

# NATIONAL ACADEMY OF SCIENCES OF BELARUS Research Institute of Radiology (RIR)



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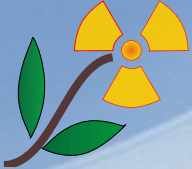
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## **EXPERIENCE WITH THE MANAGEMENT OF LONG-TERM EXPOSURE AFTER A NUCLEAR ACCIDENT**

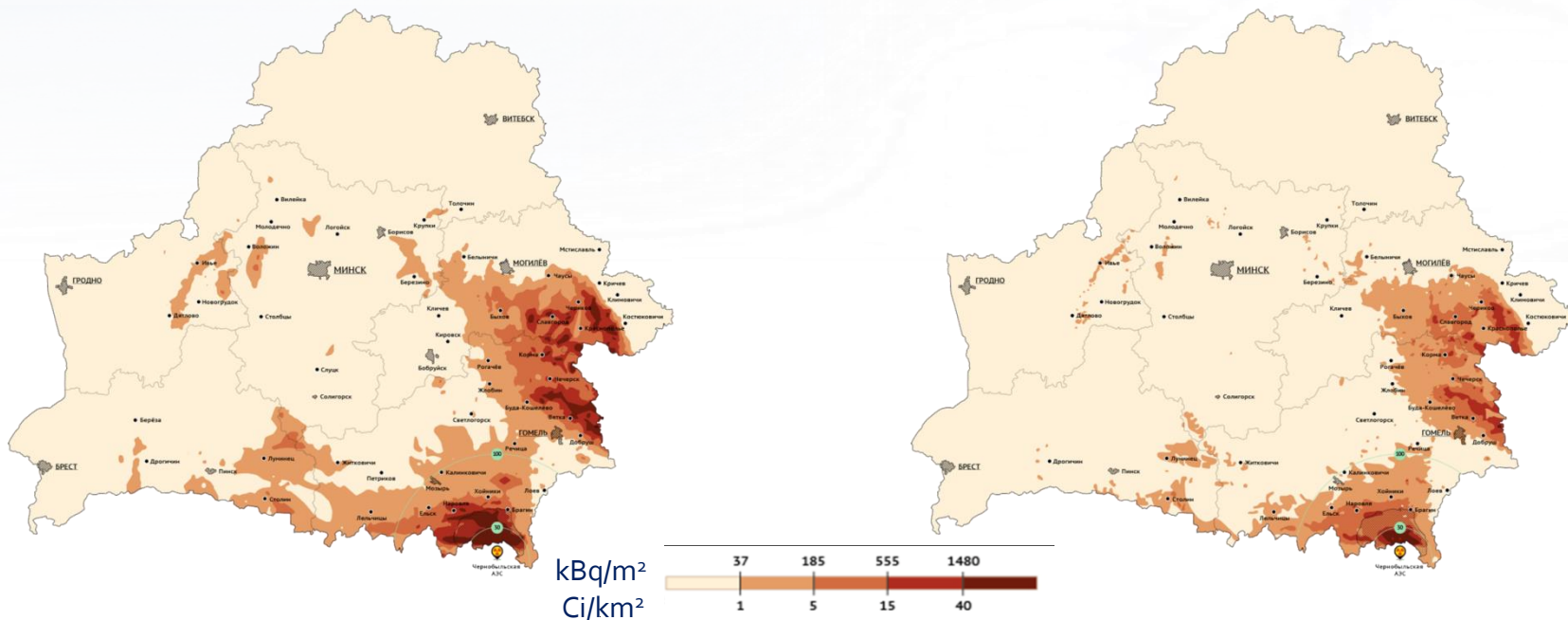
Speaker:

Victoria Drobyshevskaya

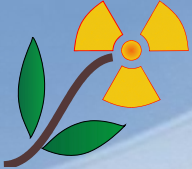


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**Research Institute of Radiology (RIR)**

**$^{137}\text{Cs}$  deposition densities in Belarus**

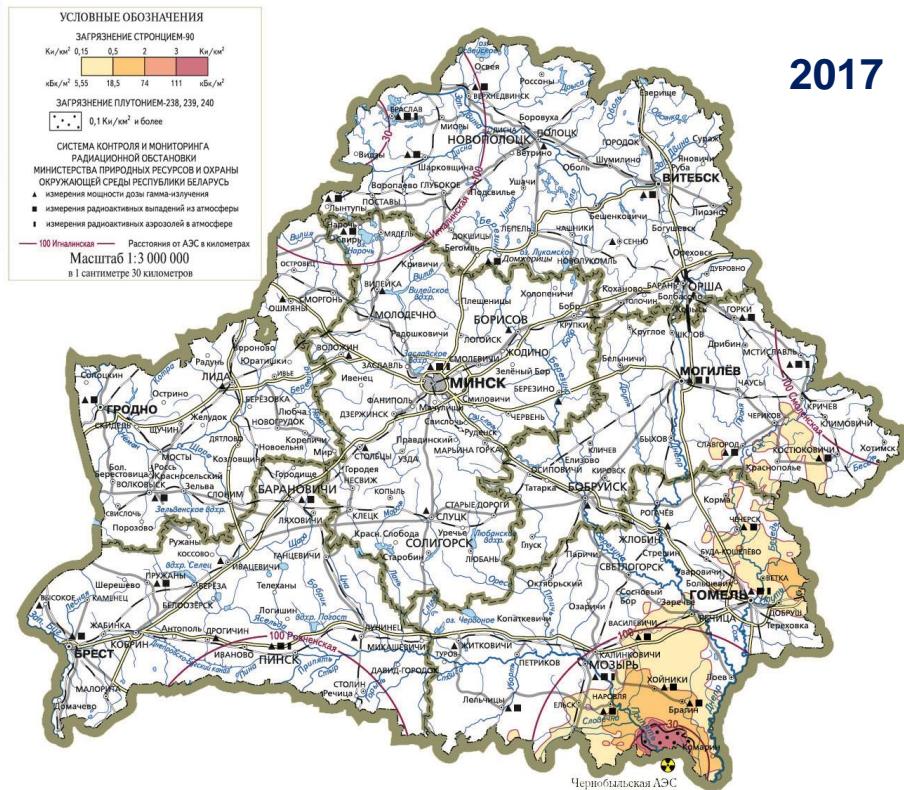


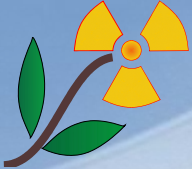
The present-time area of radionuclide contamination, due to natural decay, is reduced 1.7-times as against initial deposition. Total contaminated area occupies 13 % Belarus territory.



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## Belarus contamination by strontium-90 and plutonium--238,239,240





# Research Institute of Radiology (RIR)

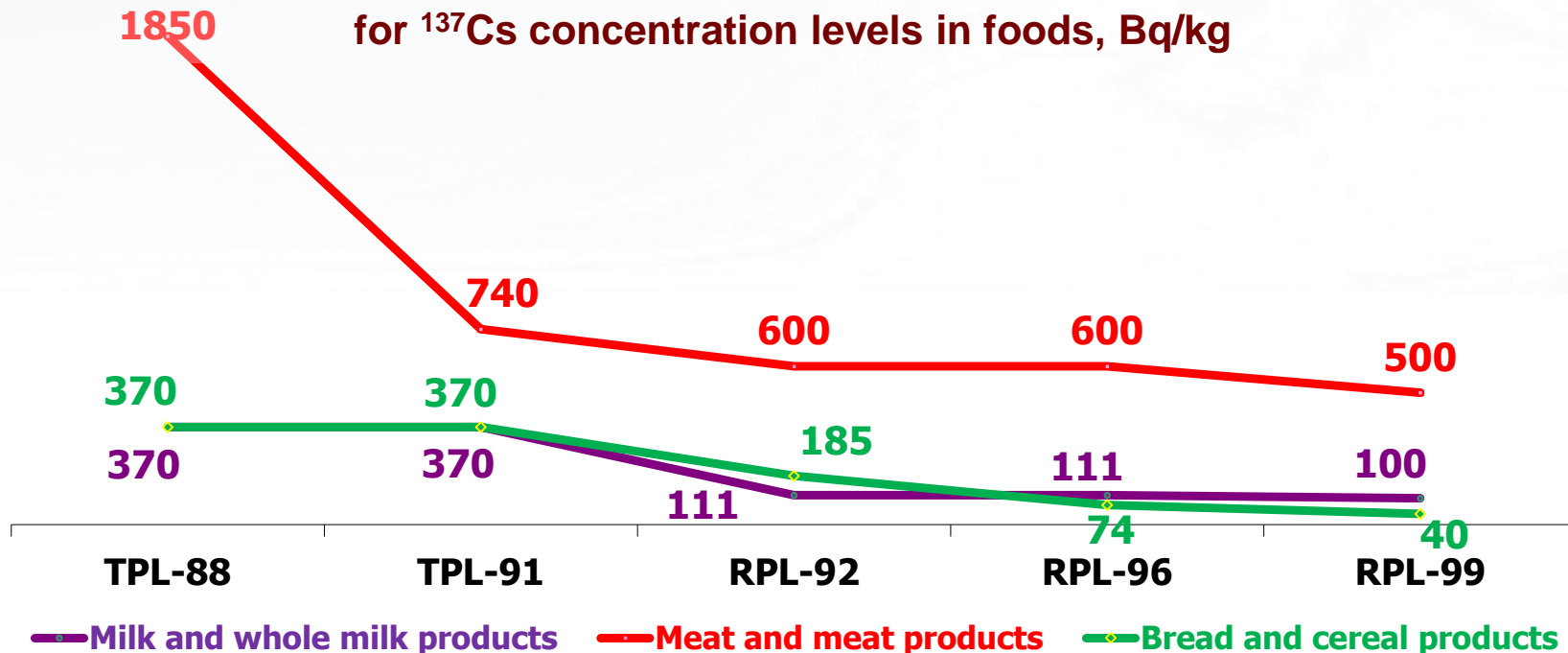
## Reference Levels for $^{137}\text{Cs}$ concentrations in foods (Bq/kg, Bq/l)

Product	EC	Belarus	Russian Federation	Ukraine	CUSTOMS UNION TP TC 021/2011
<b>Year of adoption</b>	<b>1986</b>	<b>1999</b>	<b>2001</b>	<b>1997, 2006</b>	<b>2011</b>
Bread, flour and cereal products	600	40	40–60	20-50	40
Milk	370	100	100	100	100
Baby food	370	37	40-60	40	40
Dairy products	600	50–200	100–500	100-500	100
Meat and meat products	600	180–500	160-180	200-400	200
Fish	600	150	130	150	130
Eggs	600	-	80	100	-
Vegetables, fruits, potatoes, roots	600	40–100	40–120	40–70	80



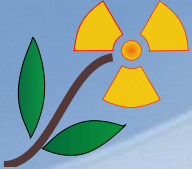
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**Revision of the National Standards  
for  $^{137}\text{Cs}$  concentration levels in foods, Bq/kg**



TPLs – Temporary Permissible Levels

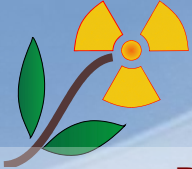
RPLs – Republican Permissible Levels (RPL-99), current national standard for  $^{137}\text{Cs}$  concentration levels in foodstuffs

**Permissible Levels for  $^{90}\text{Sr}$  Concentrations in Food, Bq/kg, Bq/l**

<b>FOOD PRODUCT</b>	<b>BELARUS RPLs-99</b>
Drinking water	0,37
Milk and whole milk products	3,7
Condensed and concentrated milk	not defined
Rennet cheese and cream cheese spread	not defined
Butter	not defined
Fish and fish products	not defined
Bread and cereal products	3,7
Potatoes	3,7
Vegetables	not defined
Baby food of any type (ready-to-eat)	1,75

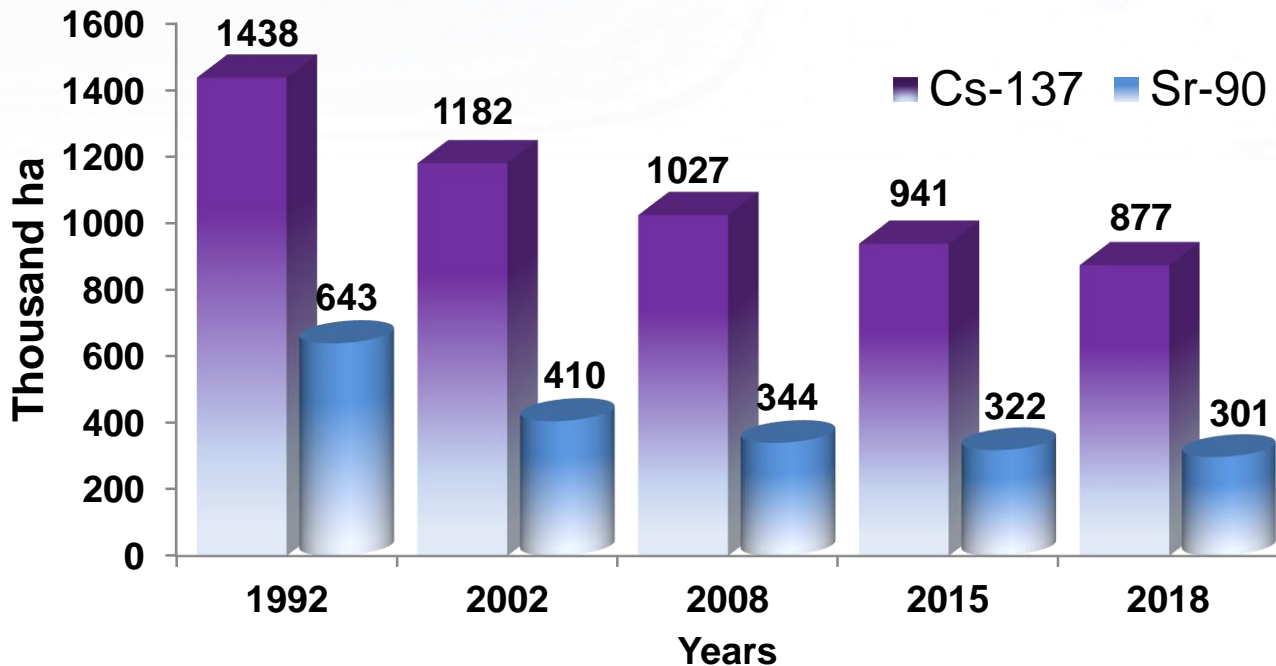


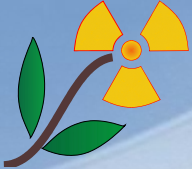
<b>FOOD PRODUCT</b>	<b>CUSTOMS UNION TP TC 021/2011</b>
Drinking water	<b>not defined</b>
Milk and whole milk products	<b>25</b>
Condensed and concentrated milk	<b>100</b>
Rennet cheese and cream cheese spread	<b>100</b>
Butter	<b>60</b>
Fish and fish products	<b>100</b>
Bread and cereal products	<b>20</b>
Potatoes	<b>40</b>
Vegetables	<b>40</b>
Baby food of any type (ready-to-eat)	<b>25</b>



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**Dynamics of contamination of agricultural lands in Belarus during 1992-2015  
(cesium-137 > 37 kBq/m<sup>2</sup>, strontium-90 > 5,5 kBq/m<sup>2</sup>)**





## System of protective actions in agricultural production

### Organizational

- Exclusion of lands from using;
- Change of agricultural specialization;
- Optimization of land usage and crop structure;
- Creation of cultural pastures and hayfields.

### Technological

- Cleaning and washing of foods;
- Prior technological processing;
- Advanced technological processing.

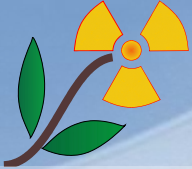
### Agrochemical

- Lime treatment of acid soils;
- Application of phosphoric and potash fertilizers;
- Application of organic fertilizers;
- Optimization of plant nutrition;
- Micro-fertilizers;
- Plant protection.

### Veterinary

- Feed rations for different animals, based on their age and production purposes;
- Pasture control over the cattle raised for whole milk and raw milk production;
- Application of cesium binders and ferrocene additives.

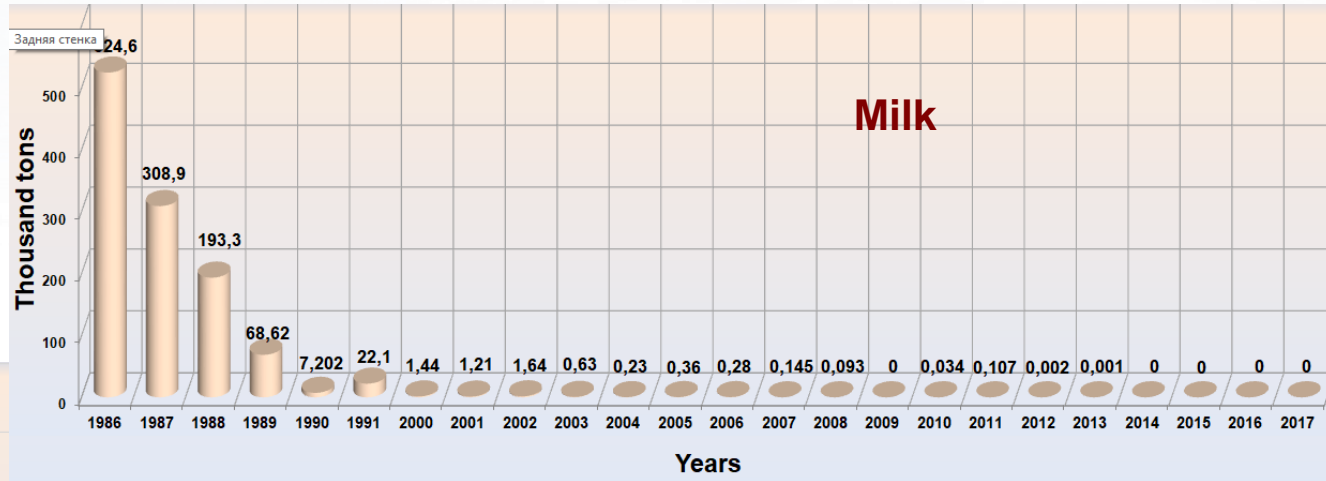
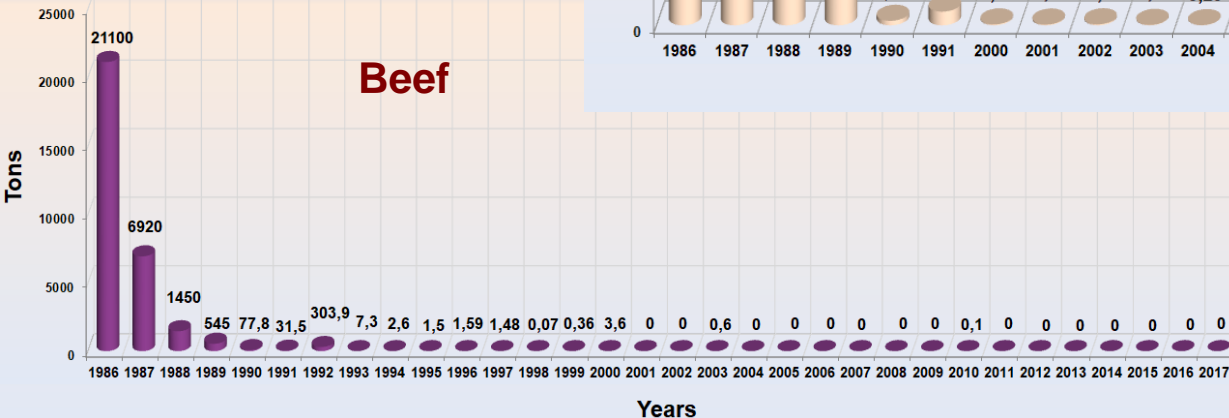




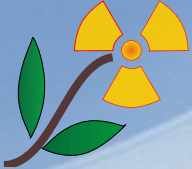
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## Dynamics of $^{137}\text{Cs}$ contamination above reference levels in milk and beef delivered to processing facilities from affected areas (public agri-sector)

Starting from 2014, there were no cases of  $>100$  Bq/l  $^{137}\text{Cs}$  concentration levels in milk delivered to dairy processing plants from affected areas.



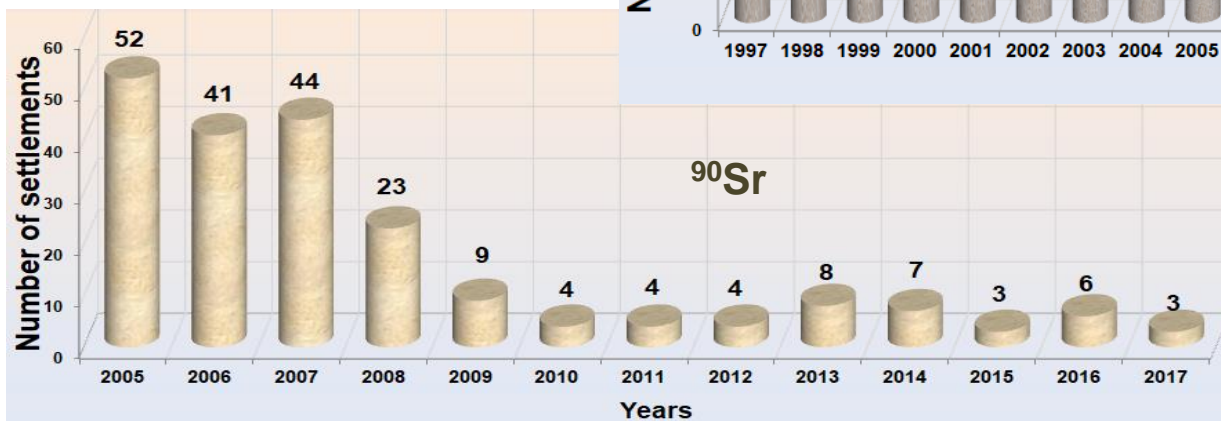
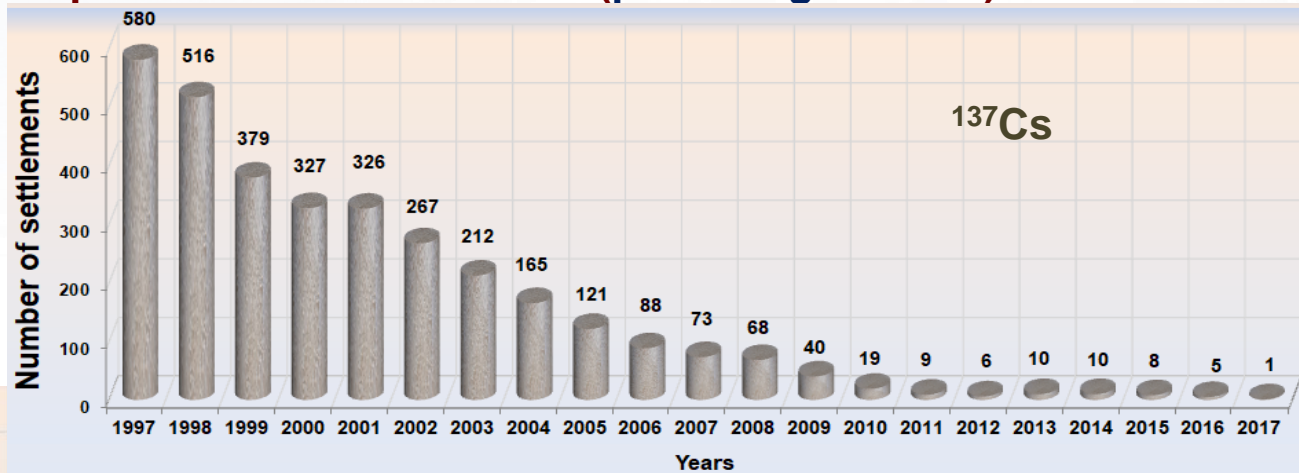
From 2011 on, meat processing facilities receive regulatory-clean beef with no excess cases.

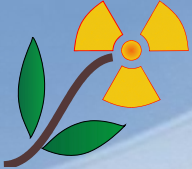


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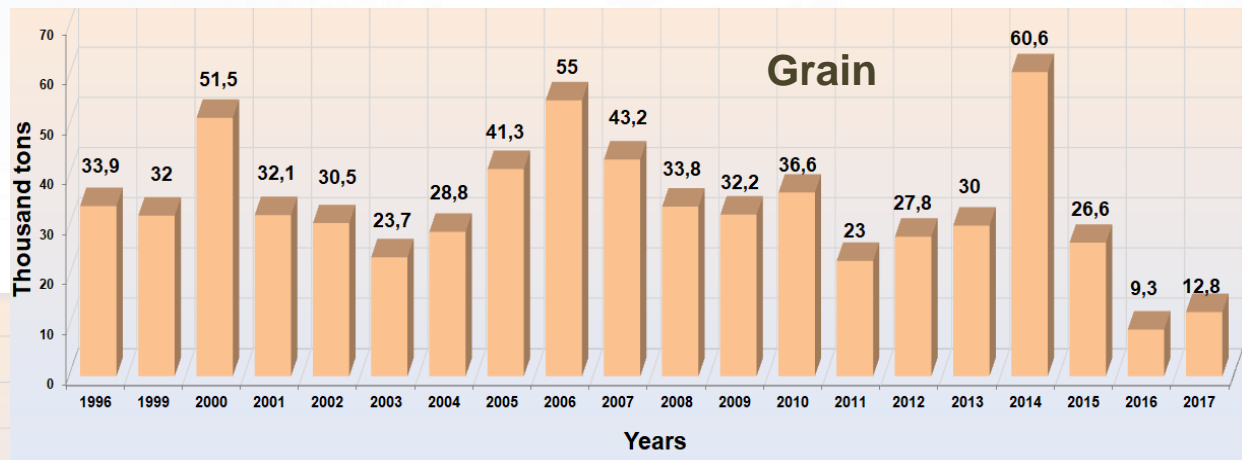
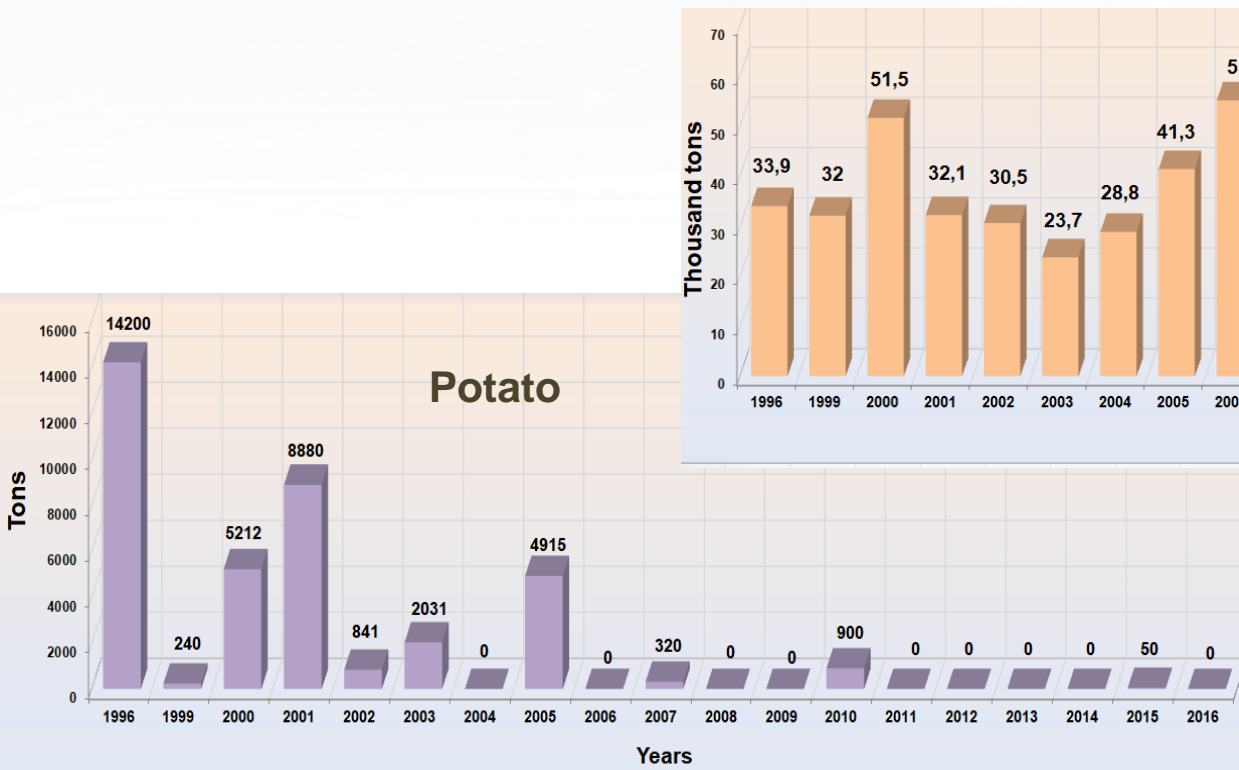
## Number of villages with detected cases of $^{137}\text{Cs}$ and $^{90}\text{Sr}$ contamination above the national permissible levels in milk (private agri-sector)

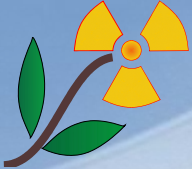
For the past six years, sanitary inspections detect excess levels of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  in milk samples annually only in 6-9 villages





## Volumes of grains and potato contaminated by $^{90}\text{Sr}$ above national permissible levels





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## Agro-technical and agro-chemical techniques towards reduction of $^{137}\text{Cs}$ uptake by agricultural produce

### $^{137}\text{Cs}$ reduction factor

#### Ploughlands



Soil Treatment (real tillage, deep tillage)

Lime Treatment

Application of organic fertilizers

Application of phosphate fertilizers

Application of potassium fertilizers

Optimization of nitrogen fertilization rates

Selection of crop types with minimal uptake ability

Root improvement (creation of new grasslands)

Surface improvement (preserving natural grasslands with renewal of grass stands+fertilizers)

Selection of grass mixtures

During the first  
5 years

Following  
the first 5 years

5,0

1,5

4,0

2,0

2,5

2,0

1,5

0,5

3,5

3,0

2,5

1,5

30

5,0

6,0

3,0

3,0

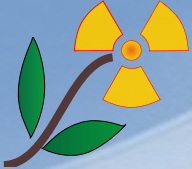
1,5

3,0

2,0

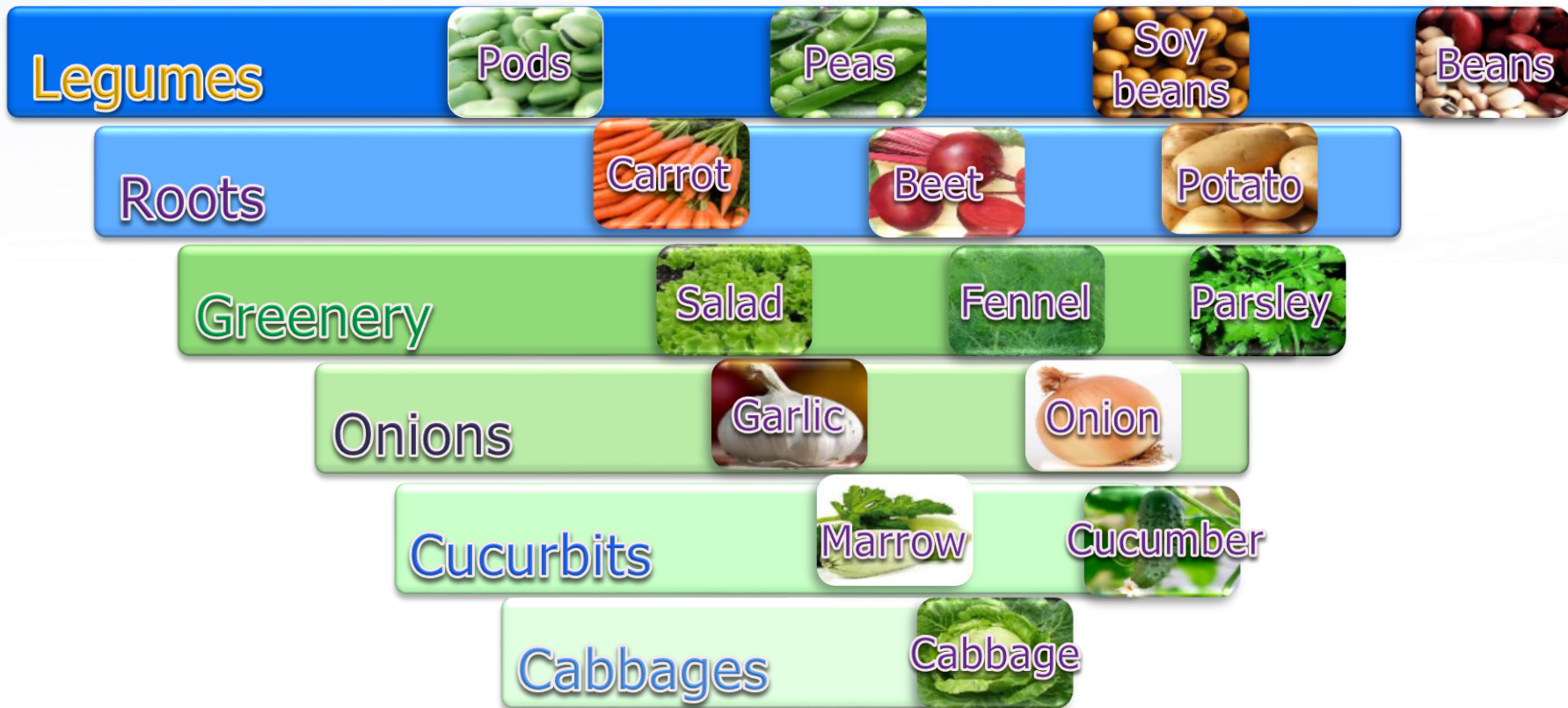
#### Meadows

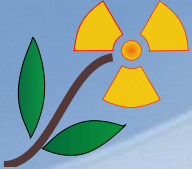




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<sup>137</sup>Cs uptake by vegetables (in descending order)





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## Application of cesium-binders



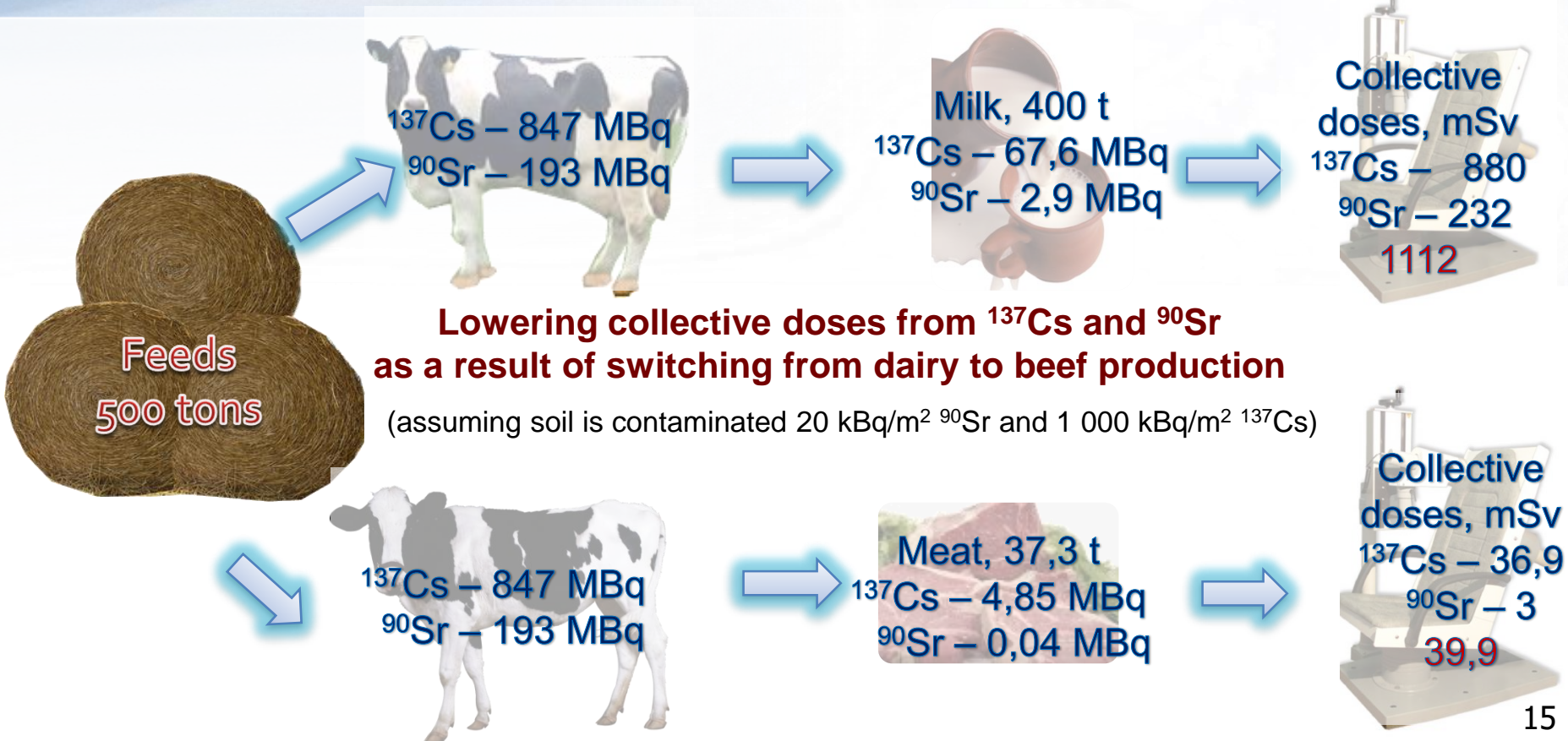
**Ferrocene**  
95%  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$   
+5%  $\text{KFe}[\text{Fe}(\text{CN})_6]$

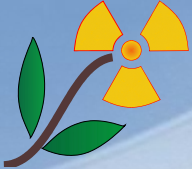
**Giese Salt**  
 $\text{NH}_4\text{Fe}[\text{Fe}(\text{CN})_6]$

**Nigrovich salt**  
 $\text{KFe}[\text{Fe}(\text{CN})_6]$

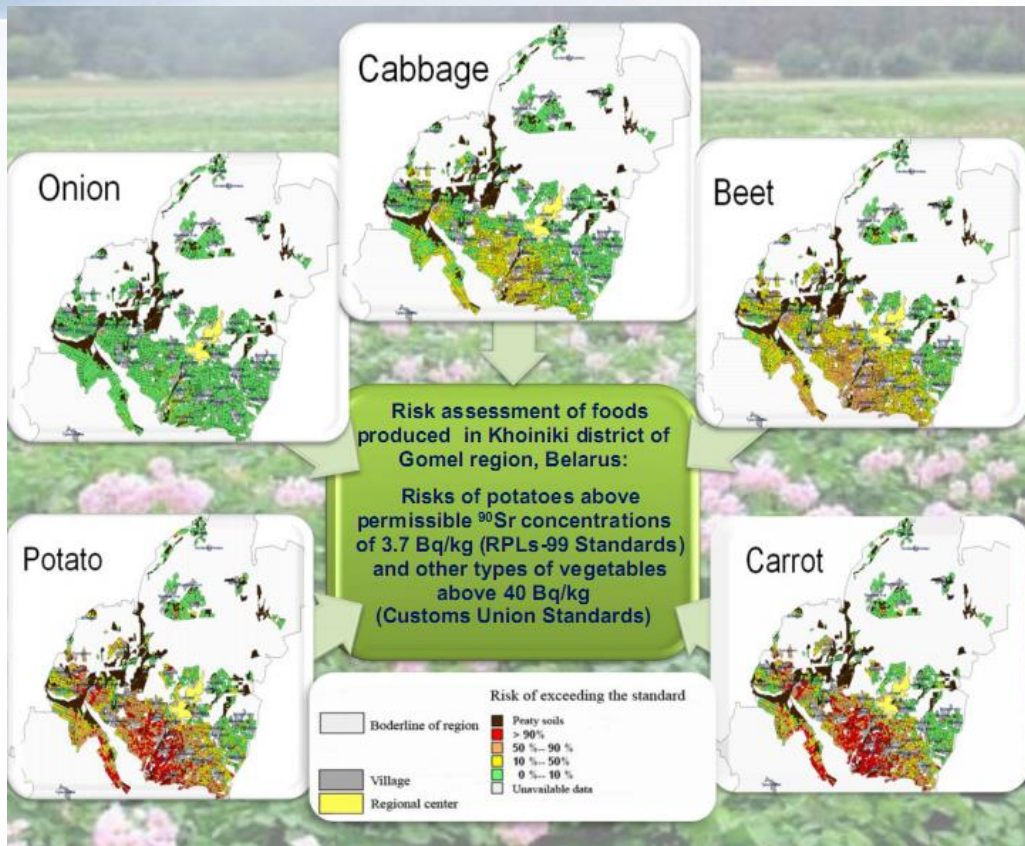


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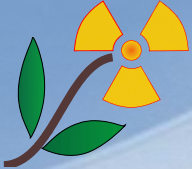


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**RISKAgro** is a special forecast tool designed by RIR to make rapid, real-time predictions of radiation levels in major vegetables and assess risk of output contamination levels above the existing national and other food safety standards.



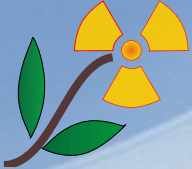


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**AgroOptimization tool: efficient use of arable lands**

This tool is used for:

- rapid assessment of a crop farm potential with account for its available resources
- determination of the most efficient farm specializations
- scientifically-grounded optimization of crop planting to increase production outputs and improve the operating efficiency of a farm enterprise



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## Differentiated use of feeds containing different contamination levels: Ration+ Calculation Model

This tool is designed to help farmers to optimize animal feeding rations using different types of forages containing different levels of  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$  contamination, in order to be able to produce safe animal foods.



Програмное обеспечение разработано для составления рационов кормления КРС для дифференцированного использования кормов с различной степенью радиоактивного загрязнения

**Ration+**

Програмное обеспечение создано в результате реализации Программы совместной деятельности по преодолению последствий чернобыльской катастрофы в рамках Союзного государства на период до 2016 года в рамках выполнения

НИУП "ИНСТИТУТ РАДИОЛОГИИ"

Инструкция по установке  
и вводу в эксплуатацию  
программы

© НИУП "Институт радиологии" Гомель, Беларусь

Данные о наличии кормов в хозяйстве    Рацион кормления    Результаты

Лактирующие коровы    Сухоостойные коровы    Нетели    Откорм    Телки до 12 месяцев    Бычки до 12 месяцев    Телки 13-18 месяцев    Первотелки

Количество, гол	Средняя масса, кг	Среднесуточный привес, г/сут
150	550	700

Рацион кормления

Рацион 1 (сплошной)     Показание прикормочной дозиметрии, Бк/кг

Рацион 2 (сенажный)     Содержание Cs-137 в предыдущем рационе, Бк

Рацион 3 (смешанный)   

без ферроцианидов    Предполагаемый срок до сдачи, сутки   

с ферроцианидами       

Тип корма	Количество корма, кг	Содержание Cs-137, Бк/кг	Содержание Sr-90, Бк/кг	Вид корма/Место хранения
Сено	3.3	689	117	Сено разотравное
Сенаж	4.4	280	80	Яма 2
Силос	11.1	43	33	Яма 5
Солома	2.2	120	32	Ржаная
Концентраты	3.3	18	8	Крмбикорм КК60
Корнеплоды	4.4	10	3	Свекла кормовая


Кормовых единиц	Переваримый протеин, г	Сахар, г
Рекомендова...	900	720
Реальное со...	657.1	663.4
Разница	-242.9	-56.6

Содержание радионуклидов в рационе

Содержание Cs-137 в рационе - 4350.4Бк/кг; Содержание Cs-137 в рационе в норме

Содержание Sr-90 в рационе - 1214.4 Бк/кг

© НИУП "Институт радиологии" Гомель, Беларусь



**ПРОГРАММА СОСТАВЛЕНИЯ РАЦИОНОВ КОРМЛЕНИЯ КРС ДЛЯ ДИФФЕРЕНЦИРОВАННОГО ИСПОЛЬЗОВАНИЯ КОРМОВ С РАЗЛИЧНОЙ СТЕПЕНЬЮ РАДИОАКТИВНОГО ЗАГРЯЗНЕНИЯ**



## Radiation monitoring system in Belarus

State control and monitoring

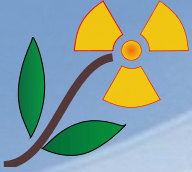


Production-stages  
monitoring



Local monitoring

Created and maintained to avoid production of foods, feeds and raw materials above permissible contamination levels



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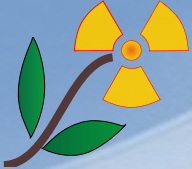
## Radiation monitoring system in Belarus

### Authorities responsible for nation-wide control :

- Ministry for Emergency Situations
- Health Ministry
- Standardization Committee
- Ministry of Natural Resources and Environmental Protection

### Authorities responsible for industrial control :

- Ministry of Agriculture and Food
- Ministry of Forestry
- Ministry of Housing
- Belarusian Republican Community of Consumer Cooperatives

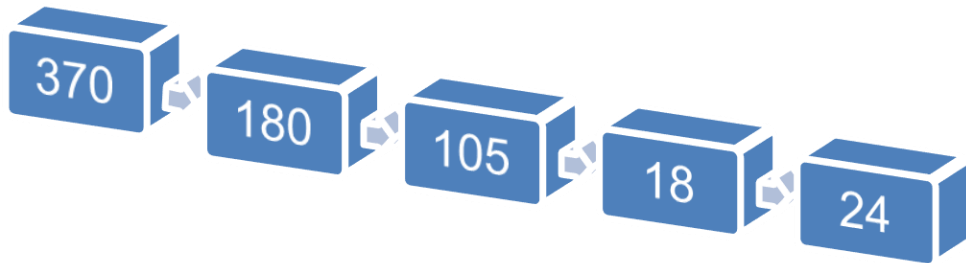


# Research Institute of Radiology (RIR)

## Monitoring at the local level

### Centers for Practical Radiological Culture (CPRCs)

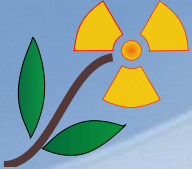
1992 → 1995 → 2003 → 2010 → 2018



The CPRCs are equipped with modern instrumentation for measuring radiation in foodstuffs and other environmental samples, as well as for measuring ambient dose rates

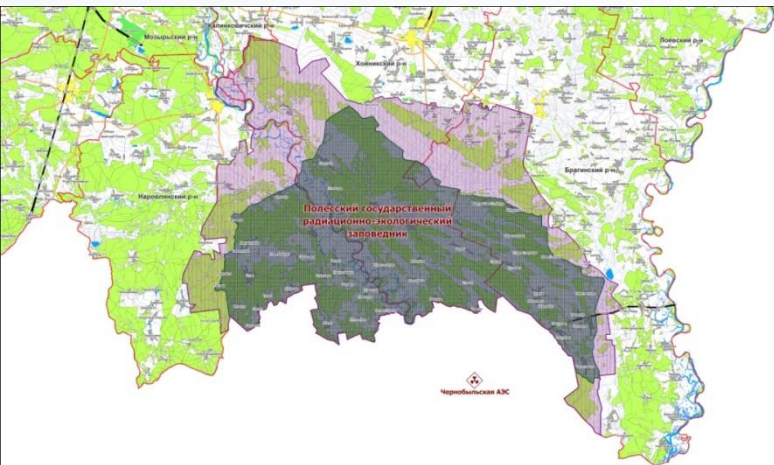


**Establishment and maintenance of the Centers for Practical Radiological Culture in affected areas of Belarus**



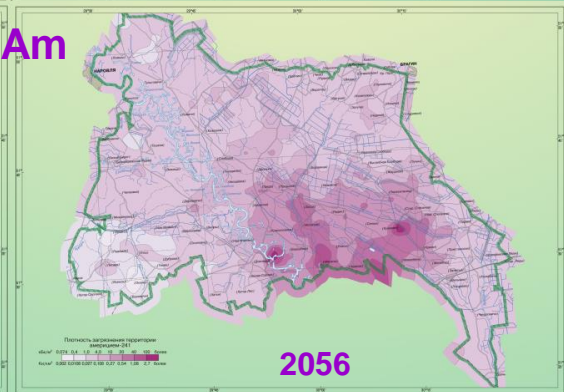
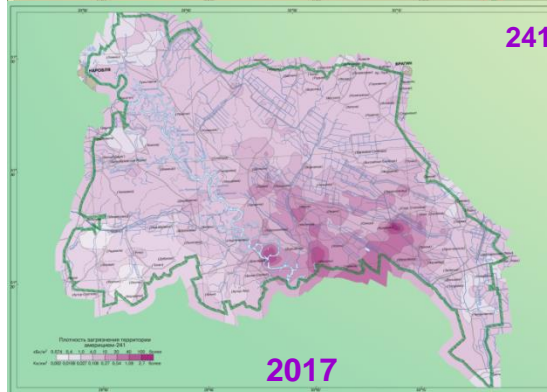
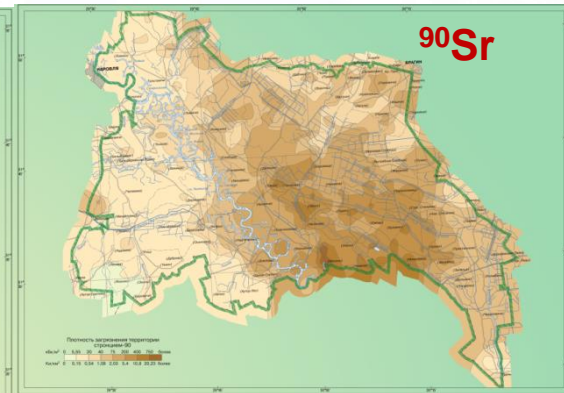
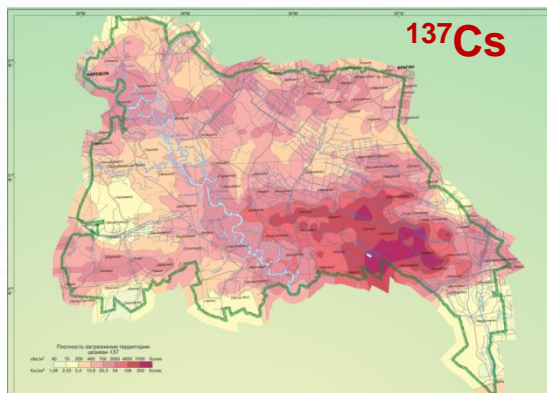
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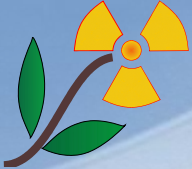
**Polesie State Radiation-Ecological Reserve (PSRER)**



**Total PSRER area: 216 000 hectares**

**This sanctuary area embodies nearly 1/3  
of all radioactive cesium,  
> 70 % strontium and 97 % plutonium  
deposited in Belarus after ChNPP accident**



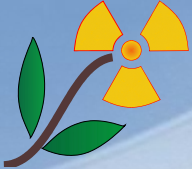


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## Polesie State Radiation-Ecological Reserve (PSRER)

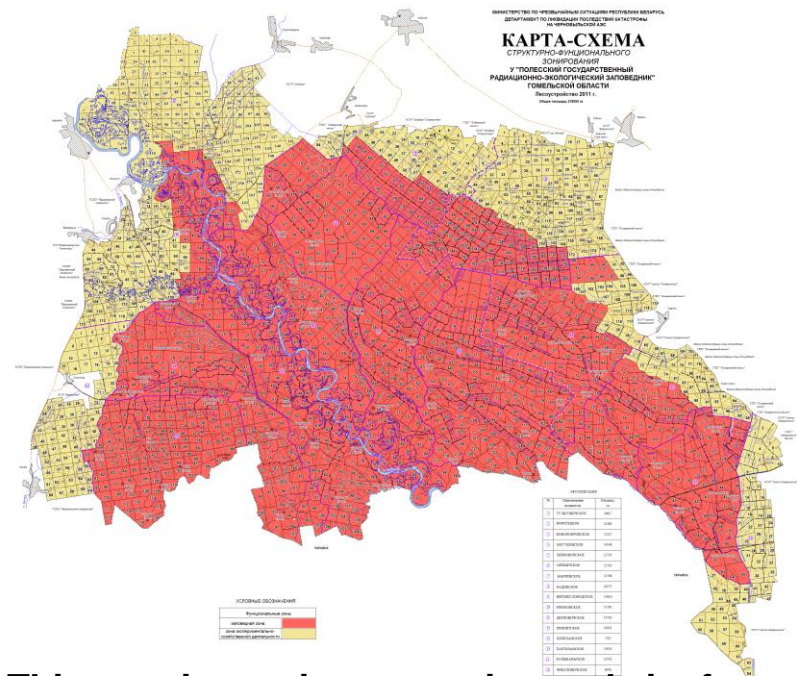


No human presence and no anthropogenic activities altered ecological conditions of this sanctuary resulting in thriving abundance of habitual and very rare species of animals and plants, which now have formed here their sustainably reproductive populations.



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**Radiation-Ecological Reserve: unique grounds for science and experimental activities**



sanctuary  
(147.7 thous. ha)

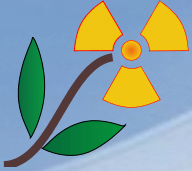


experimental grounds  
(68.4 thous. ha)



This area is a unique experimental site for studying the effects of radioactive contamination on natural ecosystems and former agricultural lands. Reserve's experimental facilities include the experimental grounds for wood processing, crop planting, horse farming and bee keeping





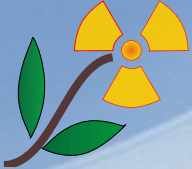
## Summary and conclusions

Post-accident experience of Belarus following the Chernobyl NPP disaster has shown that agricultural protective measures were, in general, highly effective: about 40 percent averted internal radiation dose.

Implementation of countermeasures in agriculture revealed critical areas with prevailing boggy, sandy and peaty soils, where even relatively low soil contamination by long-lived radionuclides can lead to significant contamination of crops and animal products due to the increased transfer of radionuclides from soil into plants.

Protective measures such as improving soil fertility and maintaining soil properties at their optimal level are strategically important because of their long-term effect on ensuring regulation-wise clean food products.

Information-sharing and direct involvement of rural residents in the recovery processes and decision-making is an important added-value factor that contributes to overall optimization of protective measures and improvement of the life quality.



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## Research Institute of Radiology (RIR)



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Web: [www.rir.by](http://www.rir.by)

# Thank you for your kind attention!