EFFICIENT COUNTERMEASURES: THE BASIS OF POST-CHERNOBYL REMEDIATION AND SUSTAINABLE DEVELOPMENT OF THE AFFECTED TERRITORIES OF THE REPUBLIC OF BELARUS

Presented by: professor, Dr. Viktor S. AVERIN
Contamination of Belarus with $^{137}\text{Cs}$ and $^{90}\text{Sr}$ (2001)

23% of the agricultural land has been contaminated with $^{137}\text{Cs} (>37\text{kBq/m}^2)$

10% - with $^{90}\text{Sr} (>5.5\text{kBq/m}^2)$

2% - with $^{238,239,241}\text{Pu} (>0.37\text{kBq/m}^2)$

Source: Chernobyl consequences: contamination of land, food products and countermeasures in Belarus - I. Bogdevitch
Public outreach and communication with local stakeholders other than authorities or agricultural/medical specialists was not a priority task in the initial period. The major objective back then was public health safety and protection.

During the first post-Chernobyl years any information relevant to the disaster and its consequences was disseminated in the first place amongst the officials of different national and local levels of governance involved in the post-accident response and recovery actions.

In that period there were other top-priority issues to be urgently addressed and emergency measures to be taken.

- Evacuation
- Large-Scale Decontamination
- Development of Radiation Control Systems
- Health and Social Protection
- Development and Implementation of Countermeasures in Agricultural and Forest Sectors
Decontamination

Decontamination should be **based on dose limits** established for this purpose.

1986: ambient dose 5-20 mR/h → Evacuation

In the initial period of decontamination in the USSR external radiation dose limits changed over time and depended on the category of personnel involved in the post-accident response actions.

In 1986 a dose limit was established which insured no deterministic effects of exposure. The pre-determined emergency standard was that of 250 mSv. Later it was changed down to 50 mSv, and after that, the life-span dose limit was set at 35 mSv.
## Decontamination in Belarus

### Intervention Levels

<table>
<thead>
<tr>
<th>Object of Decontamination</th>
<th>Gamma Radiation, ( \mu R/h ), or Beta Radiation, particle/min( \cdot )cm(^2)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Territories of pre-school facilities, schools and private houses</td>
<td>35-40 ( \mu R/h )</td>
<td>Removal of 25-cm soil layer</td>
</tr>
<tr>
<td>Working office and operational places:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- permanent being</td>
<td>50 ( \mu R/h )</td>
<td>Cleaning with detergents and water</td>
</tr>
<tr>
<td>- temporary being</td>
<td>100 ( \mu R/h )</td>
<td></td>
</tr>
<tr>
<td>Open areas within settlements (stores, public places)</td>
<td>60 ( \mu R/h )</td>
<td>Removal of 25-cm soil layer</td>
</tr>
<tr>
<td>Inner surfaces of houses; transportation means</td>
<td>20 particle/min( \cdot )cm(^2)</td>
<td>Cleaning with detergents and water</td>
</tr>
<tr>
<td>Roofs of buildings</td>
<td>40 particle/min( \cdot )cm(^2)</td>
<td>Cleaning with detergents and water</td>
</tr>
</tbody>
</table>
Decontamination

500 settlements of Belarus were decontaminated during 1986-1989 period, 60% – in 2-3 stages.

- removal of contaminated soil and "clean" refilling;
- dismantling of objects not subjected to decontamination;
- asphalting of streets, roads and pavements;
- roof replacement;
- waste disposal.

7.3 million m$^3$ of soil was cut off and replaced with 1.57 million m$^3$ of clean soil.
Communication and Trust.
Some Facts from the Chernobyl Experience

Chernobyl and Fukushima similar trust build-up problems

By the end of 1986, a special plan of actions was developed for extension of radiological knowledge primarily in the farm sector:

- lectures and meetings of scientists with stakeholders in contaminated areas;
- radio and television broadcasts;
- popular science editions;
- film production;
- distribution of posters and radiology-related printed handouts.
In the framework of radiation protection and target-oriented implementation of protective measures

Two categories of population should be distinguished when choosing the most appropriate strategy of protective measures for reducing the internal dose in the long term

**Category 1:** Residents of contaminated areas who consume foodstuffs of local production

**Objective:** Reduction of individual effective doses received through the consumption of local contaminated foodstuffs

**Category 2:** People who live in clean areas, but may consume foodstuffs produced in contaminated areas

**Objective:** Reduction of the collective radiation dose associated with export of foodstuffs produced in contaminated areas
Assess the radiation situation and determine the levels of ionizing radiation exposure

Exclude production and storage of foodstuffs and raw materials with radionuclide concentration levels above the specified limits

Evaluate the effectiveness of protective measures, provide their optimal and targeted implementation

Develop a sound *strategy* of recovery actions
<table>
<thead>
<tr>
<th>Activity</th>
<th>During the first 5 years</th>
<th>After the first 5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Treatment (real tillage, deep tillage)</td>
<td>5,0</td>
<td>1,5</td>
</tr>
<tr>
<td>Lime Treatment (lime rate: 1,5 Hr)</td>
<td>4,0</td>
<td>2,0</td>
</tr>
<tr>
<td>Application of organic fertilizers</td>
<td>2,5</td>
<td>2,0</td>
</tr>
<tr>
<td>Application of phosphate fertilizers</td>
<td>1,5</td>
<td>0,5</td>
</tr>
<tr>
<td>Application of potassium fertilizers</td>
<td>3,5</td>
<td>3,0</td>
</tr>
<tr>
<td>Optimization of nitrogen fertilization rates</td>
<td>2,5</td>
<td>1,5</td>
</tr>
<tr>
<td>Selection of crop types with minimal uptake ability</td>
<td>30</td>
<td>5,0</td>
</tr>
<tr>
<td>Root improvement</td>
<td>6,0</td>
<td>3,0</td>
</tr>
<tr>
<td>Surface improvement</td>
<td>3,0</td>
<td>1,5</td>
</tr>
<tr>
<td>Selection of grass mixtures</td>
<td>3,0</td>
<td>2,0</td>
</tr>
</tbody>
</table>

Effectiveness of Agrotechnical and Agrochemical Techniques Towards Reduction of $^{137}$Cs Uptake by Agricultural Produce
Gradual Revision (reduction) of Permissible Levels for $^{137}$Cs Content in Food, Bq/kg

TPLs – Temporary Permissible Levels
RPLs – Republican Permissible Levels (RPLs-99 is a current national standard for $^{137}$Cs)
Internal Radiation Doses of the population of Belarus depending on particular RPLs, mZv/year

TPLs – Temporary Permissible Levels
RPLs – Republican Permissible Levels (RPLs-99 is a current national standard for $^{137}$Cs)
Crop Yield Processing and $^{137}$Cs Content in the End Products, %