percent). Imported beef mostly comes from India and Brazil. 95 percent of local beef producers are smallholders that have up to seven heads. The climate of the Alpine zone and fresh greens available in the mountains during the hot summer months create favorable conditions for cattle breeding. Needless to say that beef and milk are vital for generating household income for farmers.

The average price for beef in 2009 was AMD 1 700 per kilogram<sup>22</sup>, production volumes were 49 6000 tonnes, and beef sales accounted for 15 percent of agricultural GDP (AMD 552 098 000 000).

**Fish and seafood:** (Includes data on fresh, frozen, dried and canned fish). More than 900 thousand tonnes of crayfish was produced and exported from Armenia in 2012. However, in this commodity group we will discuss only fish. Production volumes of fish in Armenia have increased rapidly during the last decade, which implies that there is a big opportunity for growth in this market.

**Figure 14. Fish production volumes in Armenia in 2009-2012 (thousand tonnes)**

<sup>22</sup> FAO 2011 – Food security and Agriculture highlights



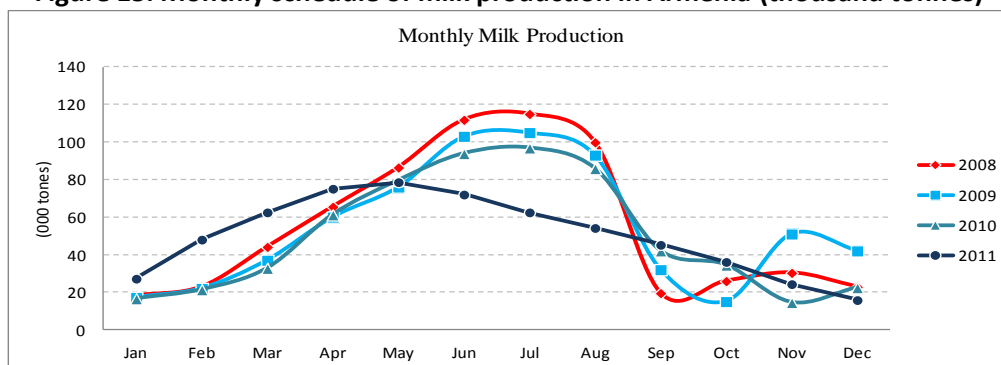
Source: NSS RA

In 2005 annual per capita fish consumption was only 0.3 kg<sup>23</sup>, while by 2011 it had increased to 3.8 kg. The main species produced and consumed are trout and sturgeon. The availability and quality of artesian and spring water makes fish production possible mainly in the Ararat and Aragatsotn marzes. All fish farms have their own wells to pump artesian water into the fish reservoirs.

Fish production is now considered a promising export industry. Large fisheries cooperate with European and Russian companies to export large volumes of frozen fish and sturgeon caviar. Self-sufficiency ratio for fish in 2009 was 63.4 percent.

**Milk:** Includes data on milk, powdered milk and all dairy products except butter (As per FAOSTAT). Specifics for the milk chain include the large number of small farmers and the need for immediate delivery to final consumers or processing plants. Also, milk production is highly seasonal. Milk production follows the same pattern every year, and the volumes in the summer are roughly 3-4 times higher than during the winter months (See Figure 15).

**Figure 15. Monthly schedule of milk production in Armenia (thousand tonnes)**

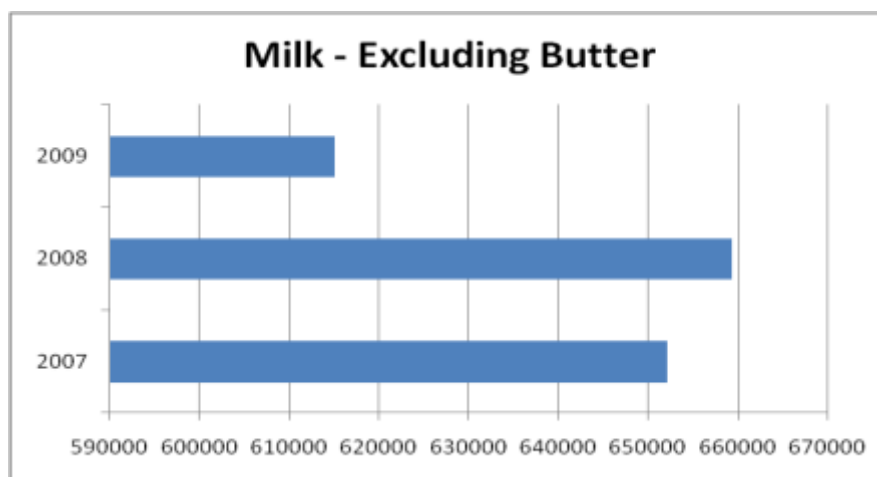


Source: NSS RA

Milk is considered a commodity that can help to address food security issues. Milk production volumes declined sharply in 2009 (see Figure 16).

**Figure 16. Milk production patterns in 2007-2009 in Armenia (tonnes)**

<sup>23</sup> "Review of fisheries and aquaculture development potentials in Armenia"  
<http://www.fao.org/docrep/014/i2103e/i2103e00.pdf> last assessed on the 21st of April, 2013.



Source: FAOSTAT

Gegharqunik and Shirak marzes have a cool climate throughout the summer months, and at different altitudes across the marz, which makes cattle breeding relatively inexpensive (as soon as the summer sun burns grass on the meadows, farmers set camps in the mountains, where they stay until the heat recedes).

Milk is a highly perishable commodity, which makes collecting it quite difficult. Almost 40 percent of the milk that is produced gets delivered to processing plants and dairy producing factories. Generally processors are responsible for collecting milk. This implies that getting milk from remote areas is profitable neither for processors nor farmers (the farther the village, the lower the price offered for milk).

**Table 6. Milk production volumes by Marz in the RA (thousand tonnes)**

	2008	2009	2010	2011
Yerevan	3.6	2.1	2.3	2.0
Aragatsotn	76.4	77.1	74.1	74.8
Ararat	49.5	41.0	38.1	36.5
Armavir	42.8	39.8	36.1	36.1
Gegharkunik	117.5	116.4	112.4	114.5
Lori	77.8	77.8	77.1	76.2
Kotayk	68.1	54.6	51.3	51.8
Shirak	98.9	97.5	99.0	98.8
Syunik	56.4	59.7	55.8	55.9
Vayots Dzor	25.0	17.3	19.9	20.0
Tavoush	45.9	32.4	34.8	34.9
<b>Total RA</b>	<b>661.9</b>	<b>615.7</b>	<b>600.9</b>	<b>601.5</b>

Source: NSS RA

The milk processing industry is represented by about 250 companies that produce cheese, sour-cream, yogurt, curd and ice-cream. Cheese dominates on the local dairy market and gets exported to mostly Russia.

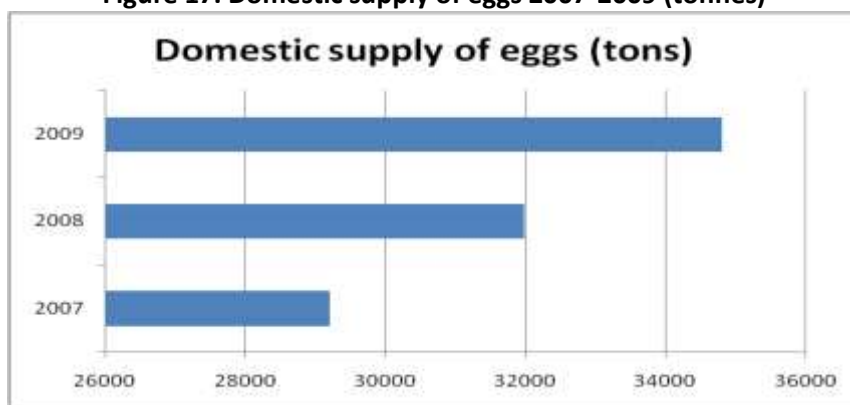
The self-sufficiency ratio for milk in 2009 was 90.7 percent. The average price that farmers received for milk in 2009 was AMD 105 per liter.<sup>24</sup> Production volumes were 615 700 tonnes, and milk sales accounted for 11.7 percent of agricultural GDP (AMD 552 098 000 000).

**Eggs:** Egg production in Armenia is concentrated on large poultry farms. Armenia has been self-sufficient in the production of eggs for many years.

<sup>24</sup> NSS 2009 publications. Prices and price indexes

The industry went through major changes after 2010. The “Arax” poultry farm management equipped idle facilities with new technologies and increased the number of laying hens, thus sharply increasing the market supply. An oversupply of eggs brought prices down by almost three times and resulted in small and medium-sized producers withdrawing from the market. This also simplified the supply chain for eggs. Poultry farms are responsible for the production have storage areas or allocation points in the city of Yerevan, where their contract drivers pick up boxes of eggs and distribute them to big supermarkets and small shops across the city.

**Figure 17. Domestic supply of eggs 2007-2009 (tonnes)**



Source: FAOSTAT

Production volumes were unusually low in 2007 due to an outbreak of avian influenza although production volumes picked up again after 2008. The largest volumes of eggs are produced in the Kotayk and Armavir marzes.

**Table 7. Egg production volumes by marz in the RA**

	2008	2009	2010	2011
Yerevan	34.0	32.0	33.5	27.9
Aragatsotn	29.1	47.1	70.4	59.7
Ararat	45.4	56.3	76.7	55.0
Armavir	84.0	92.4	126.3	135.5
Gegharkunik	73.1	60.5	68.3	56.6
Lori	30.4	34.4	39.7	47.3
Kotayk	165.7	181.4	156.4	125.7
Shirak	42.2	41.9	40.3	39.7
Syunik	20.9	24.8	28.2	26.9
Vayots Dzor	13.9	15.0	17.6	17.5
Tavoush	37.4	44.3	44.8	41.8
<b>Total</b>	<b>576.1</b>	<b>630.1</b>	<b>702.2</b>	<b>633.6</b>

Source: NSS RA

In 2009 the self-sufficiency ratio for eggs was 100 percent. The average price of eggs in 2009 was AMD 55, and 630 million eggs were produced. Egg sales accounted for 6.2 percent of agricultural GDP (AMD 552 098 000 000).

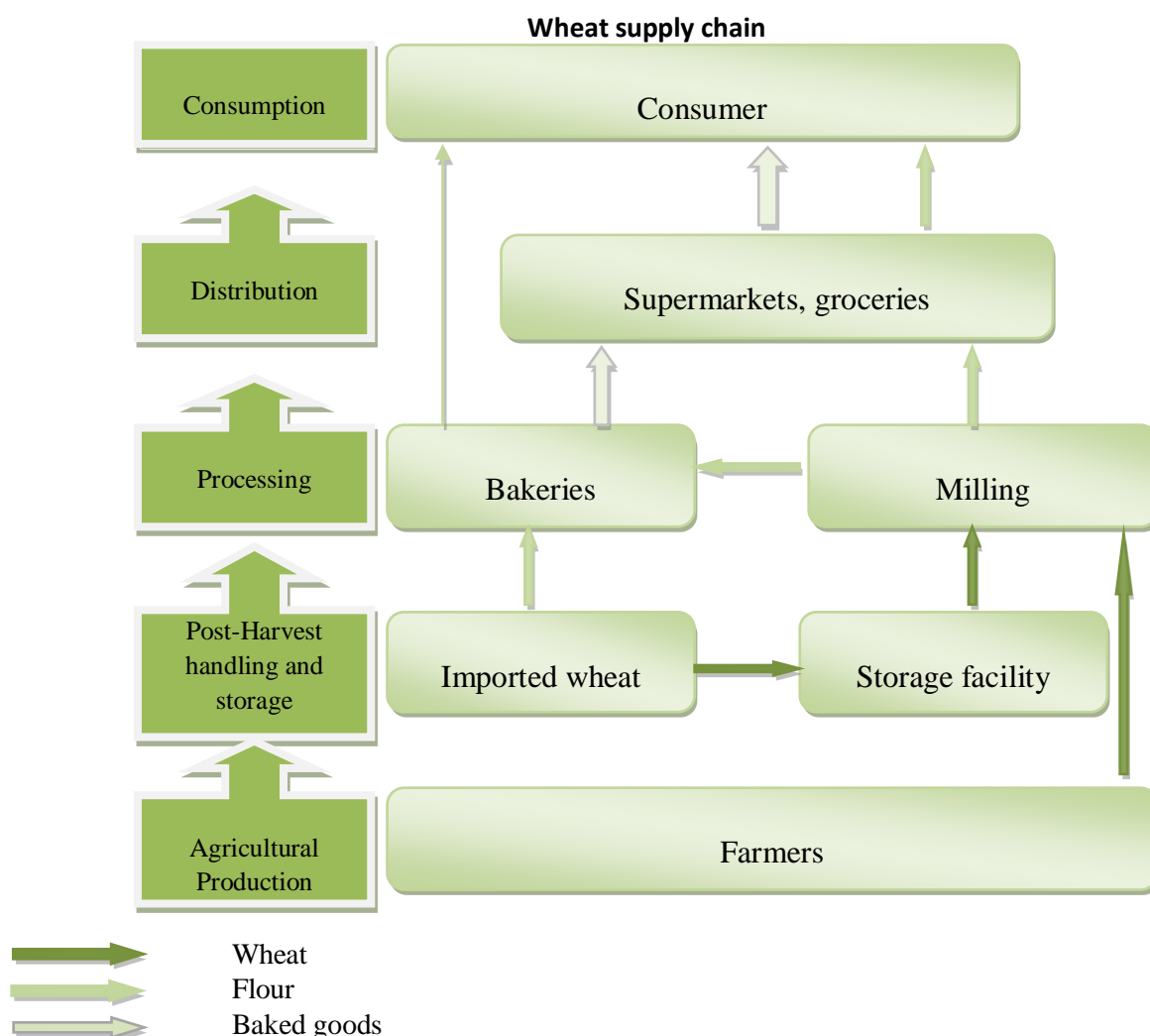


## 4. Assessment of FLW in selected agri-food chains

### 4.1 Description of priority agri-food chains for in depth analysis

For the critical loss point analysis we selected five agri-food chains based on their economic importance for the country in terms of employment generation, contribution to food security, impact on smallholders or share in agricultural production of the region. The five types of produce selected are wheat, potatoes, tomatoes, apples and milk.

**1. Wheat:** The grain sector is important for Armenia due to the geopolitical situation, the elimination of poverty and assurance of food security in emergency situations. Fluctuations in the supply and price of grains directly impact the entire population but particularly the poor segment, which can hardly sustain their livelihoods. This urged the Government to prioritize grain production and development, and implement programs aimed at increasing the production of grain, and especially wheat, in Armenia. Wheat import and production data (see Table 8) shows that self-sufficiency in wheat production is quite low and Armenia heavily depends on international wheat suppliers, mainly from Russia (50 percent of wheat is imported).



In 2010, the GoA started a program called “Wheat Seed Production Development Plan 2010-2014 for the Republic of Armenia”, which is aimed to increase the production of grain and ensure an increase in self-

sufficiency levels through increasing productivity of grain production in Armenia. The Ministry of Agriculture plans to produce elite and super elite seeds to supply to farmers and wheat producing organizations (Agrolratu, 2012). This will contribute to high quality and cheaper seeds being available to many farmers in Armenia.

**Table 8. Wheat production, imports and self-sufficiency ratio in Armenia**

	2007	2008	2009	2010	2011
Wheat production, thousand tons	254.2	225.7	198.1	183.5	224.1
Wheat import, thousand tons	443.0	347.2	397.8	365.5	392.0
Self-sufficiency, %	36.5	39.5	33.3	33.5	36.5

Source: NSS, RA

**2. Potatoes:** Potatoes are considered a staple food, and along with wheat they help address food security issues. Potato production is mainly concentrated in Gegharkunik marz where potatoes are considered the main source of income for many farmers. Table 9 shows that almost 50 percent of potatoes produced in the country originate from Gegharkunik marz.

**Table 9. Potato production in Gegharkunik marz in 2009**

	Republic of Armenia	Gegharkunik marz
Gross agricultural output, total	552.1	94.0
Sown areas under potatoes	31 998.0	14 742.0
Gross harvest of potatoes	593.6	254.3

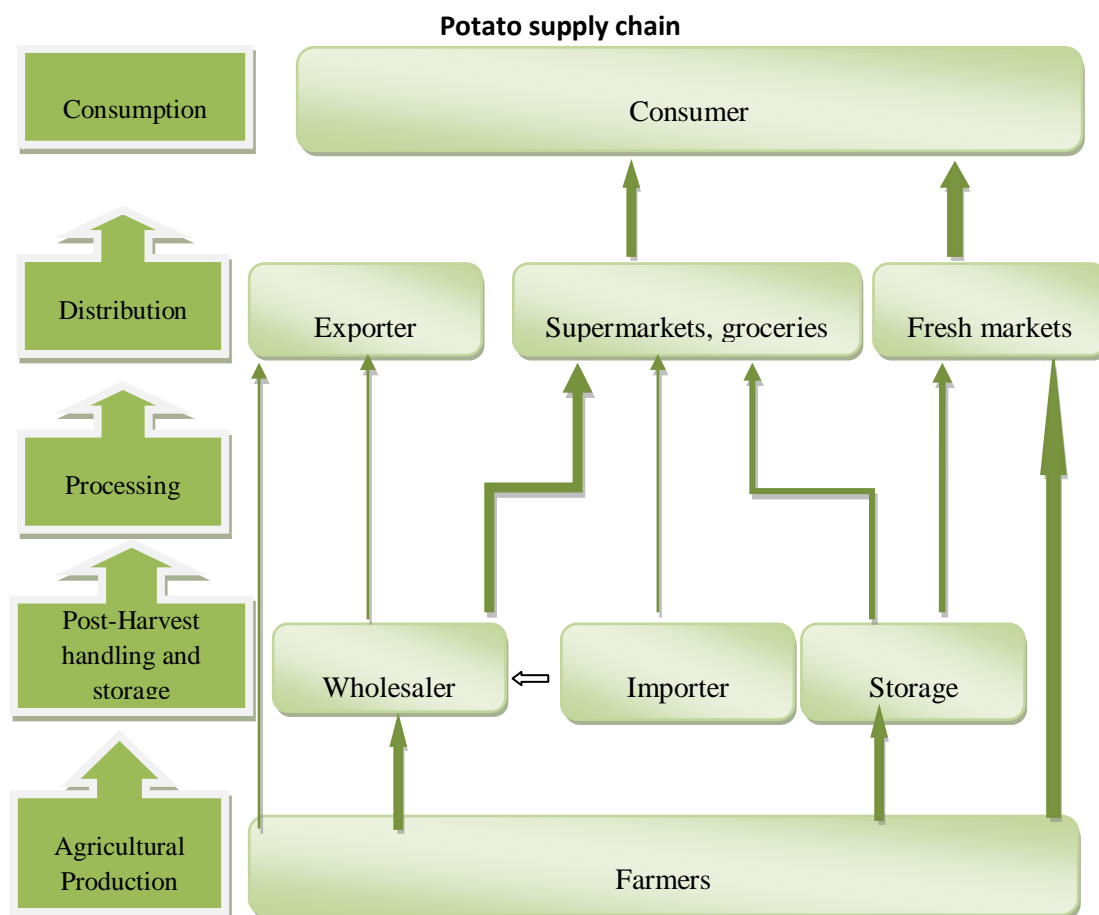
Source: NSS, RA

The Chambarak and Vardenis Region study conducted by Advanced Social Technologies also proves that potato production is vital for nearly all families in Gegharkunik marz. Surveys provide evidence that 92.1 percent of households in Chambarak grow potatoes,<sup>25</sup> some households sell potatoes or trade them for other produce, although most families grow potatoes to provide for their basic needs.

### Potato supply chain

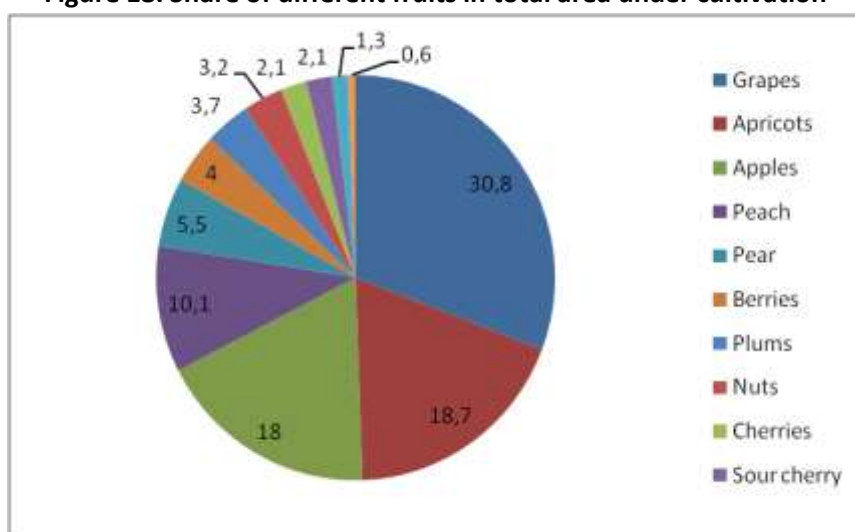
The potato supply chain has very few participants and is fairly simple. Agricultural production, as well as post-harvest handling and storage are mainly conducted by farmers. Potato processing volumes are insignificant (there are just a few very small potato chips producers), so processing does not exist per se. There are some commercial storage facilities and a few wholesalers that buy potatoes from farmers and resell them to supermarkets or traders on fresh markets.

<sup>25</sup> Advanced Social Technologies, 2005 “Vardenis and Chambarak regions of Gegharkunik Marz : current situation and perspectives for development”



**3. Apples:** Apples are one of the most widely cultivated fruits in Armenia and are grown in almost all regions of the country. However, the cultivation of apples for industrial use is focused only in certain regions, where 65-70 percent of total production takes place. These major areas are Aragatsotn with 20-25 percent, and Kotayk with 18-23 percent<sup>26</sup>.

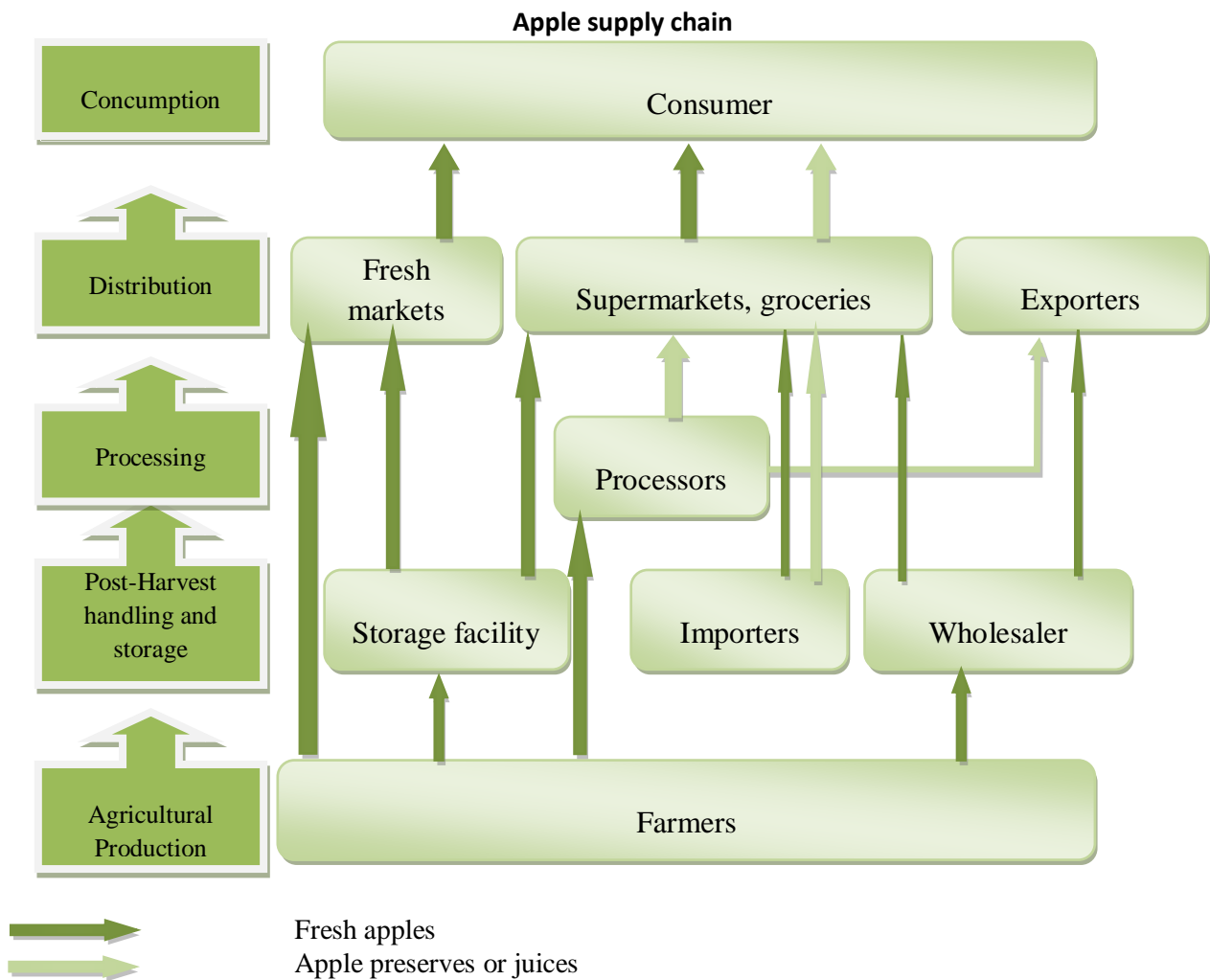
**Figure 18. Share of different fruits in total area under cultivation**



Source: NSS, RA

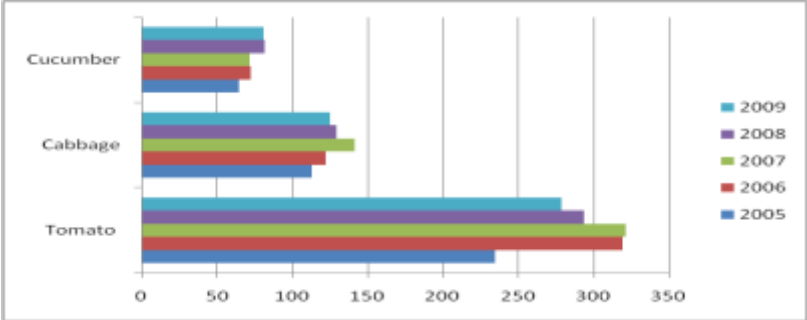
<sup>26</sup>Fruitful Armenia “Framing the “Next level up” of sustainable agriculture in Armenia”, 2008

Apple production in Armenia is important for smallholders (apple farmers sell their fruit throughout the year) and in terms of food security (it is one of the few fruits that are inexpensive and can be preserved and consumed out of season). Apples also account for a very large share of total fruit consumption (21percent) and in area under cultivation (18 percent) within total fruits.



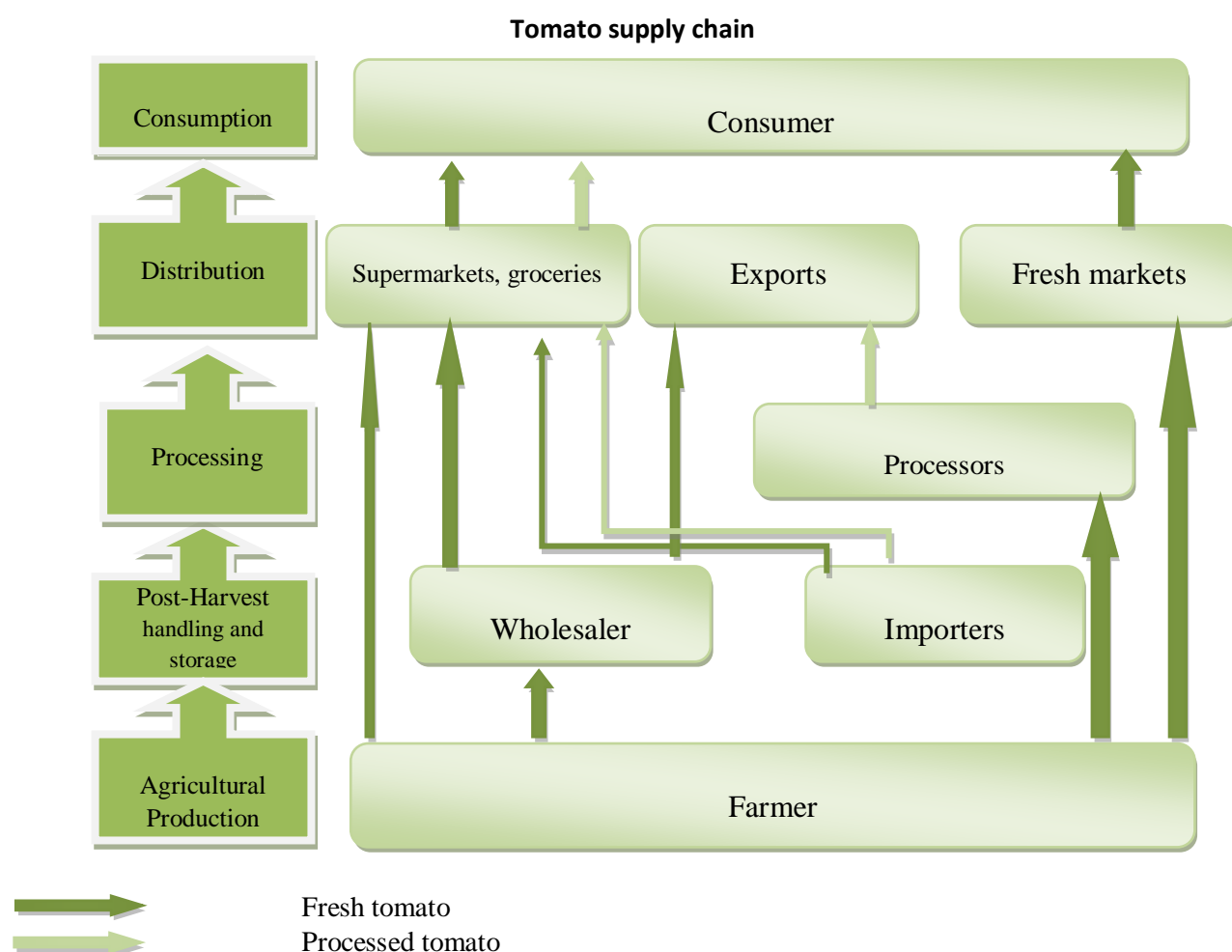
**4. Tomatoes:** During Soviet times tomato production in Armenia was high and tomatoes were exported to other Soviet Union countries (around 100 000 tonnes annually). In Armenian households tomatoes is the main vegetable that is preserved in summer-time and used in food throughout the year. The importance of tomatoes in Armenia has been validated by the fact, that tomato has been the vegetable with the highest production and consumption volumes for many years (See Figure 19 for top three vegetables in terms of volumes produced).

**Figure 19. Volumes of vegetable production in Armenia in 2005-2009 (thousand tonnes)**



Source: NSS, RA

Tomato production is mainly concentrated in Ararat marz (52 percent of all tomatoes produced in Armenia in 2011), and Armavir marz (33 percent of tomatoes produced in Armenia in 2011). Tomato production is the main sources of income for farmers in these two regions.



The tomato supply chain is quite similar to that of apples, except that tomatoes cannot be stored for long. This high perishability decreases farmers' bargaining power, and all tomatoes must be sold on the market, to wholesalers or to processing plants within a few days. Armenian tomatoes are quite popular in Russia and are exported, but mostly as a processed commodity. In 2011 out of 898 tonnes of tomatoes that were exported only 113 tonnes were exported fresh or frozen. More than 50 percent of tomatoes harvested in 2011 were procured by processing plants that produce tomato paste, ketchups, juices and canned vegetables. A detailed supply chain for tomatoes is presented in the figure above.

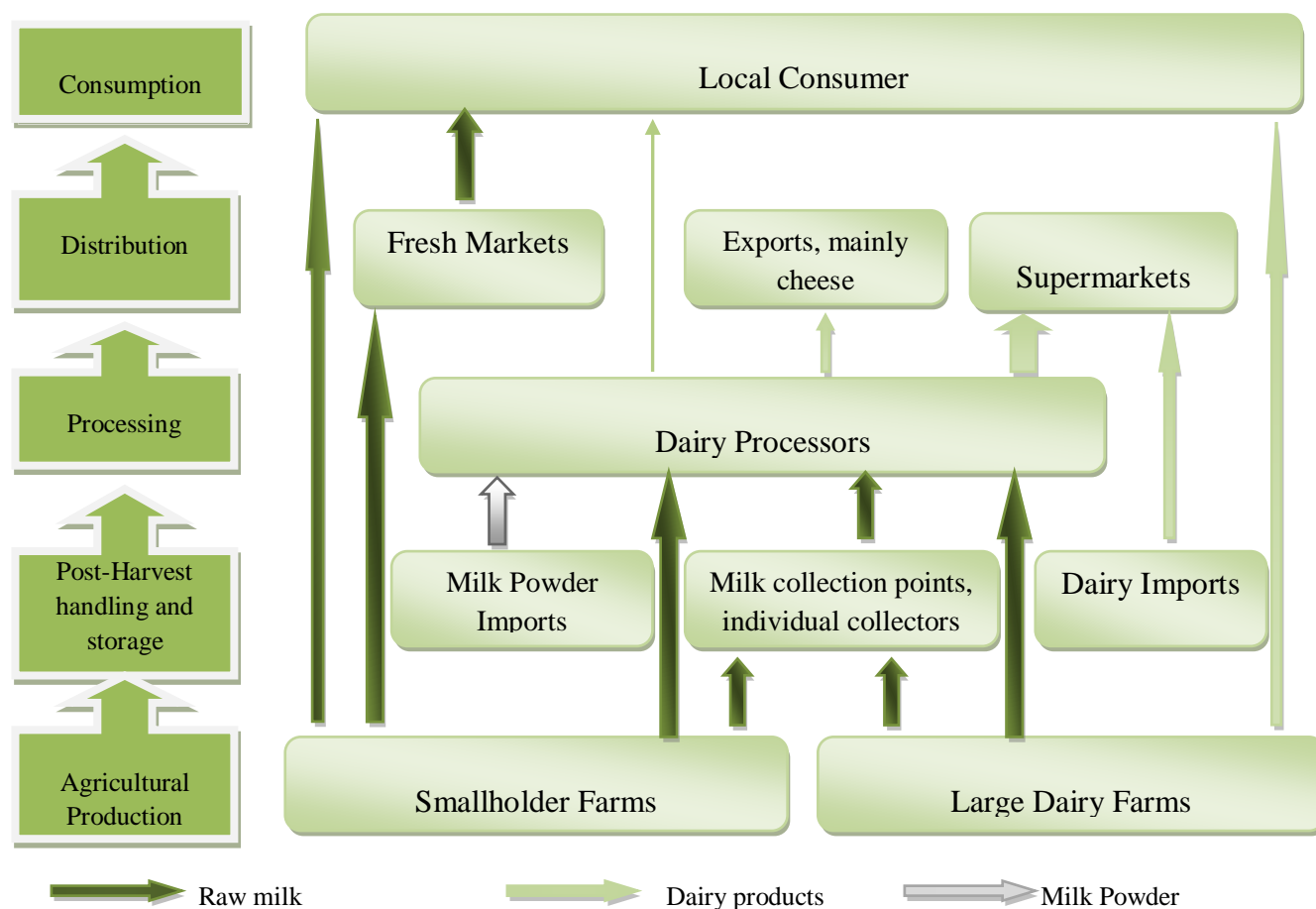
**5. Milk:** The milk supply chain is included in the list of priority agri-food chains, since milk is a commodity that has a huge impact on smallholders. In 2008 across the country there were 173 700 dairy farms, and over 96 percent of these farms had less than seven heads (Table 10).

**Table 10. Dairy farms by number of heads as at 1 January 2008**

	Number of dairy farms	More than 100 head	70-99 heads	15-69 heads	7-14 heads	Up to 7 heads
Total	173 716	49	505	1 971	4 057	167 134

Source: NSS, RA

### Milk supply chain



The Table 11 below provides detailed information on product category volumes and uses in 2009, based on FAOSTAT. Data for potatoes was obtained from the 2009 National Food Balance published by NSS.

**Table 11. Overview of selected commodity groups in 2009 (thousand tonnes)**

	Produced in the country	Imported	2009 Stock variation	Exported	Used for feed and seed	Processing	Available for use in food
Wheat	198.1	409.7	-68	0.9	79.3	1.5	458
Potatoes	593.6	1.7	57.4	5.9	411.8	0	235
Tomatoes	278.6	0.2	2.8	4.2	0.8	0	276.5
Apples	120.1	1.5	-5.9	0.9	8.8	55.2	51.6
Milk and milk products (excluding butter)	615.7	28.9	-26.5	3.1	47.8	0	567.3

Source: FAOSTAT, NSS RA (for fish and potatoes)

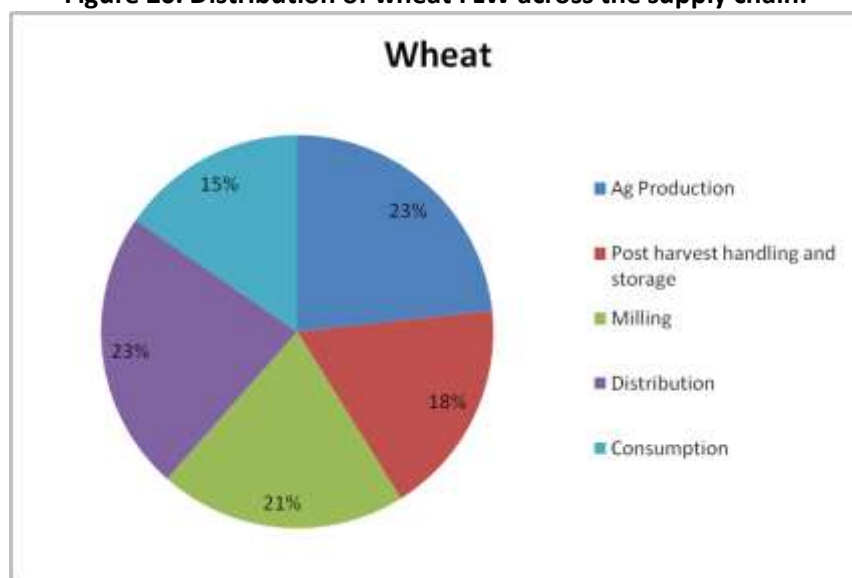
#### 4.2 Critical loss points for each product

**Wheat:** Total wheat waste and losses throughout the supply chain in Armenia added up to 127 600 tonnes, which is more than half of the wheat produced domestically.

**Table 12. Wheat production, supply, waste and loss in 2009<sup>27</sup> (thousand tonnes)**

Production	198.1
Domestic supply quantity	538.9
Available for food	458.0
<b>FLW</b>	<b>127.6</b>
FLW as a percentage of the commodity available for food	<b>27.9%</b>

Source: FBS and own calculation.

**Figure 20. Distribution of wheat FLW across the supply chain.**

Source: Own data

Almost 28 percent of wheat available for human consumption is either lost or wasted. The distribution of waste and loss in the stages of the supply chain (

Figure 20) shows that the biggest amount of FLW occurs during the agricultural production and distribution steps. Losses during milling include natural processing losses.

**Potatoes:** The total volume of potato waste and losses throughout the supply chain in Armenia was 64 300 tonnes, which is about 11 percent of the total volume produced.

**Table 13. Potato production, supply, waste and loss in 2009<sup>28</sup> (thousand tonnes)**

Production	593.6
Domestic supply quantity	646.8
Available for food	235.0
<b>FLW</b>	<b>66.5</b>
FLW as a percentage from available for food	<b>28.3%</b>

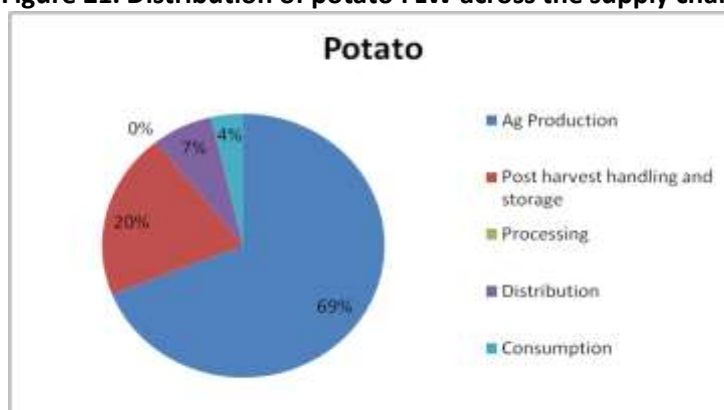
Source: FBS and own calculations

<sup>27</sup> The statistical data on production and supply of the commodity was obtained in 2009, while the share of commodity waste and loss was obtained through surveys in 2013.

<sup>28</sup> The statistical data on production and supply of the commodity was obtained in 2009, while the share of commodity waste and loss was obtained through surveys in 2013.

The distribution of waste and loss in the stages of the supply chain shows that the biggest share of FLW occurs during the agricultural production step.

**Figure 21. Distribution of potato FLW across the supply chain**



Source: Own data

As mentioned above, losses during the agricultural production stage include losses in the field when the product is ready to be harvested. For potatoes, these losses account for 85 percent of losses in the agricultural production stage. Farmers in Gegharkunik marz reported big losses caused by rodents in potato fields, while farmers in Shirak marz reported fungus that grows when the climate changes during the harvest period.

**Tomatoes:** The total volume of tomato waste and losses throughout the supply chain in Armenia was 27 900 tonnes, which is more than 10 percent of all tomatoes produced.

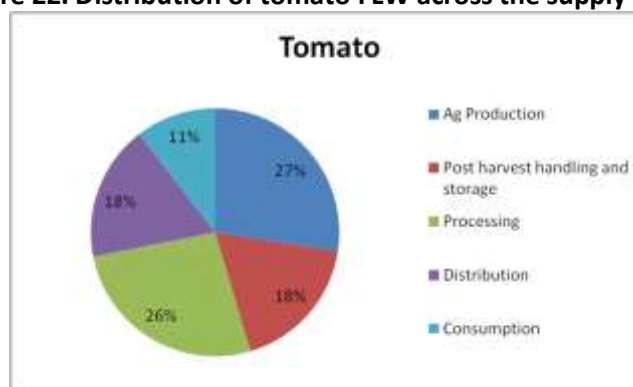
**Table 14. Tomato production, supply, waste and loss in 2009<sup>29</sup> (thousand tonnes)**

Production	278.6
Domestic supply quantity	277.3
Available for food	276.5
<b>FLW</b>	<b>27.9</b>
FLW as a percentage from available for food	<b>10.1%</b>

Source: FBS and own calculations

The biggest share of FLW occurs during the distribution stage (Figure 22), followed by agricultural production and processing.

**Figure 22. Distribution of tomato FLW across the supply chain.**



Source: Own data

<sup>29</sup> The statistical data on production and supply of the commodity was obtained in 2009, while the share of commodity waste and loss was obtained through surveys in 2013.



Losses in the distribution stage were mainly due to the loss of produce on open markets. About one third of tomatoes sold in Armenia are distributed through open/fresh markets. The tomato harvesting season starts in mid-summer, and lasts until early fall, which is the hottest period in Armenia. Open markets are not equipped with refrigerators or cool areas where resellers can keep fruit and vegetables. The produce is kept in boxes in the direct sunlight, or in the best case scenario under covered boots, which is still not enough to protect the produce. Losses reported in the agricultural production stage were due to unfavorable weather conditions in the harvest period and as a result of pests and birds. Losses during the processing stage include natural waste assumed by processing operations.

**Apples:** The total volume of FLW for apples came up to 9 500 tonnes, which was less than 8 percent of the total volume of apples produced in the country.

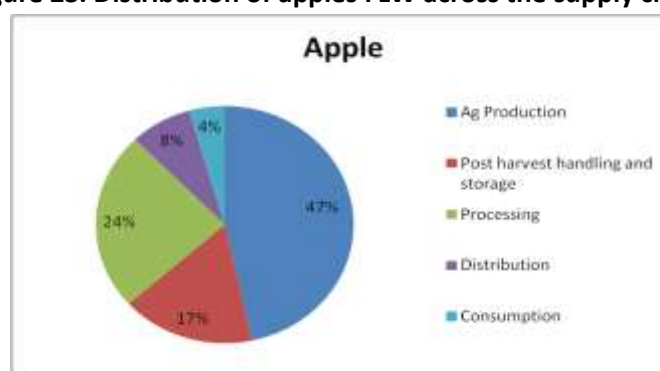
**Table 15. Apple production, supply, waste and loss in 2009<sup>30</sup> (thousand tonnes)**

Production	120.8
Domestic supply quantity	115.6
Available for food	51.6
<b>FLW</b>	<b>9.8</b>
FLW as a percentage from available for food	<b>19%</b>

Source: FBS and own calculations

The distribution of waste and loss in the stages of the supply chain (3) shows that the biggest share of FLW occurs during agricultural production stage.

**Figure 23. Distribution of apples FLW across the supply chain.**



Source: Own data

Losses of apples during the agricultural production stage are caused by pests, birds and humidity issues. Some farmers mentioned that tall trees are hard to climb and some fruit may not be accessible for picking and may be left on the tree.

**Milk:** The total volumes of losses and waste of milk and products made from milk amounted to 56 900 tonnes, which accounts for 9 percent of the total volume of raw milk produced in the country.

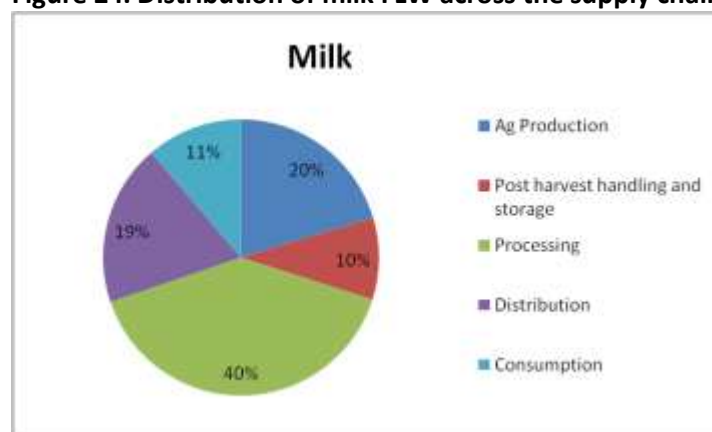
<sup>30</sup> The statistical data on production and supply of the commodity was obtained in 2009, while the share of commodity waste and loss was obtained through surveys in 2013.

**Table 16 Milk production, supply, waste and loss in 2009<sup>31</sup> (thousand tonnes)**

Production	615.7
Domestic supply quantity	615.1
Available for food	567.3
<b>FLW</b>	<b>56.9</b>
FLW as a percentage from available for food	<b>10%</b>

Source: FBS and own calculations

The largest portion of FLW can be observed in the production stage, although most of this occurs as a result of technological procedures. Waste and losses are also sizable in agricultural production (cow mastitis), and in the distribution stage (due date expiration).

**Figure 24. Distribution of milk FLW across the supply chain**

Source: Own data

### 4.3 Summary assessment of FLW

To obtain FLW data, several surveys of supply chain participants and numerous interviews with industry experts were conducted. Below table provides a detailed representation of FLW percentages in each stage of the chain.

**Table 17 FLW percentages in each stage of the supply chain**

	Ag. production	Post-harvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	15%	5%	6%	7%	5%
Roots and tubers	19%	6%	0%	3%	1%
F&V <sup>32</sup>	6%	4%	3%	4%	3%
Meat	1%	0.1%	1%	1%	1%
Fish and seafood	20%	0.1%	0.2%	3%	1%
Milk	2%	0.1%	4%	2%	1%
Eggs	23%	1%	0.1%	0.1%	0.1%

Source: Own data

<sup>31</sup> The statistical data on production and supply of the commodity was obtained in 2009, while the share of commodity waste and loss was obtained through surveys in 2013.

<sup>32</sup> The survey data covers only apples and tomatoes. Since fruits make up the higher share within this commodity group, and since most of fruits are more perishable than apples, we have estimated that waste and losses in the commodity group will be about 2 % higher, than the average losses for the two products.

**Agricultural production:** To obtain data on agricultural production we conducted interviews with agricultural commodity producers. We selected the producers that are typical for the particular commodity in Armenia. For example most of the milk in Armenia is produced by smallholders (96 percent of dairy farmers have up to seven cows)<sup>33</sup>. On the other hand most eggs produced in the country come from large poultry farms, although some smallholders sell eggs as well. In this case the surveys were carried out at several large poultry farms.

**Post-harvest handling and storage:** To obtain data on losses during post-harvest handling and storage, we identified which players in the chain are able to provide this function and contacted them. For fruit and vegetables this function is performed by farmers, wholesalers, exporters and commercial storage facilities. For milk it is performed by milk collection points and for wheat it is performed by farmers and importers.

**Processing and packaging:** For information on losses during processing we contacted juice and preserve production plants, mills and bakeries, dairy producers and meat processing plants.

**Distribution:** For food losses during the distribution stage we conducted surveys with eight representatives of supermarket chains, eight mid-size groceries, 20 small shops, 17 mini-shops<sup>34</sup> and two butcher's outlets. We also surveyed 15 fruit and vegetables resellers on the open markets of Nor Nork and Komitas.

**Consumption:** For food waste at the consumption stage we conducted a phone survey of 506 consumers in Yerevan.

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<sup>33</sup> Hovhannisyan A. 2008.

<sup>34</sup> We refer to a mini-shop as the one that has less than 5 employees, small shop has 5-50, mid-size grocery has 50-100, and supermarket chain has over 100 employees.

## 5. Analysis of key factors, priority actions and policies for reducing food losses and waste

Previous studies on FLW have proven that in low-income countries food is mostly lost during the production-to-processing stages, while in more developed countries it is mainly lost or wasted in the distribution and consumption stages of the supply chain. Our study findings mainly agree with this view.

In this section we describe causes of FLW and suggest prevention mechanisms for each step of the supply chain.

### Agricultural production:

#### Causes of food losses and waste

- **Improper timing of harvests**  
Lack of farmer knowledge about harvest timing leads to losses in volumes (overripe fruit turns soft and are hard to store, while under ripe fruits dry out and lose weight). Sometimes crops might be harvested early because farmers want to deliver them to the market while prices are still high.
- **Improper harvesting procedures and lack of mechanization**  
A lack of farmer knowledge about harvesting procedures, for example irrigating before the harvest, may cause fungi that can spoil sizable portions of the harvest. After the collapse of the Soviet Union farms were privatized, but farmers did not have enough money to replace old farm machinery. Some crops cannot be harvested with human labour and without major losses. Unsuitable combine harvesters cause huge losses during the harvesting phase.
- **Animal mortality during breeding**  
Most livestock farmers in Armenia are smallholders, who often cannot afford veterinary consultations or all the necessary immunizations. Since animals are not kept in closed farms, any disease can wipe out the grazing livestock population from the meadows.

#### How to prevent food losses and waste

- **Education**  
Most agricultural production in Armenia is run by smallholders, who do not have proper knowledge in the field of agronomy. Specialized trainings on harvesting and cultivating certain crops would increase harvest volumes. Develop strong linkages between extension centers and farmers.
- **Technical support**  
Financial investments are needed to obtain farm mechanization. The idea of several small farmers sharing the same machinery may be promoted and implemented. It might be useful to analyze and apply the idea of farm machinery cooperatives (like in France) in Armenia.

### Post-harvest handling and storage:

#### Causes of food losses and waste

- **Poor storage facilities**  
The main reason for food loss at this stage in the supply chain is the limited number of and access to refrigerated storage facilities. Fruit and vegetables in particular have to be kept at the same temperature throughout the storage period. Farmers do not have the financial means to keep produce in commercial storage units for months at a time. There is also lack of cold storage facilities in Armenia and although some were established under the Millennium Challenges Armenia (MCA) project, these are not fully functional.
- **Rodents and pests**

Potato farmers in Gegharqunik marz stated that they had lost crops to rodents, which wiped out almost 20 percent of their potatoes after harvest; both on the fields and in the storage rooms.

- **Poor storage techniques and know-how**

Farmers use the same storage areas (mostly in the basements of their own houses) from year to year. Those areas need to be sprayed for certain fungi and diseases before every harvest. Many farmers in Armenia do not even know that fresh produce can spoil in the storage room due to improper ventilation. Clearly, there is insufficient knowledge/capacity to ensure the adequate post-harvest handling and treatment of agricultural products.

#### **How to prevent food losses and waste**

- **Education**

Farmers and transportation and delivery providers need to be trained on commodity storage and handling skills. Farmers have to be informed about the humidity and temperature conditions necessary for storing particular goods.

- **Technical support**

Cold chain storage rooms with back up power systems have to be installed and operated, especially in areas with fruit orchards and vegetable fields. High quality pesticides have to be available to combat pests and rodents without affecting harvests. Milk collection points need to facilitate milk inspections, and must comply with certain hygiene standards.

There is no data about cold storage facilities, their capacity or technical conditions. It would be useful for Armenia to make an inventory of all cold storage facilities and their capacities and later formulate clear proposals on how many new units are needed.

#### **Processing and packaging:**

#### **Causes of food losses and waste**

- **Processing procedures**

Agricultural products, especially fruit and vegetables are very seasonal, which is why most of them are processed and sold later as juices or preserves. A few processors have fully renovated production lines and high tech processing equipment; others are operating processing plants established during Soviet times. By using obsolete equipment factories incur higher waste during processing.

- **Poor packaging**

Quite often, when produce is sold on open markets, farmers or intermediaries deliver it in plastic crates, wooden boxes or plastic bags. This might cause large amounts of waste due to mechanical damage and decrease the appeal of the products to supermarkets.

#### **How to prevent food losses and waste**

- **Processing technologies and equipment**

Improving processing technologies, as well as introducing new production lines and equipment can decrease food waste at the processing stage. There are certain tools to measure resource efficiency management systems at companies (e.g. PROREMAS). Processors should be trained on how to use these tools. This would allow companies to identify gaps and inefficiency points and come up with solutions.

- **Packaging**

New types of packaging, like special boxes for transporting berries or soft fruits and vegetables would increase the product shelf life significantly.

## **Distribution:**

### **Causes of food losses and waste**

- **Distance from main food markets**  
Quite often farmers have to transport their agricultural products to main city markets, where they can reach the final consumer or deliver produce to wholesale or retail points. This becomes very difficult if farms are located far from Yerevan (which is the main consumption point for agricultural products), or if the farmer does not possess or cannot rent a truck.
- **Inability to sell own produce**  
During the harvest season (especially for perishable fruits and vegetables) farmers may not be able to address delivery issues, since they are very busy harvesting the crops. Even if farmers' could overcome this obstacle and get to the market in Yerevan, they could still be unable to sell the produce due to a lack of networking and specialization in selling.
- **Inadequate selling conditions**  
Most of the fresh food in Armenia is sold on open air fresh markets. Sellers set the produce on counters or leave it in the boxes under the sun. By the end of a hot summer day the unsold goods are either sold for home processing for a very low price or are set aside for animal food.
- **Short expiration dates for dairy products**  
Fresh pasteurized milk has a shelf-life of 4 days at 4°C but in reality, milk frequently becomes spoilt before the expiry date. This is not the fault of the processors or distributors, but is mainly due to the very poor hygienic quality of raw milk collected or due to improper conditions in milk collection points.

### **How to prevent food losses and waste**

- **Establishment of farmer cooperatives**  
The establishment of cooperatives has been successfully supporting farmers in transportation and distribution activities. Joint resources will allow cooperatives to own trucks and keep booths in large open markets. In this case transportation and distribution activities will not distract farmers from their main work and a constant presence in the market will bring recognition and create network of customers.
- **Development of marketplace**  
To reduce food losses and waste at the distribution step, the traditional market system needs to be developed or changed. Fresh markets need to have covered shops and refrigerated storage facilities to avoid large volumes of food loss.

## **Consumption:**

### **Causes of food losses and waste**

- **Inadequate storing conditions**  
Households in Armenia often buy products in bulk and pay lower prices. Commodities like apples, potatoes and onions are purchased in late fall and kept in cool storage rooms to be used during the winter months. Inadequate storage conditions lead to spoilage of this food and consumers end up paying more.

### **How to prevent food losses and waste**

- **Improved storage conditions**  
To reduce food losses and waste during the consumption step, households' food storage could be improved.
- **Food purchase planning**

Social messages on food purchase planning may decrease unnecessary large volumes of food purchased by households.

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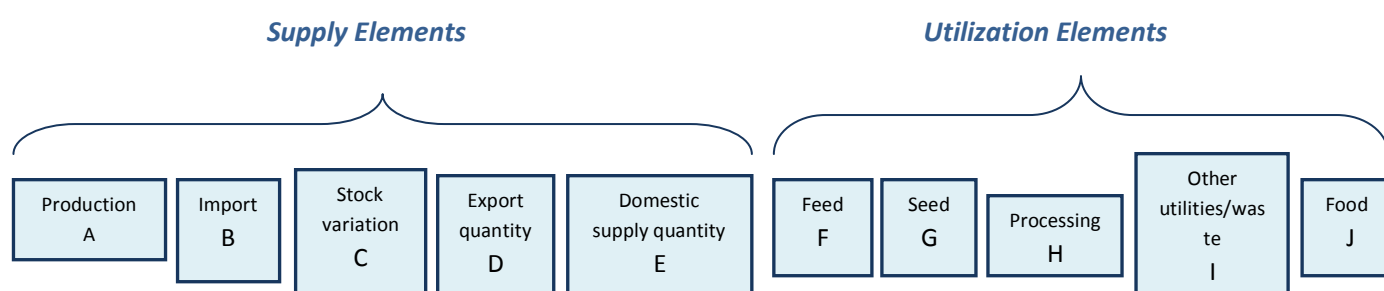
## Appendixes

### Appendix 1. Food balance sheets

To have results compatible with previous studies conducted by FAO we have used the same model to show the flow of commodity in FBS.<sup>35</sup> The only difference is that within utilization elements we have omitted “waste”, since the data on waste has been obtained directly from supply chain participants. For detailed FLW calculations we have used 2009 data from FAOSTAT.

A FBS shows the patterns of a country’s food supply during a specific period of time. For each food item the domestic supply (E) equals the sum of production (A), imports (B) and stock variations (C). Food available for human consumption (J) is left after withdrawing utilization sources such as exports (D), feed (F), seed (G), processing (H) and waste or other utilities (I) (Figure 35).

Figure 35. Model of the mass flow in FSB.



<b>A Total domestic production:</b>	reported in primary crops for crops; carcass weight for meat; live-weight equivalent for fish and total production leaving the manufacture for processed commodities.
<b>B Total domestic import:</b>	all movements of the commodity in question into the country/region.
<b>C Stock variation:</b>	changes in foremost government stocks.
<b>D Export quantity:</b>	all movements of the commodity in question out of the country/region.
<b>E Domestic supply quantity:</b>	Sum of A, B, and C
<b>F Feed:</b>	the amounts of the commodity in question used to feed animals.
<b>G Seed:</b>	the amounts of the commodity in question used for reproductive purposes, e.g. seed, planting, eggs for hatching or fish for bait.
<b>H Processing:</b>	the amount of the commodity available for human consumption as part of processed food products, containing several commodities.
<b>I Other utilities/waste<sup>36</sup>:</b>	the amounts of commodity lost during handling, storage and transport between production and distribution as well as amounts of the commodity used for non-food purposes, e.g. oil for oil production and wheat for bio-energy.
<b>J Food:</b>	all forms of the commodity available for human consumption, e.g. wheat flour, vegetable oils etc.

All volumes in the FBS are reported in primary product or primary product equivalents. Food Balance Sheet data will partially be used in this survey. However, taking into consideration that the data (waste and loss allocation factors) for FBS has been collected back in 2007, and since no research on food wastes and losses was conducted in Armenia before, thus the waste and loss proportions may not reflect the country specifics, we will get own numbers based on the surveys, interviews and expert opinions.

<sup>35</sup> FAO Global Food Losses and Food Waste, 2011 <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf>

<sup>36</sup> According to faostat Food Balance Sheet “Other utilities/Waste” category includes “the amounts of commodity lost during handling, storage and transport between production and distribution as well as amounts of the commodity used for non-food purposes, e.g. oil for oil production and wheat for bio-energy.” Since within the research we calculated country specific waste and losses data, here on the mass flow figure we will refer only to waste occurring due to other uses of the commodity. The detailed calculation of amounts lost during handling, storage and transportation can be found in Appendix 3.

## Appendix 2. Quantification of results

Food waste and loss will have to be calculated at each stage of the value chain as a percentage of the volumes of produce introduced to that stage. In some stages, like Agricultural Production (Harvesting) it will be practically impossible to tell what the exact volume of produce available for harvesting was. Here we will introduce the idea of Potential Production, which will represent this volume. Potential Production equals the sum of Production harvested and reported by the farmer and Waste (produce lost on the field – damaged by pests, birds, rodents, weather conditions, etc.).

$$\begin{array}{|c|} \hline \text{Potential Production} \\ \hline \text{PP} \\ \hline \end{array} = \begin{array}{|c|} \hline \text{Production} \\ \hline \text{P} \\ \hline \end{array} + \begin{array}{|c|} \hline \text{Waste} \\ \hline \text{W} \\ \hline \end{array}$$

For the step Agricultural Production, where we do not have Possible Production volumes, we will use the following formula to calculate waste:

$$W = r * P$$

Where

W is waste at the current stage

r is the waste rate as a fraction of Production

P is Production

In general for other steps of Supply Chain the formula for waste will be:

$$W = r * PP$$

All data is reported in primary product equivalent (while speaking of milk losses, we will introduce all dairy product losses in milk equivalent).

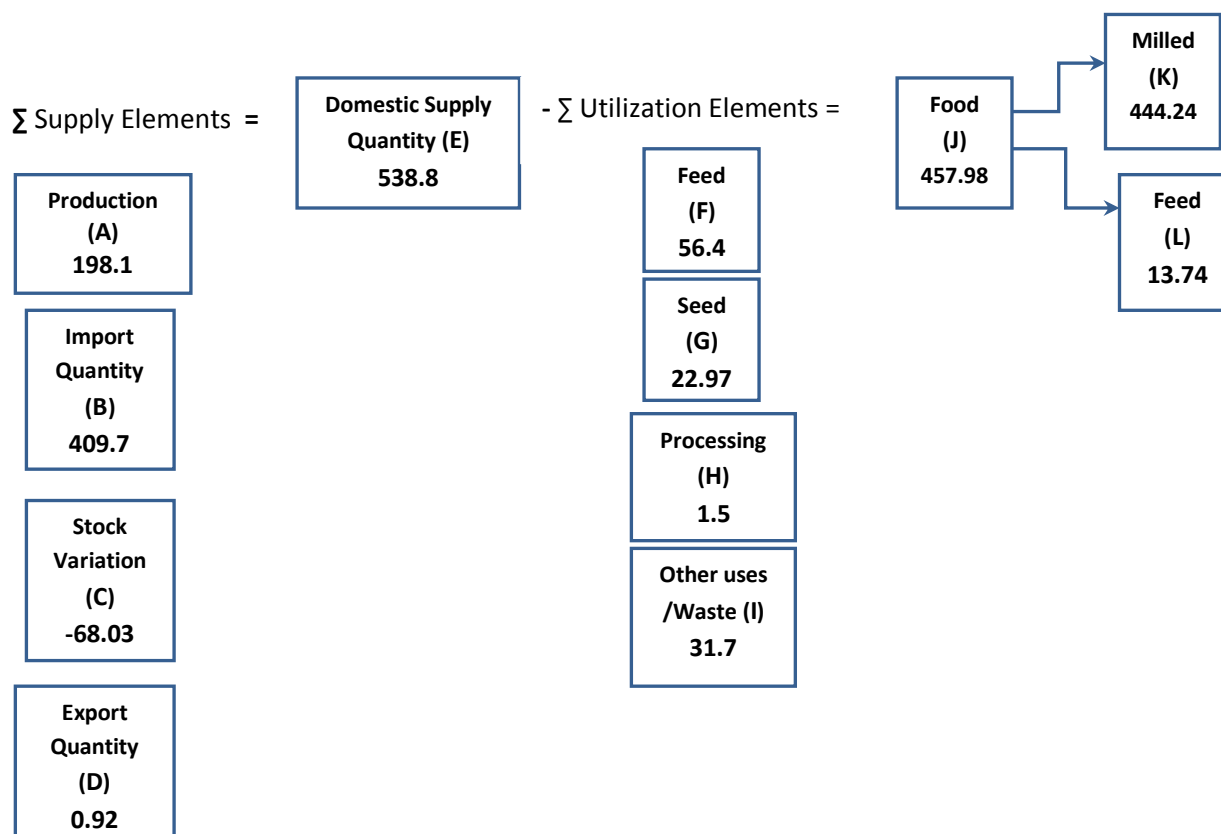
Total waste for all steps will be equal sum of Waste from each step multiplied by corresponding edible weight conversion factors.

### Appendix 3. Example of calculation of food losses and waste

The sample calculation for food losses and waste was done on the example of wheat.

6 below shows the mass flow of wheat in Armenia in 2011 (thousand tonnes).

Figure 46. Mass flow of wheat in Armenia in 2009, (thousand tonnes).



Processing (H) – the amount of the commodity available for human consumption as part of processed food products, containing several commodities was very small.

Other uses/Waste (I) for the current study it was recalculated, so we omitted the waste data reported in the food balance sheet of the FAOSTAT.

*Waste percentage in each step of the food supply chain for wheat:*

Agricultural production – 15 percent

Postharvest handling and storage – 5 percent

Processing and packaging (milling and packaging) – 6 percent

Distribution – 7 percent

Consumption – 5 percent

*Calculation of primary equivalent wheat losses and waste in each step of the FSC:*

Agricultural production:  $0.15/(1-0.15)*198.1 = 34.95$

Postharvest handling and storage:  $0.05*457.98 = 22.89$

Processing and packaging (milling and packaging):  $0.06*(457.98-22.89) = 26.1$

Distribution:  $0.07*(457.98-22.89-26.1) = 28.6$

Consumption:  $0.05*(457.98-22.89-26.1-28.6) = 19.02$

Out of domestic supply of wheat (538.8), some part (79.37) was allocated as a feed and seed, so the losses in the agricultural production stage were not pure losses from the wheat intended for human consumption, which means the loss of 34.9 has to be adjusted for wheat used for feed, seed. The portion of loss in agricultural production that was not intended for human consumption is  $(79.37/538.8)*34.95 = 5.14$ . This leaves the loss of wheat intended for human consumption equal to  $34.95-5.14=29.8$  thousand tons.

*Conversion factors on edible wheat losses and waste in each step of the FSC:*

Agricultural production loss:  $29.8*0.97 = \mathbf{28.92}$

Postharvest handling and storage loss:  $22.89*0.97 = \mathbf{22.21}$

Processing and packaging (milling and packaging) loss:  $26.1*0.97 = \mathbf{25.32}$

Distribution loss:  $0.07*(457.98-22.21-25.3) = \mathbf{28.73}$

Consumption loss:  $0.05*(457.98-22.21-25.3-28.7) = \mathbf{19.09}$

We also had a 2 percent reported loss that occurred on the field before the harvest, when the wheat was ready, but the harvest got delayed or got affected by rodents and pests. So Possible Production has to be more than Production (198.1) by: Difference between PP and P =  $0.02/(1-0.02)*198.1 = 4.04$

Taking into consideration allocation and conversion factors, the loss will be:

$(4.04-4.04*0.15)*0.97 = \mathbf{3.34}$

Total loss comes to **127 610** tonnes, which is nearly **28 percent** lost from the wheat available for human consumption.

#### Appendix 4. Allocation of fruits and vegetables between various distribution agents

Fruit and vegetables in Armenia are sold through wholesale and retail agents. The biggest wholesale market is in Malatia, while locations of retailers are quite diverse. Retail fresh fruit and vegetable segment can be categorized into agricultural markets, shops, supermarkets and other areas (including farmer's market on Kasyan street).

Based on the retail trade sector study conducted by America CJSC consulting company, as well as previous reports of ICARE and own calculations and estimations, we assembled the allocation of fruits and vegetables between various retailers as follows.

Table 18. Allocation of F&V between different distributing agents.

Retailing agents	Proportion of F&V sold
F&V kiosks/shops	<b>44%</b>
Open/fresh markets	<b>28%</b>
Supermarkets	<b>24%</b>
Other	<b>4%</b>

Source: America, own data.

Based on this data we have assigned weights to FLW occurring in the distribution stage. In our example resellers on the fresh markets have reported loss in tomato of 8 percent, supermarkets have reported 6 percent loss and small specialized kiosks – 1 percent loss. Taking into consideration proportion of volumes (weights) of fruits and vegetables sold by each of those agents, we come up to the total tomato waste of 4 percent in the distribution step:

$$0.44*1\%+0.28*8\%+0.24*6\% = 4.1\%.$$