

***The Consequences of Chernobyl
Accident in the Agriculture of Zhytomyr
region and counter-measures against
them***

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UKRAINE IS THE EPICENTRE OF CHERNOBYL NUCLEAR CATASTROPHE



- ✓ As a result of Chernobyl accident there are 6,7 million hectares of territories polluted, among them 1,2 million hectare of agricultural grounds with density of radioactive pollution of the soil by ^{137}Cs from above 37 KBq /m².
- ✓ 130,6 thousand hectares of agricultural grounds which have been withdrawn from economic use still require rehabilitation and returning in production.
- ✓ On the polluted by radionuclides territories there are 2161 settlements in which live over 3 million people, from them 600 thousand children.



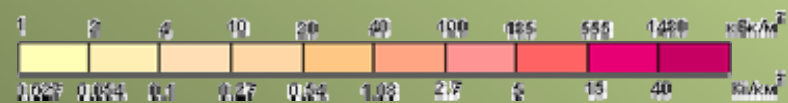
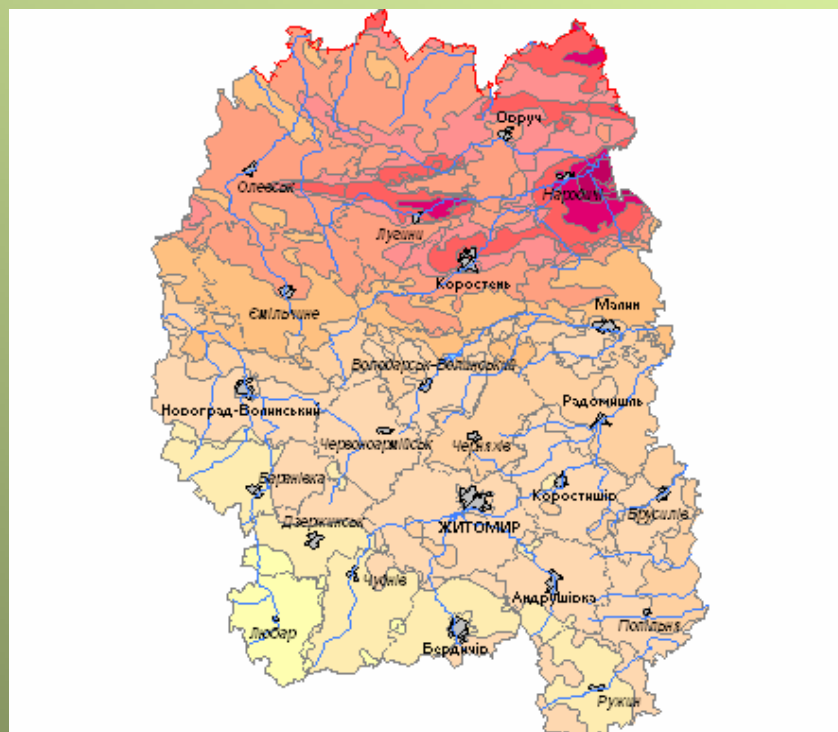
Zhytomyr region was one of the first to feel the blow of Chernobyl radiation.



- ✓ Pollution of its territory basically has taken place on April, 26-27th, 1986. The most expressed radioactive trace is observed in northern areas which border upon Belarus.
- ✓ To the zone of radioactive pollution were ascribed half of the region territories, third of its agricultural grounds and almost the same area of arable lands. The area of land with pollution level by ^{137}Cs from above $1,0 \text{ Ki}/\text{km}^2$ makes **977,6** thousand in hectare.
- ✓ To the zone of radioactive pollution were ascribed 9 areas **734** settlements in which lived about **386,3** thousand persons.



Density of pollution of the territory ^{137}Cs (year 1998)



Pollution by radiocaesium of the region by a condition on 01.12.1998, th ha

City, region	Total area			
	Pollution density, Ki /km ²			Total
	1-5	5-15	>15	
c. Korosten	-	3,5	-	3,5
Narodychi district	46,9	38,8	36,9	122,6
Ovruch d-t	169,6	53,2	17,0	239,8
Lugyny d-t	65,5	18,0	2,9	86,4
Olevsk d-t	172,6	15,8	1,2	189,6
Korosten d-t	110,6	21,0	0,4	132,0
Emilchyno d-t	108,2	0,7	-	108,9
Malyn d-t	52,6	0,6	-	53,2
Novograd-Volynsky d-t	53,8	0,7	-	54,5
Volodar-Volynsky d-t	7,1	-	-	7,1
In region	766,9	152,3	58,4	977,6



Density of the farmland pollution by caesium-137

#	Distict	Farmlands and household forests, ha			
		With the density of pollution, Ki/km ²			Total
		1-5	5-15	>15	
1	Narodychi	30073	24915	11117	66105
2	Ovruch	78195	12807	2098	93100
3	Lugyny	37745	9683	594	48022
4	Olevsk	51613	9647	780	62040
5	Korosten	80322	15537	433	96292
6	Emilchyn	58201	657	-	58858
7	Malyn	29653	572	-	30225
8	Novograd-Volynskyi	11762	-	-	11762
9	Volodar-Volynskyi	6419	-	-	6419
10	c. Korosten	-	-	-	-
TOTAL		383983	73818	15022	472823



Belonging of the farmlands to the pollution zones

Relatively to the pollution zones the given territories look like this:

- ✓ 4th zone- 383,9 th ha (density of pollution 1 - 5 Ki/km²);
- ✓ 3rd zone - 62,4 th ha (density of pollution 5 - 15 Ki/km²);
- ✓ 2nd zone - 26,4 th ha (density of pollution 5 - 15 and more then 15 Ki/km²).



**Areas of the territories, that are polluted
with ^{137}Cs more then 15 Ki/km², that are
withdrawn from land tenure, ha.**

District	Were subject to withdrawal	Are actually withdrawned	Including farmlands
Novograd-Volynsk	2237	1473	-
Voldar-Volynsk	2205	122	-
Emilchynsk	7312	5054	-
Korosten	21679	23319	181
Lugyny	4157	2532	159
Malyn	4866	5678	-
Narodychi	32573	21131	9630
Ovruch	11213	3600	326
Olevsk	6167	1042	617
Total in Zone	92409	64045	10813



Quantity of the settlements ascribed to zones of radioactive pollution according to the current legislation.

District	1 st Zone of alienation	2 nd Zone unconditional (obligatory) removal	3 rd Zone of the Guaranteed voluntary removal	4th Zone of the strengthened radioecological control	Total
Narodychi	4	36	36	8	84
Ovruch	3	19	107	30	459
Lugyny	-	4	35	11	50
Olevsk	-	2	45	14	61
Korosten	-	1	26	86	113
Emilchyno	-	-	44	757	119
Malyn	-	1	-	103	104
Novograd-Volynskyi	-	-	10	28	36
Volodar-Volynskyi	-	-	8	8	8
Total	7	63	301	363	734

Dynamics of the population of Zhytomyr region in the zones of radioactive pollution owing to Chernobyl accident

Year	Total in the region	Including in zones		
		II zone	III zone	IV zone
1990	424285	16738	211079	196469
1991	419646	14375	211833	193438
1992	419917	13067	213400	193450
1993	417531	10618	220559	186354
1994	407203	8539	215538	183126
1995	401283	7775	212454	181354
1996	396136	6451	210259	179426
1997	390802	5784	207126	177892
1998	386320	4963	205255	176102
1999	381657	4462	203354	173841
2000	375900	4101	200166	171633
2001	369899	3857	199798	166244
2002	361969	4408	196007	161524
2003	357772	4232	194180	159360
2004	352519	4018	191778	156723
2005	347732	3847	189650	154235
2005 до 1990 (+,-)	-76553	-12891	-21429	-42233

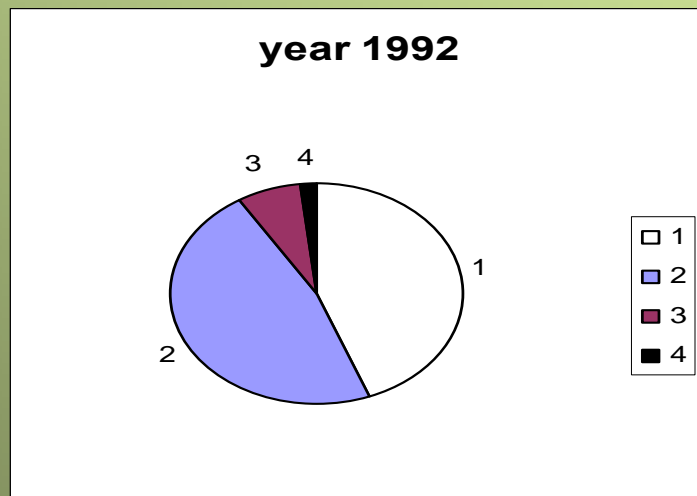


During the time, that has passed since the accident on the ChNPP, the radiation situation in Ukraine has considerably improved. It has happened as a result of:

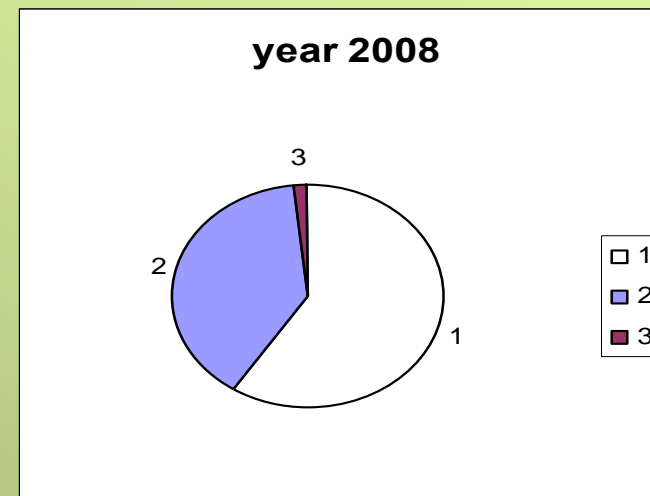
- realization of careful radiation monitoring of an agricultural production, manufacture, its quality control;
- realization of the complex of counter-measures in a field of agricultural production directed on decrease of pollution of foodstuffs of the population;
- existence of natural rehabilitation processes (physical decay of radionuclides, their fixing and redistribution in the environmental objects).



Pollution of the farmlands by ^{137}Cs in the 9 districts of Zhytomyr Polissya



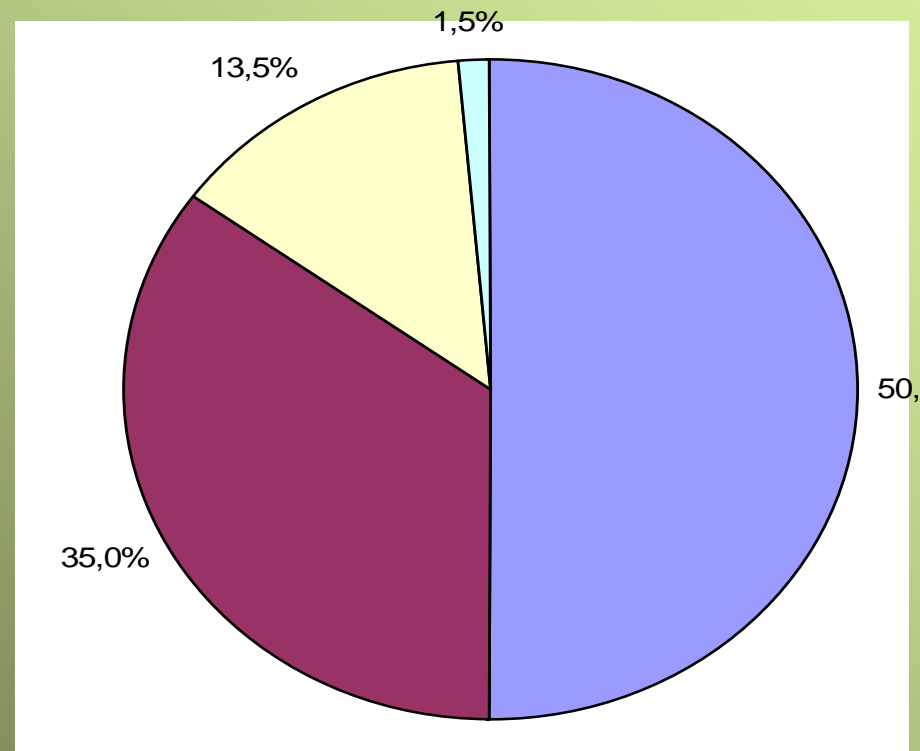
1. up to 1 Ki/km^2 – 290,9 th ha (41,7%)
2. 1-5 Ki/km^2 – 274,5 th ha (44,4%)
3. 5-15 Ki/km^2 – 42,6 th ha (6,9%)
4. >15 Ki/km^2 – 10,0 th ha (1,6 %)



1. up to 1 Ki/km^2 - 259,7 th ha (58,9%)
2. 1-5 Ki/km^2 – 174,0 th ha (39,4%)
3. 5-15 Ki/km^2 - 7,4 th ha (1,7%)



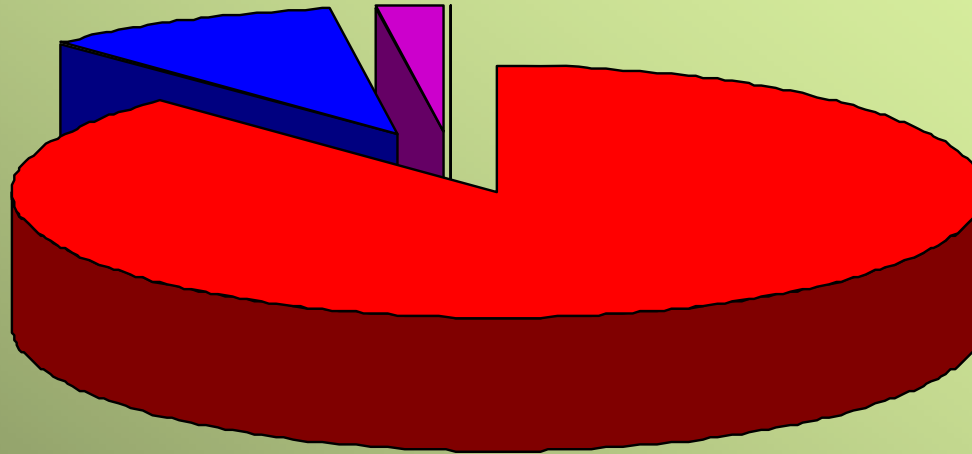
Forming structure of the irradiation dose of the population in 1986



- ✓ 35% - external irradiation
- ✓ 13,5 - internal irradiation
- ✓ 50% - internal irradiation due to inhalation of radionuclides



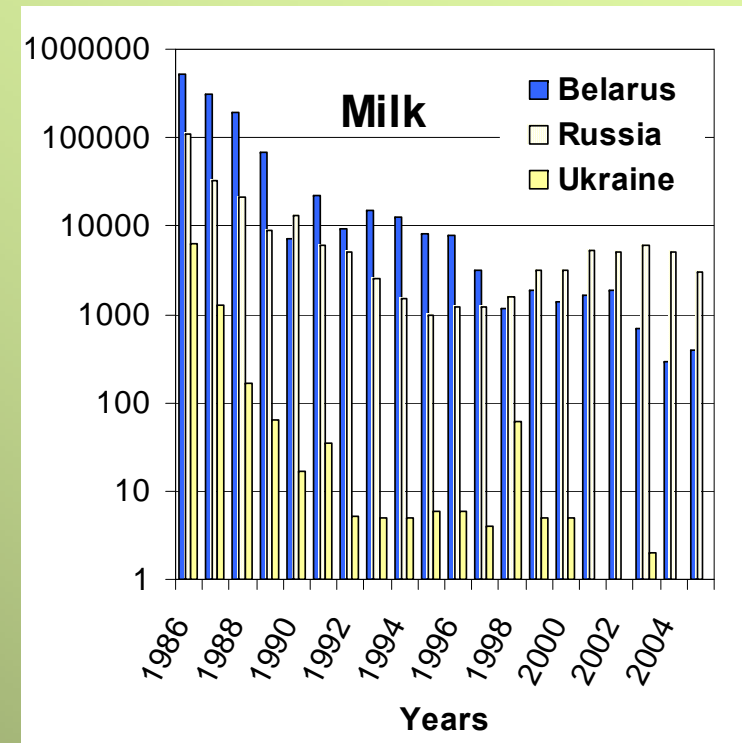
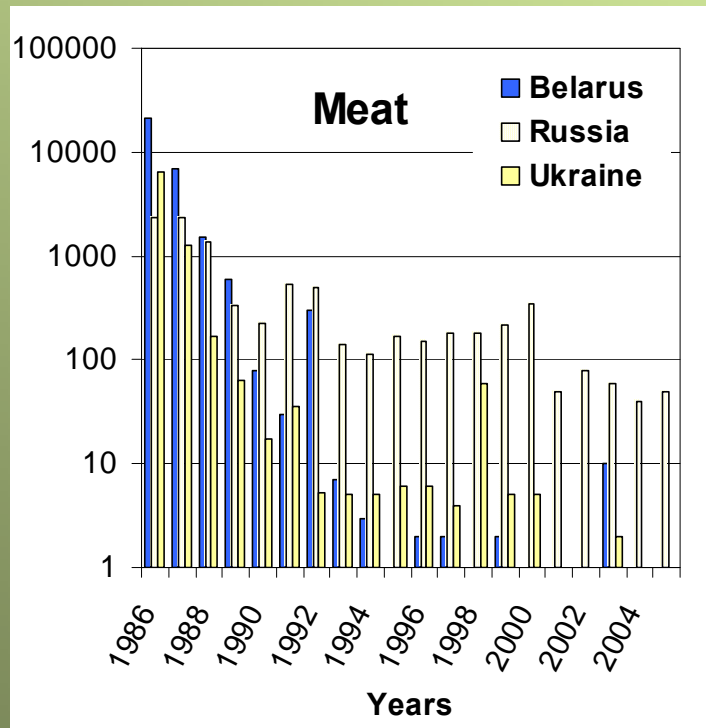
Forming structure of the dose loads of the population in northern areas of Zhytomyr region in 2008



- 80-95% - internal irradiation from radionuclides, arriving in the organism with foodstuffs
- 5-20% - external gamma-radiation
- <2% - internal irradiation from radionuclides, received by the organism with drinking water
- <0,1 - internal irradiation from inhalation receipt of the radionuclides in the organism



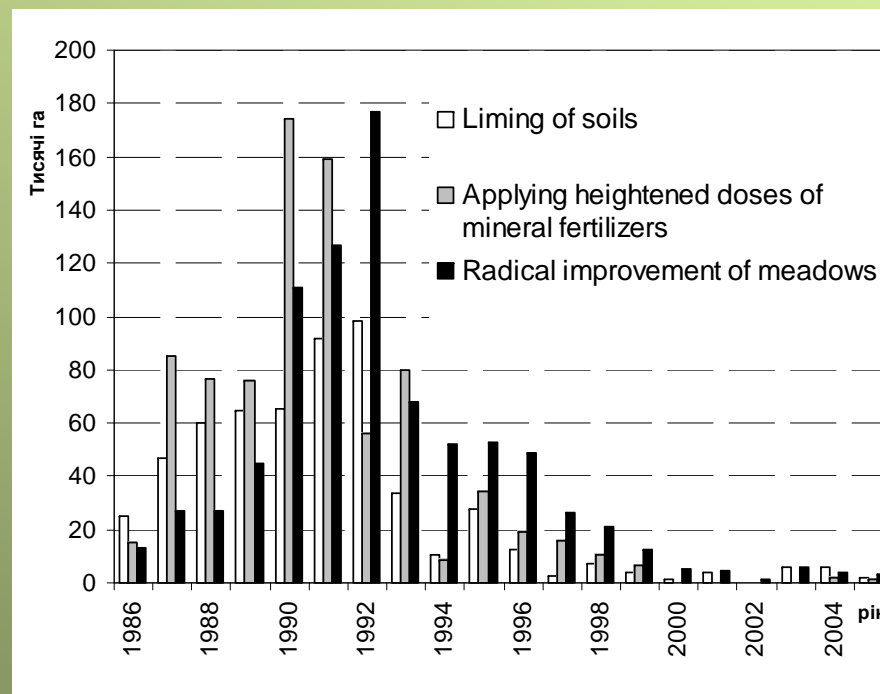
From the beginning of 90-s there was no production which was polluted above the state standards



Volumes of meat and milk, which are polluted with radionuclides with excess of established standards, which were received on meat and milk processing and packing factories of Ukraine



Realization of counter-measures in the agricultural production sphere of Ukraine after the Chernobyl accident



Absence of optimization and the efficiency control of the application of the counter-measures

Inopportuneness of realization because of the tender delay



Radiological efficiency of realization of the counter-measures

CONTER-MEASURE	Efficiency of the reduction of the content of ^{137}Cs in production, times	
	Mineral soil	Biogenic soil
Liming 4-6 t/ha	1.5-3.0	1.5-2.0
NPK *. Optimum ratio	1.5-2.0	1.5-3.0
Manure 20 т/га	1.5-3.0	-
Liming + NPK	1.8-2.7	2.5-4.0
NPK + Manure	1.5-3.0	-
Liming + Manure + NPK	2.5-4.0	
Sapropel	2 - 4	
Zeolite	1.5-2.5	
Ploughing after the accident: 1st year	2.5-3.0	3.0-4.0
next years	1.5-1.8	1.5-2.2
Ploughing with turning over the stratum(1 st year after the accident)	8-12	10-16
Radical improvement: on fallow land	3-9	4-16
next years	1.8-2.5	2-3
Superficial improvement: on fallow land	2-3	2-14
next years	1.5-1.8	1.5-2.5
Ferocin bolus		5-7
Ferocin powder		2-5
Salt-drop with ferocin		2-4
Mineral and salt briquettes + fodder mixture		3-5



Nowadays in Zhytomyr region



• *In the zone of unconditional (obligatory) evacuation there are still more than 4 thousand persons in 63 settlements living.*

• *Half of them has up to 10 person living (1-2 families).*

• *In half of the settlements permanently and in 24 settlements in some cases radioactivity of the milk exceed permissible level of pollution (LA -2006)*

• *There are some cases of exceeding of content of ^{137}Cs in potatoes, vegetables and ^{90}Sr in grain cultures, what was not noticed in passed years.*

• *The dose load on the population in 36 settlements exceeds the norm (1 mg.Zv/ hour).*



Quantity of the settlements in Zhytomyr region with the of correspond passport dose

Year	Dose, mZv/year				
	more then 5	from 1 to 5	from 0,5 to 1	less then 0,5	Total
1991	27	273	167	256	723
1993	3	215	198	361	777
1994	1	138	209	274	622
1995	0	141	228	312	681
1996	2	163	134	399	698
1997	2	163	134	399	698
1998	1	131	165	396	693
1999	1	106	179	407	693
2000	0	116	129	447	692
2001	0	93	137	470	700
2003	0	49	129	522	700
2004	0	60	129	511	700
2005 - 2007	0	36	153	511	700

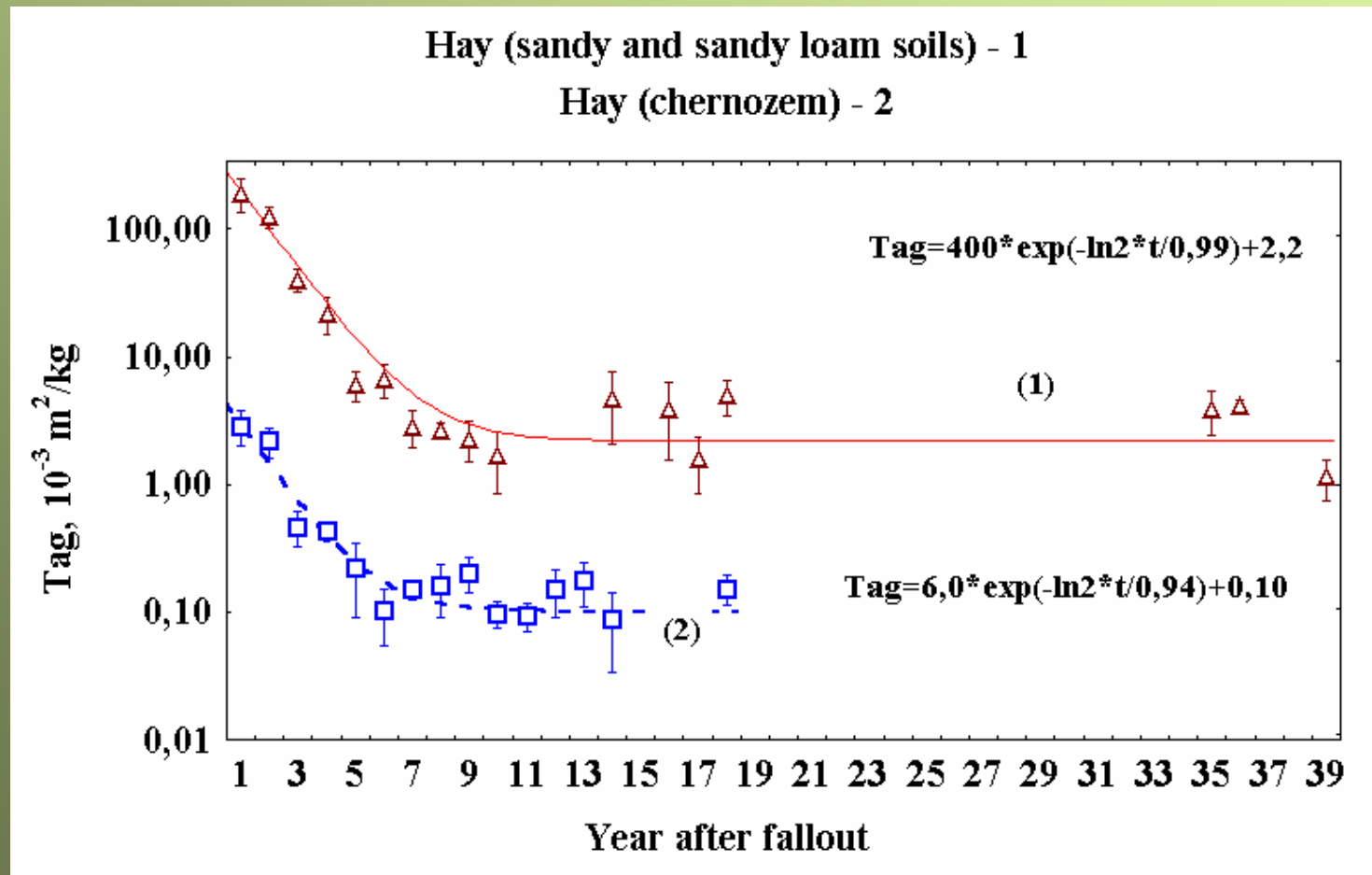


Distribution of the settlements with excess of the state standards (AL-06) of the content of ^{137}Cs in milk (100 Bq/l) for 2004-2007

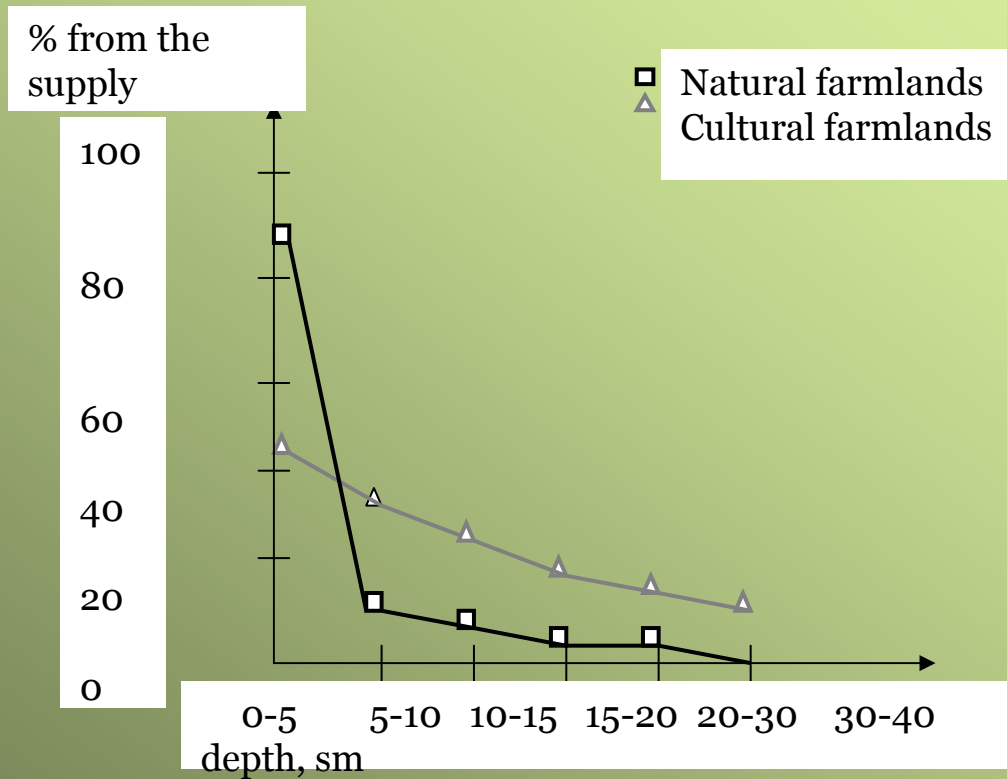
District	Quantity of settlements, where milk is being produced with the exceeding of AL-97	Quantity of the inspected settlements
Vinnytsya	0	89
Volynsk	166	166
Zhytomyr	53-84	700
Ivano-Frankivsk	0	5
Kyiv	0-4	469
Rivno	86-154	339
Sumy	0-1	11
Ternopil	0	10
Khmelnysk	0	9
Cherkassy	0	103
Chernigiv	0-4	248
Chernivtsi	0	14



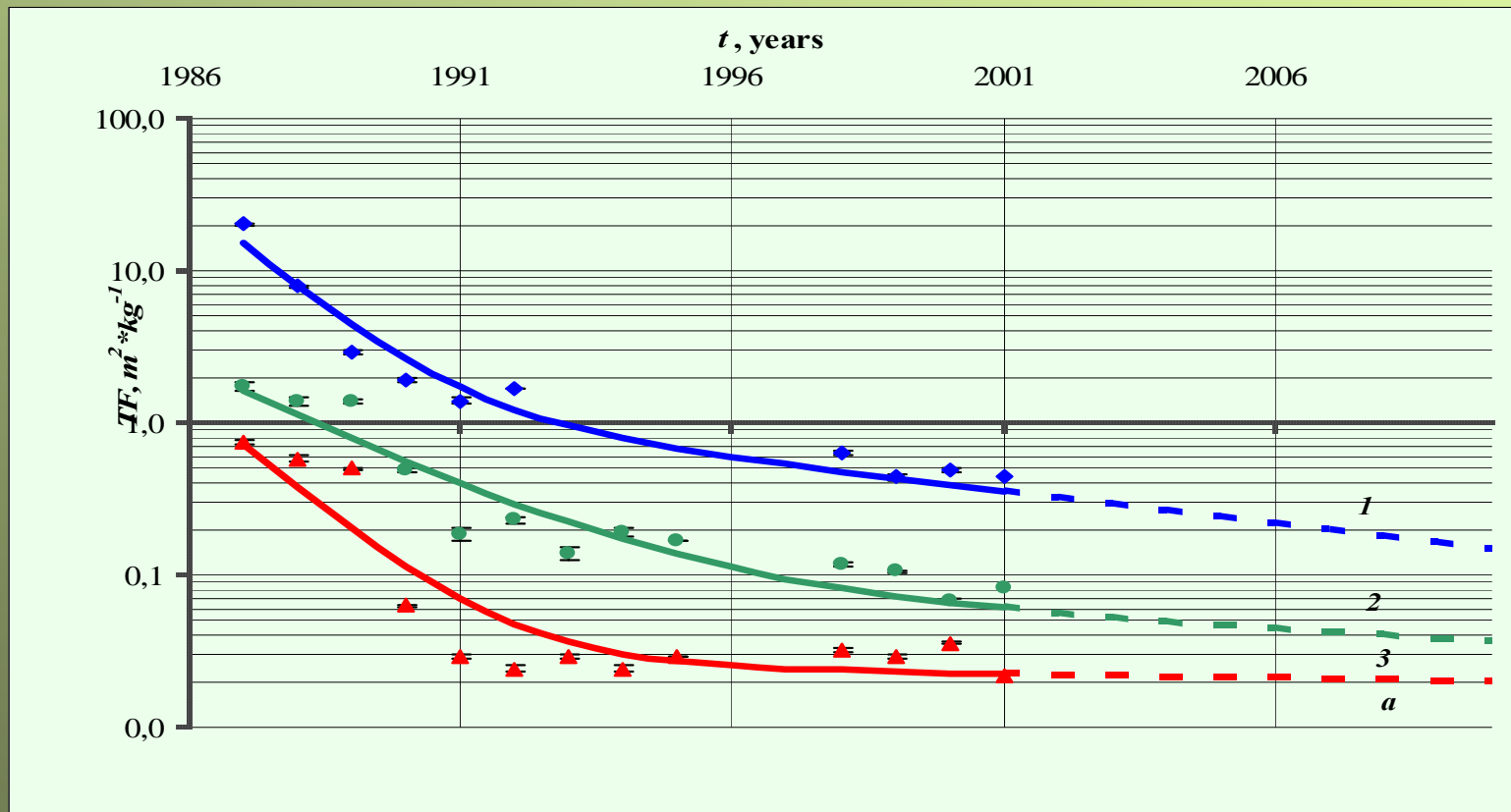
20 years after the Chernobyl accident the processes of the natural sorption of the radionuclides by soil almost exhausted them selves.



Distribution of ^{137}Cs by the profile of the soil



Dynamic of transition factor in plants on different soils



Specific activity of ^{137}Cs in vegetables and forest mushrooms in v. Khrystynovka (2003-2008)

Kind of production	Year	Specific activity of ^{137}Cs , Bq/kg		
		minimum-maximum	arithmetical mean	AL-97 i AL-2006
Potato	2005-2008	9,0÷98	14±9	60
Red beet	2005 -2008	10÷160	11±17	40
Carrot	2005 -2008	15÷50	9±8	40
Pumpkin	2005 -2008	10÷400	47±29	40
Cabbage	2005 -2008	15÷180	37±11	40
Dried mushrooms	2008	4380÷180000	44500±53000	2500
Fresh mushrooms	2008	800÷45380	9450±10600	500



The activity of the ration and the dose of the internal irradiation owing to ^{137}Cs in inhabitants of the Narodychi region, village Khrystynivka

Foodstuffs	Consumption, kg/day.	Concentration ^{137}Cs , Bq/kg	Receipt to the organism ^{137}Cs , Bq	% from the total receipt of ^{137}Cs
Foodstuffs of the vegetable origin				
Bakery	0,41	24,0	9,8	0,32
Potato	0,5	9,2	4,6	0,15
Root vegetable	0,05	18,8	0,9	0,03
Leaf vegetable	0,05	15,3	0,8	0,03
Fruits	0,4	4,7	1,9	0,06
Total	1,41		18	0,59
Year dose, mZv/year	0,09			
Foodstuffs of the animal origin				
Diary	1,0	61,3	61,3	2,01
Meat	0,2	30,3	6,1	0,20
Eggs	0,14	2,5	0,4	0,01
Fish	0,05	48,6	2,4	0,08
Bcero	1,39		70,2	2,3
Year dose, mZv/year	0,36			
Foodstuffs of the forest origin				
Berries	0,011	7230	79,5	1,72
Mushrooms	0,01	288356	2883,6	94,50
Total	0,021		2963,1	96,22
Year dose, mZv/year	15,14			
Total within 24 hours	2,821		3051,3	100
Year dose, mZv/year	15,6			



Conclusion

- ✓ From the beginning of the 90-s there was no production which was polluted above the state standards, which was received on meat and milk processing and packing factories of Ukraine
- ✓ Nevertheless in the zone of unconditional (obligatory) evacuation there are still more than 4 thousand persons in 63 settlements living
- ✓ Reduction of volumes of the counter-measures, high pollution levels of a foodstuff of own production cause the significant contribution of an internal irradiation in total dose load.
- ✓ In 36 settlements of the region the dose load on the population exceed the standard (1 mZv/hour).
- ✓ The regulation of the internal dose of the irradiation (consumption of the polluted products) is more efficient the external dose regulation.
- ✓ Presence of the big areas with a low polluted farmlands demands realization of a complex of rehabilitation measures on their returning to the industrial operation.
- ✓ Rehabilitation of the polluted farmlands by a method of cultivation of cultures for technical purposes is the important stabilizing social and radiological factor for the polluted region.



Thank you for your attention !