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ENERGY AUDIT OF TECHNOLOGIES IN POTATO GROWING

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Technology (method) of economically viable production is the level according to that one the main goal is realized – obtaining competitive commercial product that absolutely, in 100%, guarantee adequate income.

Introduction. In modern agriculture there are two well-known contrasting ways of potato planting, - comb method and a smooth one. The depth of applying tubers into the soil with a comb planting is – 6-8 cm, but with a smooth planting is 10-12 cm [1].

The essential disadvantage of the above-mentioned methods is their disability to maintain soil density at level 1,1-1,2 ha/cm3, over a long period of time, that is a basic new operation for active forming of Solanum tuberosum L. and potato (tubers) development [2].

Considering this fact there was proposed and studied a surface method where tubers are arranged (manual or mechanically) on the bottom of the furrow in depth 5-6 cm that was formed with the previous (or simultaneously with planting) of field marking. After the tubers arrangement the field is covered with barley straw of layer in 20-25 cm.

With such technology applied the average potato yield in 2008-2010 years. Was 190 cwt per hectare that 15% higher in comparison with comb method using.

The object of current researches became that fact how the yield change make influence upon energetic balance of the technology; correspondingly the subjects i.e. implements in achieving goal were: 1) technology (process) map and 2) reference books of energy equivalents.

Brief review of literature. Howard Odum (American) is considered as a founder of energy analysis who in the late 1960s of last century stated the basic principles of the method according to that the efficiency of commercial production in the industry, farming, region, and, at last, in the global level.

Initially the idea of Odum was supported by the Japaneses K. Sugiyama, Y. Shimozi, (1972), W. Dekkers, J. Lange (1974) [3, 4], who proposed a simplified calculation of energy consumption, according to that energy costs equaled the double straight lines. The sum total of direct and related costs provides general:

Widespread use of mentioned above method in farming took place after 1975, when it was officially recognized and received its present name: energy analysis in agriculture (V.R.

Technology operation	Fuel energy	Labour (cost)			Energy consumption, MDJ		
	kg/ha	MDJ	person per hour	MDJ	direct	related	general
Stubble cleaning	2,41	103,63	0,27	0,62	104,25	208,50	312,75

Volobuyev) suggested to call, it as agrarian energetics, but his proposition wasn`t feely supported). In May, 1976 there has taken place a special symposium in energetics of farming, where there was made a conclusion, - energy analysis opens up entirely new possibilities for profound scientific consideration of the efficiency problem of agricultural production [5].

Moldova was the first in the countries of the nearest borders that used the energy value of plant farming production where S.I. Thoma, N.S. Balauru, A.V. Tetyu, V.A. Kovda, G,A. Bulatkin, V.I. Votolin, Ya. Toth, I. Kyshsh worked out such problems as: efficiency improvement in farm mechanization, fertilizer system, irrigation, plant protection, selection and the process of setting the areas for applying corresponding crop variety [6-8].

Energy analysis made possible for N.S. Balauru and A.V. Tetyu to reveal that the identical maize yield increase was reached in black earth zone common at the level of 0.45 tons per hectare with NPP (nitrogen-phosphorus-potassium proportions) -180 and 270 kg/ha [5].

E.A. Sergeantu and Z.N Kosyuha (1982) proved that under the conditions of Moldova fertilizer applying according to the industrial technology in maize growing is economically cost – effective, and energetically isn`t paying because of low efficiency ratios - 1,06-1,50 [9].

The works of Russian G.A. Bulatkin, V.I. Vatolin, V.R. Volobuev in energy analysis in agriculture are well-known [10-13].

The monograph of O.K. Medvedovsky and P.I. Ivanenko in energy analysis of intensive technologies is growing of winter wheat, spring barley, maize, millet, buckwheat, potato [14] is very popular in Ukraine.

Research methods. Basic ground in methods of energy analysis in plant farming industry are considered the author (or typical) technology (process) maps in growing of agricultural crops, some reference books in energetic equivalents for energy resources (benzene, diesel fuel, coal, natural gas, woods, electric power); mineral fertilizers (nitrogen, phosphorus, potassium, complex); local fertilizer (manure, composts, lime materials); pesticides (herbicides, insecticides, fungicides, retardants); seeds; horse and manual equipment; labor resources; farm machinery and implements (tractors, automobiles, tank trucks, trailers, plows, cleaners, harrows, cultivators, sowing machines, hitch, fertilizer, distributors), etc.

After calculating all the operations in the technology map follows making final table of all the costs and determining the ratio of energy efficiency accumulated in yield to the general energy spent for reaching its project level.

The composition of the related energy costs includes: energy introduced into mining, coal, gas and other types of raw materials, as well as the energy consumption of farm, machinery, fertilizers, the ways of plant protection, irrigation (irrigation systems) and so on [6].

Research results. In the average level of yielding of potatoes on the control (St) -18,5 tons per hectare (15,5 (in 2009) + 13,6 (in 2010,) + 18,8 (in 2011)+ 26,0 (in 2012) and in experimental variants (SV) - 22,6 t / ha (18,6 + 16,6 + 24,0 + 31,3) direct energy costs were on St – 68,83 GJ, SV - 49,97 GJ (Table 1).

Table 1. Energy consumption with technological cycles of work in potato growing on different methods

Technological cost	St		SV	
	GJ/ha	%	GJ/ha	%
The basic ground tillage	20,93	34,4	20,93	41,9
Soil preparation and potato planting	16,97	27,9	15,55	31,1
Seeding (planting) management	7,36	12,1	3,28	6,6
Harvesting	15,57	25,6	10,21	20,4
Total:	60,83	100	49,97	100

Table 2. Energetic structure of costs in potato growing per 1 hectare of seeding (planting) with different technological schemes

Calculating indexes	Unit of measuring	Energetic equivalent of physical units, mJ	Standard (on control)			SV		
			Material and resource costs in physical units	GJ	%	Material and resource costs in physical units	Energy consumption	
							GJ	%
Labour resources	Person per hour	42	135	5,67	9,3	108	4,54	9,1
Machines and mechanisms	Motor per hour	88	162	14,26	23,4	130	11,44	22,9
Fuel	kg	53	312	16,54	27,2	250	13,25	26,5
Electricity (power costs)	kVt per hour	12	37	0,44	0,7	37	0,44	0,9
Manure	tonns	168	20	3,36	5,5	20	3,36	6,7
Nitrogen	kg $_{a.s.}$	87	60	5,22	8,0	60	5,22	10,4
Phosphorus	kg $_{a.s.}$	13	40	0,52	0,8	40	0,52	1,0
Potassium	kg $_{a.s.}$	8	60	0,48	0,8	60	0,48	1,0
Insecticides	kg	258	2,8	0,72	1,2	2,8	0,72	1,4
Fungicides	kg	117	6,4	0,75	1,2	6,4	0,75	1,5
Herbicides	kg	264	13,7	3,62	6,0	-	-	-
Seeds	t	3700	2,5	9,25	15,2	2,5	9,25	18,5
Total:				60,83	100,0		49,97	100,0

Difference in energy consumption was 10,86 GJ (60,83-49,97); in percentage – 21,7. (60,83/49,97*100-100(%)) due to the reducing production costs for before planting soil preparation and tubers planting with the surface planting technology (SV) – 1,42 GJ (16,97-15,55), seeding management – 4,08 GJ (7,36-3,28) and in harvesting – at 5,36 GJ (15,57- 10,21).

Corresponding to cycle (stage) costs there have taken place their changes in material and resources groups (Table 2).

The simplification of the technology in potato growing with the surface method of planting (SV) allowed reducing labor resources at 25% (135/108*100-100(%)), machinery and mechanisms maintenance - in 41,6% fuel-in by 24,8%, that energeti-

Table 3. Rations of energy efficiency in growing potato with the comb and surface method of planting.

Technologies of planting	Harvesting per 1 ha		Production costs in GJ	K_{ee}	Dominance of K_{ee} SV over St, %
	physical mass, tons	in GJ			
Comb method (St)	18,5	68,45	60,83	1,13	47,8
Surface technology (SV)	22,6	83,62	49,97	1,67	

cally as it was already noted equivalently 10.86 GJ.

Naturally, the determined positive analogically reflected in energy efficiency ratio (Table. 3).

As shown in table 3 energy efficiency ratio (Kee) with applying comb method of planting was – 1,13(68,45/60,83); surface – 1,67(83,62/49,97), that 47% exceeded St.

According to the data of O.K. Medvedovsky and P.I. Ivanenko [14] concerning energy efficiency ratio of potato growing in Polesie (Institute of Potato growing at UAAN), it was 1,33, and in the former state farm "Ukraina" in Vasilkivsky district in Kyiv province – 1,55.

These data are presents as a reference that relatively provides the objectiveness of the results given.

Conclusion

Energy consumption in potato growing with surface planting decreases at 10.86 GJ, while the efficiency of energy resources utilizing increases in 47.8%.

Література

1. Sinyagin I.I. Areas of nourishing plants. - M .: Rosselhozizdat, 1975 - 382 p.
2. Potato: encyclopedia reference book. / Ministry of Agrarian Policy in Ukraine, Ukrainian Academy of Agricultural Sciences. Bila Tserkva (Kyiv region.): BNAU, 2002 - T.4 /Andriyenko I.I., Beloshytsky N.Y., Bondarchuk A.A. et al. / In edition of A.A. Bondarchuk, M.Ya. Molotsky. - 2009. - 375 p.
3. Sugiyama K., Shimozi Y. Some problems in economy oriented environmentology // I.J Earth Sci: Nagoya Univ. - 1972. - 20. - P. 1-29.
4. Dekkers W.A., Lange J.M., de Wit C.T. Energy production and use in Dutch agriculture // Neth. J. agric. Sci. - 1974. - 22. - P. 107-118.

Balaur N.S., Tetyu A.V. Energy evaluation in peas cultivating. Kishinev: Shiintsa, 1988. - 115 p.

5. Balaur N.S., Toma S.I., Tetyu A.V. Applying energy analysis for evaluation efficiency of technologies in cultivating field crops. Kishinev: Express-information Mold. NIINTI, 1983 - 23 p.
6. Kovda V.A. Bulatkin G.A., Vatolin V.I. Energetic costs in agriculture // Reports of VASHNIL. – 1980. - №4. - P. 2-4.
7. Toth Ya., Kishsh I. - Energy Economy and efficiency increase of its application in industrial production of maize// International Agricultural Journal. - 1982. - №12. - P. 16-19.
8. Sergeantu E.A., Kosyuga Z.N. Effectiveness of mineral fertilizers using in maize cultivation on the industrial technology: Review of Information Mold. NIINTI. - Kishinev, 1982. - 52 p.
9. Bulatkin G.A. Energy efficiency of fertilizers application in agrotsenose // Methodical recommendations. - Pushchino, 1983. - 47 p.
10. Bulatkin G.A., Vatolyn V.I. Consumption of energetic resources in agrotsenozah // Experimental biogeotsenology and agrotsenozes. – M.: Science. – 1979. – P.115-117.
11. Bulatkyn G.A., Vatolin V.I. Energy costs and reserves of their economy in agriculture // Reports of VASHNIL. - 1981. - №9. - P. 3-5.
12. Volobuyev V.R. Agroenergetics – actual, scientific and practical problem // Soil Science. – 1979. - №10. - P. 5-14.
13. Medvedovsky O.K., Ivanenko P.I. Energy analysis of intensive technologies in agricultural production. - K .: Urozhay, 1988. - 208 p.

АНОТАЦІЯ

Строяновський В.С., Рихлівський І.П. *Енергетичний аудит технологій вирощування картоплі // Біоресурси і природокористування. – 2015. – 7, № 1–2. – С.92–95.*

Технологія економічно-доцільного виробництва є тим рівнем, за яким реалізується його головна мета – отримання конкурентоздатного товарного продукту, який стовідсотково гарантує належний прибуток.

Енергозатратність вирощування картоплі за поверхневого садіння зменшується на 10,86 ГДж, а ефективність використання енергоресурсів зростає на 47,8%.

АННОТАЦИЯ

Строяновский В.С., Рыхливский И.П. *Энергетический аудит технологий выращивания картофеля // Биоресурсы и природопользование. – 2015. – 7, № 1–2. – С.92–95.*

Технология экономически целесообразного производства является тем уровнем, по которому реализуется главная его цель - получение конкурентоспособного товарного продукта, полностью гарантирующего надлежащую прибыль.

Энергозатратность выращивания картофеля при поверхностной посадке уменьшается на 10,86 ГДж, а эффективность использования энергоресурсов растет на 47,8%.