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SOYA IN THE SYSTEM OF STANDARDIZED SOURCE OF RAW MATERIALS AND TRANSFER OF INTEGRATED TECHNIQUES

The purpose. To determine the role of soya in the system of standardized source of raw materials and transfer of integrated techniques in Ukraine. **Methods.** Dialectic, abstract-logical, and economic-statistical. **Results.** Complex analysis of positioning Ukraine concerning the basic plants of monitoring of production and use of soya and products of its processing is carried out. It is shown that in medium- and long-term perspective it is necessary to orient on change of accents in effective use of the crop and its resource provision. Therefore problems of soya need to be surveyed already today under different visual angles from strategic items of SWOT-analysis in view of directions of production and consumption. **Conclusions.** Considering strategic importance of soya for Ukraine the integrated approach with transferring development and production to the level of standardized source of raw materials and transfer of integrated techniques is necessary. From position of national security of Ukraine and efficient implementation of competitive advantages open coordination and integration of soya in recycling, engineering and alimentary branch are selected as the important component principles. Use of methodology of formation of integrated techniques on a modular approach with necessary compensatory and active cooperation opens new organizational approaches and appreciable perspectives for implementation of genetic potential of productivity of soya.

Key words: soya bean, standardized source of raw materials, transfer of agrotechniques.

Results. All crops are traditionally categorized by type of raw materials: starchy, proteic, oleaginous, technical, energy and highly-specialized. Here, it is important to take into account how types of raw materials logistically fit with a processing scheme. For example, in case of soybean oil and meal blend seamlessly into logistics, especially in the view of heat treatment of meal during oil extraction. In the face of

globalization processes, expansion of the system of food and non-food consumption is becoming of great importance. It is enough to remind of the entire trends of non-traditional food products, which have been introduced into the nutritional system lately (pizza, sushi, soybean products). At the same time, corn, rice, wheat and soybean cumulatively account for 43% of calories and 40% of proteins of daily diet [5]. The leading position of soybean among actively used cultivated plants is worth noting. Soybean protein costs 14 times as little as milk protein, 21 times – as meat protein, 1.8 times - as wheat protein, and 6.9 times – as rice protein. This crop is noticeable for the fact that up to 85% of soybean byproducts in the world are used in animal husbandry [6]. Therefore, cultural traditions and their creativity under the current market conditions are becoming more and more active factors in the formation of consumer demand and covering of new market segments.

Today, the soybean segment in the global production of oil crops exceeds 60%. Around 80 countries grow soybean. The soybean production in the world is growing. For example, 264.2 million tons were obtained in 2010, 315.1 million tons - in 2014, and the global soybean yield will amount to about 290 million tons in 2015 (USDA's prediction).

In Ukraine, the overall production of soybeans has increased by more than 16 times for the last 11 years: from 231.9 thousand tons (2003) to 3.900 million tons (2014) [2].

Analysis of the positioning of Ukraine regarding the main monitoring objects demonstrates a clear positive dynamics for the last 5 marketing years (2009 - 2010, 2010 - 2011, 2011 - 2012, 2012 - 2013, 2013 - 2014 MY). Ukraine hit top 10 world producers and exporters of this leguminous crop. According to the USDA, in 2014-2015, Ukraine ranked 8th among the world soybean producers. In addition, the country has also increased its share in the global export from 1.1% in 2010 - 2011 to 1.7% in 2015-2014 [2]. In terms of rate of growth in production of soybeans, Ukraine has closed the gap between major manufacturers and lengthened the lead over Russia and the EU - 27 (Fig. 1).

Provided that this rate is retained, one can expect improvement of the

position of Ukraine among the main players in the soybean market in the mid-term, especially from the standpoint of a significant potential of the crop as a promising raw material resource and possibility of increasing areas under this crop.

Given the specifics of soybean, even if record yields (2011) are achieved, it is proboscis to expected sufficiently dynamic growth in the average multi-year yield capacity in Ukraine in the near-term. Taking into account the average multi-year yield of soybean for the 14 monitoring years from 1999 to 2012 (Ukraine - 1.39 t/ha, Russian Federation - 1.04 t/ha and the USA - 2.7 t/ha), the organization of production in different countries has distinctive features (Fig. 2).

While the Russian Federation and for now Ukraine lay emphasis on increasing areas and (to a lesser degree) on increasing yield capacity, the USA focuses on reducing the gap between minimum and maximum values against the background of high and stable average multi-year yield (Table) (which is strategically important for Ukraine). At the same time, the USA's approaches are strategically suitable as a model of organization of production and complex use of soybean for Ukraine.

Today in Ukraine, soybean with its considerable genetic potential of productivity does not fully fulfills it (FGPP 30-60%).

Ukraine is predicted to increase the overall production of soybean by 1.8 times by 2017: up to 4.3 million tons, which can mean an additional need for nitrogen of approximately 100 thousand tons (if mineral nitrogen deficit is $\leq$ 50 kg/ha factoring in nitrogen fixation). One should remember that soybean also needs phosphorus, potassium, magnesium, calcium to give a good yield. Therefore, additional expenses will also increase by at least 1.8 times.

Under these conditions of production, soybean requires systemic solutions with a clear focus on: technology transfer (so that all factors work with appropriate efficiency); level of standardized raw materials (to make soybean necessary for processors and consumers and to provide the production with reliable marketing outlets); balance between domestic and foreign consumption (so that there would be places to sell soybean with

appropriate economic results by creating a stable demand for the next level innovations and by increasing the investment potential). Soybean is grown in Ukraine in all agro-climatic zones, but the main acreage (64.2%) is located in the forest-steppe zone (Fig. 3). This attests to the potential of soybean and its significant prospects in Ukraine in the near-term even with available technologies (by increasing sown areas) [4].

At the same time, In this case, in the mid- and long-term one should change emphasis in the effective use of this crop and its resource support [3]. From the one hand, it is necessary to take into account the fact that Europe increases the soybean production not due to the expansion of sown areas (except Ukraine and Russia). On the other hand, one of the leaders in the production and consumption of soybean, China, prefers more productive corn (correspondingly giving larger areas under corn) [1] and solves the soybean challenge owing to growth in the import and outside production.

It is also worth taking into account information about the export and import of soy in the world. For example, 53 countries export soybean, and Ukraine's share in the global export was 1.7% in 2014. Asian countries are major importers of soybean: 42.8%; EU imports 35.4%: Latin America - 13.1%: Africa - 5.2%. Ukraine’s import if soybeans and processed products is negligibly little (in 2014, imports of soybean was 5 thousand tons, of soybean oil - 0.01 thousand tons, of soybean meal/cake – 2 thousand tons, and export - 2 thousand tons) [2].

Today, the soybean export/domestic consumption ratio for Ukraine is estimated as close to 50:50, and 2 years ago it was 60:40. That is, on the one hand, we have a problem of incompleteness of the domestic system of soybean consumption, and, on the other hand, an increased topicality of ensuring the desirable level of competitiveness to expand the external market.

In other words, today is soybean challenges should be considered through different lens from the strategic positions of SWOT analysis with due account for trends of production and consumption.

Soybeans is worth paying attention to as a predecessor of winter crops. In

recent years in the agrarian sector of Ukraine, the production demands for intercropping within crop rotation and marketing year in order to achieve an additional economic effect. The use of ultra-early soybean and sunflower varieties as predecessors for winter crops is an example. Given the available technologies, complex of climatic, resource and organizational factors, only ultra-early-ripening, early and partially mid-early (provided super early time of sowing) soybean varieties fit with these frameworks in terms of the vegetation length. However, in this case one has to solve a whole block of biological and agronomic problems of soybean within vectors of breeding, seed production and plant growing.

Today, considering the dynamics of accumulation of the sum of effective temperatures and precipitation amount, one should accordingly adjust the system of technological support and organization of production. Experts think that soybean should not exceed 22 - 40% in crop rotation. Given the realities of today, even with hundred per cent use of soybean as a predecessor for winter wheat (which is also unlikely), it is reasonably to discuss 10% rate only in the near- term. If the expected yield of soybean up to 2 t/ha and provision with varieties belonging to various groups of ripeness are taken as baseline parameters, we will get even less.

Here, one should bear in mind that the asserted growth in cereal production to 80 million tons and more is possible only provided having an average yield of $\geq$5 t/ha. Under current conditions, corn only meets this requirement (examples from China and the USA). One should also remember that corn areas almost coincide with soybean and winter wheat areas. And if sunflower is added here, we will get quite strong competition for space and resources.

Therefore, a justified choice of crops as transfer objects will undergo significant changes in the mid-term. Since soybean, corn, sunflower and winter wheat will hardly relinquish their leading statuses, a logical question arises: What to do with other crops?

There is the only conclusion: systemic solutions and novel organizational approaches based on principles of cross-cutting coordination and national security strategies are needed. The main uses of soybean are

traditionally protein and oil. Taking into account the processing requirements, we should distinguish 2 independent lines: the 1st one – oil soybean and the 2nd one - protein soybean.

During 1 marketing year, soybean gives 700 kg of meal (cake - residua left after worm pressing; meal – residua after extraction) with protein content of 44-48% and 190 kg of soybean oil per ton of beans [8]. That is, with the yield of 2 t/ha (in 2014 2.16 t/ha) soybean provides up to 672 kg of protein and up to 380 kg of oil per ha. In this case, almost all direct costs can be acquitted just at the expense of oil. And if we take into account that these calculations were conducted with the existing "hybrid" (oil/protein) approach, good prospects are emerging, both for oil and for protein specialization. Here, it is important to maximally process products manufactured during the marketing year and to use them without nonbeneficial costs for storage.

Semi-dried soybean oil (iodine index 107 - 137) is used for food and for technical purposes. Oil has a specific fatty acid composition with predominance of unsaturated fatty acids. The polyunsaturated/saturated fatty acid ratio is 82:18. Fatty acid contens in soybean oil are as follows: of linoleic acid (18: 2n-6) - 55%; of oleic acid (18: 1n-9) – 21%; of palmitic acid (16: 0)
– 9%; of stearic acid (18: 0) – 6%; and of others - 9%. In addition, oil contains phosphatides, carotenoids, vitamins and other substances. The content of linoleic acid is a peculiarity of soybean oil. On the one hand, it is not sufficient for technical purposes, and on the other hand, it is too high for effective use for nutritional purposes. The content of oleic acid can be increased through breeding to create specific food soybean oil.
Soybean is inferior to other oil crops in terms of oil content and oil yield per ha, but as an object of transfer and as a raw material resource it is superior to them due to its acreage and processing logistics. Therefore, the optimization of fatty acid composition of oil depending on a use trend is a strategic direction for soybean.

Compared to other protein crops, soybean provides a higher protein

yield per ha. Quality parameters of soybean protein are a significant argument to expand production output and use of the crop.

On the one hand, soybeans contain a lot of proteins, but inhibitors of trypsin impede its digestion, on the other hand, inhibitors of trypsin are inactivated by heating, which is a key point, since heating of soybeans is a technological step during oil extraction and industrial processing. High water solubility of soybean albumin (up to 94%) makes it easily digestible food and forage. Soybean protein is so concentrated that a decrease in solubility to < 70% sharply reduces its value. One should take into consideration the fact that dry heating of soybeans damages amino acids. That is why soaking, which unfolds highly-hygroscopic components before heat treatment, is an obligatory operation for processing soybeans. Soybeans swell out 2.5 – 3.0 times during 14- hour soaking/

Meaning protein priority, all this separates soybean as a leading object of transfer and provision of the national protein security for a number of economically developed economies.

Thus, the soybean challenge to a large extent combines problematic factors and mechanisms to overcome them. Therefore, effective mastery of the soybean crop allows active operating its biological and raw material specificity as competitive advantages.

Investigation of compounds that have not become subjects of active use of soybean yet only confirms the above. Moreover, several compounds have a certain antagonism or dual mechanism of action. Therefore, comprehensiveness is extremely important for soybean.

The opening of new market segments based on novel soybean products can be exemplified by the fact that 25% of US printing houses use soybean ink for inkjet printers (2 - 3% of the dye market for inkjet printers in the USA). The USA uses the innovative system of consumption as one of the most valuable indicators of the economy level.

Combination of high level production and innovative consumption is an important component of a competitive economy. That is why the methodological approaches, which we have developed for the modularity-

based formation of top-to-bottom technologies, can give answers to most of raised questions, provided their effective implementation. All of the above is quite well consistent with the increase in basic capacities (by more than 8.3 times over the last decade). Tellingly, the workload of processing capacities reached 60-70% at best (on average 40 - 50%), even though each processed ton of soybean gives profit up to $ 100.

For Ukraine, the main problematics is discernible when it comes to incompleteness of the domestic consumption system and of adapted rules of the road. Today, it is premature to have a conversation about active (at Asian levels) use of soybean in the diet of Ukrainians.

Conclusions

Taking into account the strategic importance of soybean for Ukraine, a comprehensive approach with transition of development and production to the level of standardized raw material resources and transfer of top-to-bottom technologies is needed.

From the perspective of the national security of Ukraine and effective fulfillment of competitive advantages, the principle of cross-cutting coordination and integration of soybean into processing, technical and food boat branches was highlighted as an important component.

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Using the methodology of modularity-based formation of top-to-bottom technologies with required compensatory actions and active cooperation opens new organizational approaches and significant prospects to fulfill the genetic potential of soybean productivity.

Fig. 1. Analysis of the Positioning Dynamics of Countries in Terms of Soybean Production in Comparison with Ukraine, Times 2009 - 2012, (calculated from the USDA data, 2013). - USA; - India; - Brazil; - Russia; - Argentina; - EU-27; - China

Analysis of Soybean Yield Stability, 1999 - 2012 (calculated from the data of USDA, FAO and State Statistics Service of Ukraine, 2013)

Soybean yield (1999 - 2012)				
Minimum		Average multi- year, t/ha	Maximum	
t/ha	Deviation from the multi-year average, %		t/ha	Deviation from the multi-year average, %
0.83	52.0	Russian Federation 1.04	1.35	29.8
1.01	20.8	Ukraine 1.39	2.04	46.7
2.28	15.5	USA 2.70	2.93	8.5

Fig. 2. Analysis of the Positioning Dynamics of the USA and Russian Federation in Terms of Soybean Yield in Comparison with Ukraine, Times 1999 - 2012, (calculated from the data of USDA, FAO and State Statistics Service of Ukraine, 2013).
- USA, - Linear (USA); - Russian Federation - Linear (RF)

Fig. 3. Soybean Cultivation Zones in Ukraine:
- Forest-Steppe; - Steppe; - Woodlands

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