Al-Farabi Kazakh National University (KazNU)

Faculty of Biology and Biotechnology

DISCIPLINE: «Modern Problems of Plant Genetics»

Lecture 9

Impact of Genetic engineering in agriculture: zero hunger, achieving food security and nutrition and promoting sustainable agriculture.

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Aim of the lesson:

familiarization with future of agriculture and food: Sustainable Approaches to Achieve Zero Hunger.

Main questions:

1. **Applications of Biotechnology in Food and Agriculture.**
2. **The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.**
3. **Modern crop breeding for future food security.**
4. **Biofuel.**
5. **Future Prospects.**

* Applications of Biotechnology in Food and Agriculture.

- Genetic modification of crops has substantially focused on improving traits for desirable outcomes. It has resulted in the development of crops with enhanced yields, quality, and tolerance to biotic and abiotic stresses. With the advent of introducing favorable traits into crops, biotechnology has created a path for the involvement of genetically modified (GM) crops into sustainable food production systems.

- **Are Genetically Modified Crops the Answer to World Hunger?**
- Hunger is a major world crisis for which a solution has not yet been found. Since their advent, genetically modified crops have been hailed as the key to solving world hunger.

* Applications of Biotechnology in Food and Agriculture.

- GM crops are plants that have been modified, using genetic engineering, to alter their DNA sequences to provide some beneficial trait. For example, genetic engineering can improve crop yield, resulting in greater production of the target crop.

- Scientists can also engineer pest-resistant crops, helping local farmers better withstand environmental challenges that might otherwise wipe out a whole season of produce. Crops can even be engineered to be more nutritious, providing critical vitamins to populations that struggle to get specific nutrients needed for healthy living.

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* The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.

- Established in 2015, the United Nations Sustainable Development Goals (SDGs) are a global call to action designed to eliminate poverty while protecting our planet to the 2030.

- (1) The foundational SDG 2, Zero Hunger, aims to “End hunger, achieve food security and improved nutrition and promote sustainable agriculture.”

- (2) In 2022, the American Chemical Society (ACS) initiated a new five-year project entitled the ACS Campaign for a Sustainable Future Strategic Initiative.

* The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.

- **Known as Zero Hunger SDG2 seeks to eradicate hunger, increase food security, enhance nutrition, and advance sustainable agriculture by the year 2030.**

- **In addition to addressing the urgent global challenge of ensuring that everyone has access to enough, safe, and nourishing food, it also supports environmentally friendly farming methods.**

* The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.

- One of their first major activities was a Zero Hunger Summit (https://www.acs.org/sustainability/zero-hunger-summit.html), a multiday virtual event, which resulted in a Discovery Report entitled “How will chemistry solve world hunger?”

- (3) highlighting the need for rapid innovation and the development of sustainable production methods.

* The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.

- **Hunger and undernourishment are problems affecting many millions around the world, and the problem is now increasing after decades of progress and as one of the postpandemic consequences. “Our planet has provided us with tremendous resources, but unequal access and inefficient handling leave millions of people malnourished”.**

- **(4) Zero Hunger should be a priority for governments with a focus on advancing science along with societal and economic development. In developing countries, the challenge is to ensure the stable food production from farm to table, while in many developed countries, the needs are related to healthier eating and reducing food waste.**

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* End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

- Goal 2 seeks sustainable solutions to end hunger in all its forms by 2030 and to achieve food security. The aim is to ensure that everyone everywhere has enough good-quality food to lead a healthy life. Achieving this Goal will require better access to food and the widespread promotion of sustainable agriculture.

- This entails improving the productivity and incomes of small-scale farmers by promoting equal access to land, technology and markets, sustainable food production systems and resilient agricultural practices. It also requires increased investments through international cooperation to bolster the productive capacity of agriculture in developing countries.

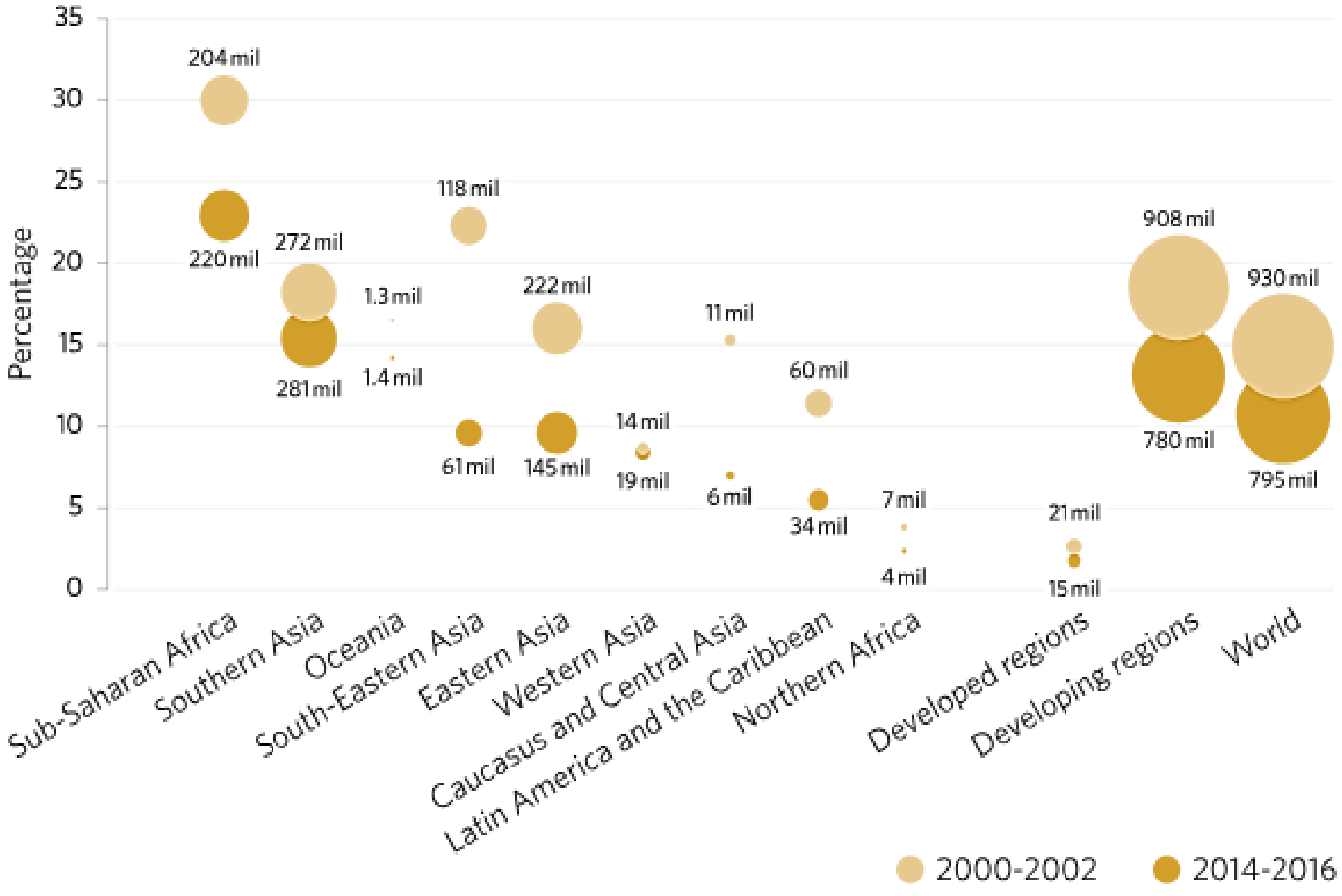
* The Future of Agriculture and Food: Sustainable Approaches to Achieve Zero Hunger.

- **Despite progress, more than 790 million people worldwide still suffer from hunger.**

- **The fight against hunger has seen some progress over the past 15 years. Globally, the proportion of undernourished people declined from 15 per cent in 2000-2002 to 11 per cent in 2014-2016. However, more than 790 million people still lack regular access to adequate food. If current trends continue, the zero hunger target will be largely missed by 2030.**

* **Number and proportion of undernourished people, 2000−2002 and 2014−2016 (millions and percentage)**

Note: Vertical position of the bubbles represents the percentage of the population that is undernourished. The size of the bubbles represents the number of undernourished people. The proportion of undernourished people is less than 5 per cent for Northern Africa and Developed regions for both time periods.



* Modern crop breeding for future food * security.

- Modern biotechnology provides a number of methods that scientists use to recognize and control the genetic structure of species for use in agricultural product development or processing.

- The implications of biotechnology includes, breeding of plants for raising and stabilizing yields by improving their ability to confront various pests, insects and other possible threats, to fight various conditions like drought and counter diseases that could attack and cold and soil acidity, biotechnology is also being applied for nutritional enhancement of various foods.

* **Modern crop breeding for future food**
* **security.**

Disease-Free Plants

Disease-free plants are a very practical applications of biotechnology, these could be produced by micropropagation method. One of the examples of such plants is banana.

Bananas are typically grown in countries where they emerge to be major source of income/employment and/or food.

Micropropagation **is a way to regenerate disease-free plantlets of bananas from tissues of healthy banana plants. It has all the possible benefits of being a revolutionary technique that is relatively inexpensive and easy to use.**

* Modern crop breeding for future food
* security.

Agriculture on acid soils

Lime can be applied to the soil to preserve the pH of the soil.
This process emerges to be excellent but is expensive and temporary as well.

Alternatively, it is possible to grow
improved cultivars which are tolerant of aluminum.

* Modern crop breeding for future food security.

Fortification of Crops

In developing countries or countries where there is a lot of shortage of food, fortified crops emerge to be an excellent food source which are supplemented with nutrients for rising malnourished children.

One of the examples of such fortified crops is 'Protato'. This, genetically modified potato, is being widely cultivated and used in India and provides approximately one-third to one-half more protein than a common potato.

In addition, this genetically modified potato also contains significant quantities of all essential amino acids, such as lysine and methionine. This 'Protato' could be a very potential food source in countries where potato is a major staple food [12]. Another example of such crops is golden rice. These genetically modified rice has a higher content of beta-carotene.

* Modern crop breeding for future food security.

Animal Feed

Genetically modified crops are practically being used in

developed countries. Such kind of crops have a very significant potential to provide more nutrients than the normal.

Reproduction in Aquaculture

Biotechnology has emerged to have great practical applications in aquaculture, biotechnology has helped to maximize the growth and production in the aquaculture.

Research is being continued in this field for better and harmless production of aquatic organisms suitable for human consumption.

* Modern crop breeding for future food security.

Pest Resistant Crops

Pest attack is one of the very common problem in a number of different crops all around the globe, these crops may include fodder crops or other crops for the purpose of getting food.

One the example of such crops is BT-Cotton.

The genes of *Bacillus thuringiensis* (Bt), a very common, are inserted in cotton crop in order for development of certain protein in it. The protein is very toxic to a number of different insects. With this aid of biotechnology, the developed BT-Cotton leads to a less pest attack ultimately leading to a significant more production.

Drought Resistant Crops

Targeted and short gun methods are two different two different but main techniques in genetic engineering. These techniques are applied in order to obtain transgenic plants that will possess the ability to confer drought resistance.

* Biofuel.

The prosperity of future is mainly based on the supply of equitable, secure, sustainable and affordable energy. Production of biofuel is one of the emerged trends in recent years. Biofuel could be an emerged and reliable substitute of fossil fuels. Six micro algae's strains were photosynthetically produced in a photo bioreactor.

Among these six micro algae, the Chlorella vulgaris strain is most dominant for the production of biodiesel. The Chlorella vulgaris has been used as feedstock. The quality of biofuel and productivity of lipids could be measured as a criterion for the selection of species to produce biodiesel.

* Future Prospects.

There is requirement of research work to disprove or prove the local scientists' claims against GM food consumption.

The layman should be questioned about potential dangers executed by GM food against human health and ecosystem, limited scientists can give response.

Why is so?? Major reason is the lack of research associated to these areas.

Consequently, GM food could be commercialized with the supreme confidence of scientists should to support food of GM technology and with making people argument about it.

- **Questions for monitoring the material being studied:**

1. **Applications of Biotechnology in Food and Agriculture.**
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3. **Modern crop breeding for future food security.**
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- **Recommended list of references:**

- 1. Шулембаева К.К., Токубаева А.А. Реконструкция генома мягкой пшеницы на основе хромосомной инженерии и отделенной гибридизации: монография. КазНУ им. аль-Фараби. - Алматы : Қазақ ун-ті, 2019. - 240 с.
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GOOD LUCK!