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# Management of the yield and radiological quality of potatoes cultivated by population on radioactive contaminated land of Belarus

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**Abstract:** The involvement of rural inhabitants in processes of self-rehabilitation and self-development could be considered as a way to improve the quality life on radioactive contaminated territory after Chernobyl accident. The results of the application of experimental technology for potato cultivation on radioactive contaminated land developed by participants in cooperation with scientists are described. The potato yield in experiment was higher on 13-27 t.ha<sup>-1</sup> or in 1.6 times than on control plots. The <sup>137</sup>Cs content in potatoes in experiment was lower on 20-30% than in control plots and lower than republican permissible level of radionuclide content. The 1 EURO invested to the potato experiment provided 2.0 EURO of net return. Therefore the management of yield and radiological quality of potatoes cultivated on private contaminated plots allowed to reduce of irradiation dose on rural inhabitants and to increase the outcome of their family.

## 1. INTRODUCTION

The agriculture is a basis for social and economic development of the majority of radioactive contaminated regions of Belarus. Therefore quality of life and health of rural inhabitants are defined by level of agriculture production and radiological quality of produced foodstuff.

The agricultural production in Belarus is conducted on 1,3 million ha of land contaminated by <sup>137</sup>Cs with deposition 37-1480 kBq.m<sup>-2</sup> (1-40 Ci.km<sup>-2</sup>) from which 0,46 million ha are simultaneously contaminated by <sup>90</sup>Sr with deposition 6-111 kBq.m<sup>-2</sup> (0,15-3,0 Ci.km<sup>-2</sup>). The main share of the contaminated agricultural areas concentrated in Gomel (57%) and Mogilev (27%) regions. The share of the contaminated lands in Brest, Grodno and Minsk regions respectively represent 7, 4, and 5% [1].

Agricultural production on radioactive contaminated areas is a one of the initial and main ways of radionuclide migration in circuit "soils - plant - animal - foodstuff - man". The researches have shown that collective irradiation doze is formed on 70%, approximately, in result of radionuclide inflow to the man body with foodstuff. First of all its are milk and potatoes, which are a basic of food in rural area. Therefore the application of the protective measures directed on the food production with the low content of radionuclide is a very important part of radiation protection of the population living on radioactive contaminated area [1].

Statistic data has shown that <sup>137</sup>Cs content in potato tubers does not exceed the permissible level at the potato growing on arable radioactive contaminated land. However about 300 kg of potatoes is consumed annually per man. Potato yield also determines the significant share of the family outcome. Therefore it is possible to improve the quality life of the rural inhabitants by increasing of potato yield with minimal <sup>137</sup>Cs activity.

Poor economic situation in agriculture does not allow to solve a problem of production of the quality foodstuff. The countermeasures for reducing of the radionuclide transfer from soil to foodstuff are mainly applied in the state farms. The application of protection measures on private producer plots is restricted because of lack of knowledge and financial resources. In this case the involvement of rural inhabitants in processes of self-rehabilitation and self-development could be a way to improve the quality life on radioactive contaminated territory.

## 2. METHODOLOGY

“Potatoes” project has been implemented within framework of “ETHOS-II” project. The method of implementation of "Potatoes" project is based on ETHOS approach.

The objective of the ETHOS approach is to develop sustainable conditions for the populations in the contaminated territories affected by the Chernobyl accident in order to improve their living condition [2]. Within the ETHOS approach there is an attempt to transfer the practical skills in radiation protection and radioecology to the inhabitants of contaminated territories, skills that can be used in day-to-day life. In this way, the inhabitants can regain control of the radiological situation and contribute to the improvement of their living conditions. The objective is to develop the practical measures, which progressively enters into the patrimony of the populations living in contaminated territory [3].

The “Potatoes” project was carried out in four villages Belousha, Gorodnaya, Olmany, Terebezhov of Stolin district of Brest region of Belarus during 2000-2002. 69 inhabitants of these villages were participants of potato teams.

The implementation of “Potatoes” project was based on following tasks:

- preliminary study of poor yield and quality of potato on personal plots;
- development and improvement of technology of potato cultivation by private producers on radioactive contaminated plots;
- carrying out the training seminars for participants of “Potatoes” project;
- carrying out of experiments by participants;
- evaluation of radiological and economical efficiency of experimental technology.

## 3. RESULTS AND DISCUSSION

The Stolin with predominated sod-podzolic sandy and peat soils is a very complex district for potato growing cultivation of potatoes. The poor native fertility and unsustainable humidity regime of soils are the restricted factors for obtaining of high potato yield. The high parameters of radionuclide transfer to plants are typical for these soils.

The  $^{137}\text{Cs}$  deposition on potato plots varied widely from 40 kBq.m<sup>-2</sup> in Terebezhov up to 400 kBq.m<sup>-2</sup> in Belousha. The  $^{137}\text{Cs}$  content in potato tubers varied from 10 to 69 Bq.kg<sup>-1</sup>. The yield of potatoes on private plots before experiments was low as 15-20 t.ha<sup>-1</sup>. There was clear motivation for participants to increase the potato yield and to reduce the radionuclide content in tubers.

The rewier with private producers has shown that selection of potato varieties, application of manure, fertilizers and plant protection means are main factors defining the level of potato yield. Simultaneously these factors have significant influence on radionuclide accumulation in potato tubers. Therefore the problem of increasing the production of good quality potatoes could be solved though the improvement of potato cultivation technology. The participants tested on their plots the experimental technology of potato cultivation developed by BRISSA scientists.

The experimental technology included:

1. The high quality seeds of new potato varieties characterized with low level of radionuclide accumulation;
2. The application of special set of fertilizers for potato cultivation. It was developed according to the agrochemical soil properties and  $^{137}\text{Cs}$  deposition of each plot to increase of yield and to reduce of radionuclide content in tuber;
3. The application of fungicides against *Phitophthora infestans* and insecticide against *Leptinotarca cecemelinida*, which make the most damage of potato plants.

The participants of first year experiment were provided with new seeds, plant protection means and complete sets of fertilizers for potato cultivation according to the proposed technology on 300 m<sup>2</sup> plots. On second year the participants increased the experiment plot up to 1000 m<sup>2</sup>. Seed material for experiment was picked out from the previous year potato yield on experimental plot. Plant protection means, complete sets of fertilizers and potato seeds were purchased for participants due to financial supporting of FERT (Formation pour l'Epanouissement et le Renouveau de la Terre, Paris, France).

The several training seminars for participants were carried out during “Potatoes” project implementation. The requirements of potato cultivation on radioactive contaminated land and the experiment results were explained and discussed there. The participants were provided with following training materials:

- Diary of potato cultivation. The diary is a chronological description of sequential implementation of elements of potato cultivation technology with the indicating of type of seed preparation for planting, rates of fertilizers, type of soil cultivation etc.). The placement of experiment is described in diary. The diary records were used for discussion on seminars;
- Booklet for potato cultivation. The main elements of the technology for potato cultivation on radioactive contaminated land are described and explained in booklet.

The results of the first year experiment have shown that implementation of experimental technology has allowed to increase the potato yield in 1,7 times in average in comparison with control fields (fig. 1.). The efficiency of applied measures was higher in Gorodnaya and Olmany, where the potato yield was increased from 22 up to 49 t.ha<sup>-1</sup> and from 20 up to 37 t.ha<sup>-1</sup> respectively. The additional potato yield in experiments of Terebezhov and Belousha was lower, but also significant.

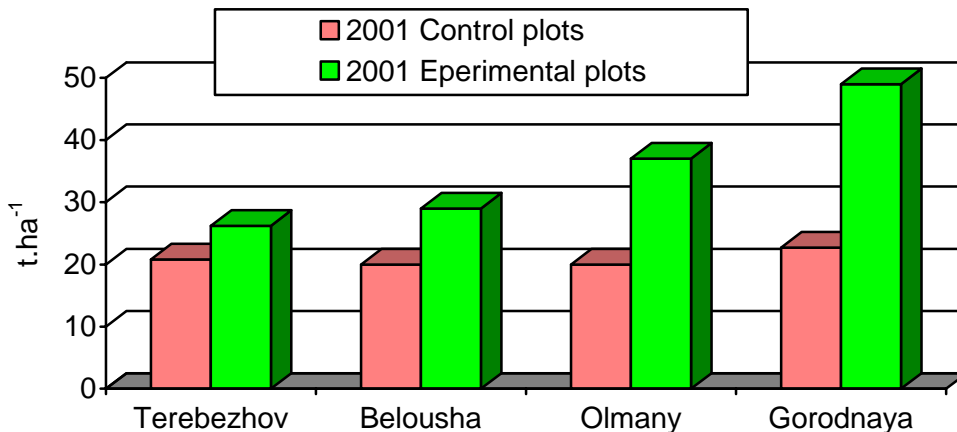


Fig. 1. Potato yields on the participant plots in 2001, t.ha<sup>-1</sup>, average per village

The weather condition of second year experiment was unfavorable for potato cultivation, especially on sandy soils. There was no precipitation from middle of May up to the end of July. The potato yield and efficiency of applied treatments were lower than previous year. However the differences of potato yield between experimental and control plots were significant. The potato yield was increased from 20 up to 33 t.ha<sup>-1</sup> in average (fig. 2.).

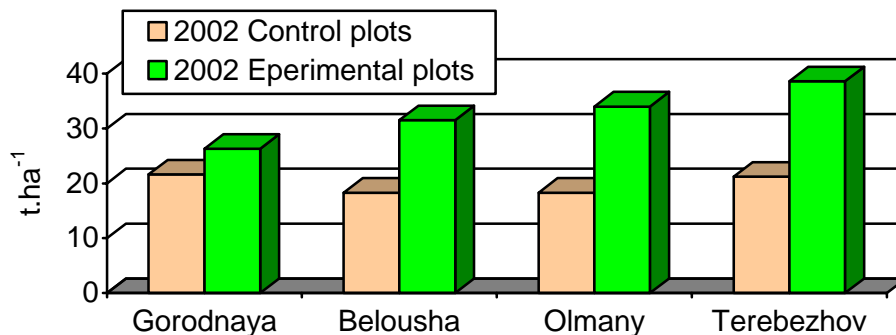


Fig. 2. Potato yields on the participant plots in 2002, t.ha<sup>-1</sup>, average per village

Therefore the developed technology of potato cultivation has allowed to increase of potato yield on 13-27 t.ha<sup>-1</sup> or in 1,6 times in comparison with control plots during two years. The implementation of the main elements of technology of potato cultivation partly allowed to reduce of the negative influence of unfavorable weather condition.

The payback of each 1 EURO invested in experimental technology (cost of seeds, fertilizers and plant protection means) has made 2.0 EURO of net return in average (fig. 3.). The cost of implementation of the experimental technology has made 370 EURO per hectare. Profitability (relation between net profit and expension cost) of potato cultivation on experimental technology was varied from 10% up to 300% depending on the weather condition, soil fertility and skill of participants.

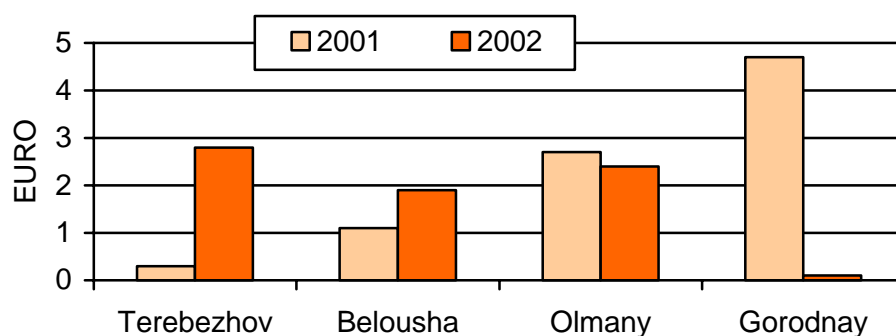


Fig. 3. Cost-benefit analysis of experimental technology, EURO of net return per 1 EURO invested

Determination of  $^{137}\text{Cs}$  content in potatoes was done at the Laboratory of Radioecology of BRISSA by using the Gamma spectrometry system, detector GC4019, CANBERRA. The same analysis was made at the local radiometric centre in each village. It was established that  $^{137}\text{Cs}$  activity of potato tubers varied from 6 up to 69  $\text{Bq}\cdot\text{kg}^{-1}$ . The application of experimental technology allowed to reduce on 20-30% the  $^{137}\text{Cs}$  content in comparison of control plots (fig. 4.).  $^{137}\text{Cs}$  activity of potato tuber was lower than permissible level on all tested plots.

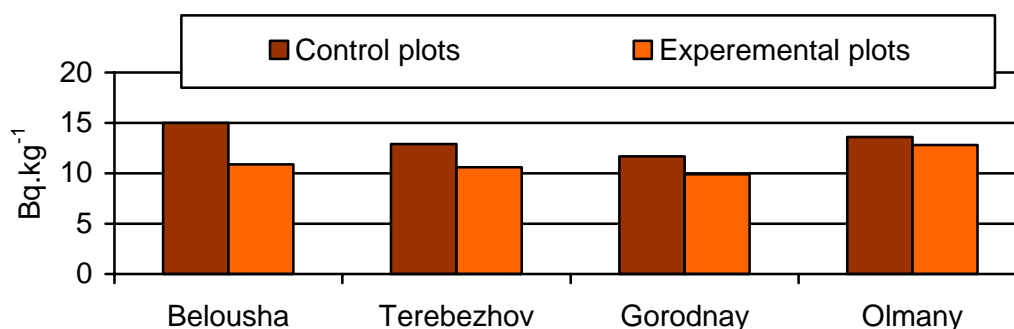


Fig. 4.  $^{137}\text{Cs}$  activity of potato tubers,  $\text{Bq}\cdot\text{kg}^{-1}$ , average per village, 2001-2002

There were significant differences in Cs activity of potato due to different levels of potassium soil supply. For example, the level of  $^{137}\text{Cs}$  accumulation in tubers was lower on plot Polukoshko V.N. with higher content of exchangeable potassium in soils in comparison with plot Kuzmich M.A. (fig. 5.). Therefore the application of potash fertilizer was important for reducing of  $^{137}\text{Cs}$  transfer from soil to plant. This measure was applied in the experimental technology. The rates of potassium fertilizer varied from 120 up to 180  $\text{kg K}_2\text{O}\cdot\text{ha}^{-1}$  depending on potassium status of soil.

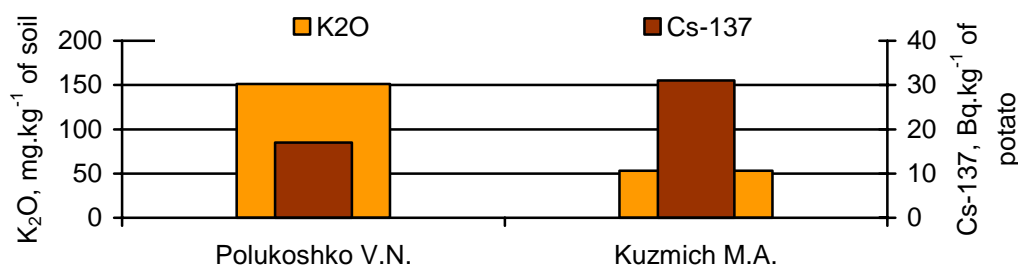


Fig. 5. Influence of potassium soil status on  $^{137}\text{Cs}$  accumulation in potatoes, Olmany, sod-podzolic sandy soil,  $^{137}\text{Cs}$  deposition - 250-270  $\text{kBq}\cdot\text{m}^{-2}$

Radionuclide accumulation in potato was depended on types of soil (fig. 6.). The  $^{137}\text{Cs}$  transfer to potato tubers from peat soil was higher in comparison with sod-podzolic sandy soil (plots of Goiko E.Z. and Krivolevich N.K., Olmany). The choice of placement for potato plots was recommended for participants.

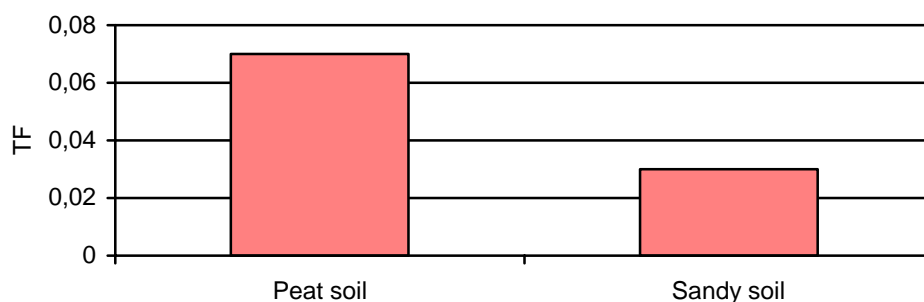


Fig. 6.  $^{137}\text{Cs}$  transfer factor (TF,  $(\text{Bq}\cdot\text{kg}^{-1})/(\text{kBq}\cdot\text{m}^{-2})$ ) from soil to potatoes on peat and sandy soils, Olmany,

It should be noted that the increasing of potato yield was the main important and visible merit for participants of "Potatoes" project. The reduction of radionuclide content in potatoes was the second significant merit of new technology.

Practically all participants tried their best to implement the requirements of experiment. But during second year experiment some participants tried to use the experimental technology on the all site of their field. The implementation of "Potatoes" project has a high social significance. The results of Potato project have been appreciated by majority of inhabitants of villages.

#### 4. CONCLUSIONS

The experimental technology of the potato cultivation on private field allowed to increase the yield on  $13\text{-}27 \text{ t}\cdot\text{ha}^{-1}$  or in 1.6 times and to reduce of radionuclide content on 20-30%. The average net return was 2 EURO per 1 EURO invested in development new technology of potato cultivation. The implementation of project has a high social significance. The involvement of rural inhabitants in processes of self-rehabilitation and self-development could be a way to improve the quality people life on radioactive contaminated territory as a common heritage.

#### ACKNOWLEDGEMENTS

BRISSA team sincerely appreciates the assistance and encouragement from experts of ETHOS group. Financial support of FERT (Director Mr. M. Mollard) is greatly acknowledged. The authors are grateful to all participants of "Potatoes" project in settlements Belousha, Gorodnaya, Olmany and Terebezhov of Stolin district for sincere desire and diligence at the implementation of experiments.

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