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DIRECTIONS OF CHANGES IN POLISH AGRICULTURE AND ITS INFRASTRUCTURE

Summary

The current situation and predicted socio-economic, technological and ecological changes, which under the influence of scientific progress, implemented Common Agricultural Policy (CAP) and globalied food markets will happen in Polish agriculture and its infrastructure by 2030 are presented in the paper. Owing to the progressive integration with the economy and markets of the European Union (EU), further intensified polarization processes and modernisation of farms is perceived accompanied by restructuring of agriculture, agri-food processing industries, production services, rural supply chains and the other infrastructure in rural areas.

The future model of agriculture and agrotechnology is shaping, which is characterized by arable area (AL) diminishing to 12M ha, a decreasing number of family commercial farms and smaller agricultural holdings to 400 thousand, diminishing livestock population and number of farms specializing in commercial production of milk, meat, eggs but also sugar beets, potatoes, vegetable and fruit. Crop yield and animal productivity will increase, so despite diminishing AL and livestock population, both the global production and final output of Polish agriculture will be growing annually by between 0.5 and 1.0%. Quantitative and qualitative increase in plant and livestock production will be taking place accompanied by farms and agricultural enterprises switching to the system of sustainable agriculture (including organic and precision farming) integrated with multifunctional rural development and protection of the natural environment in rural areas.

Various forms of mechanization and energy supplies for agricultural production will be used aiming at diminishing its cumulated energy-intensity and lowering unit costs of raw material and food product acquisition. The share of agriculture and rural areas in acquisition and consumption of renewable energy resources (RER) will be increasing. Further progress in agriculture will be dependant on modernization and all-around development of agricultural and rural infrastructure.

Key words: rural areas, agriculture, infrastructure, farms, energy-intensity, prediction

INTRODUCTION

Owing to the integration with the European Union economy Poland has a unique opportunity to accelerate a general development of the country, involving liquidation of socio-economic backwardness perceivable in rural areas and agriculture of some regions.

Poland is a medium-sized European country (313,000 km^2) inhabited by about 38 M people, prevalently city dwellers (Table 1). High registered unemployment rate (over 15%) has been noted here for many years, which still does not include partly hidden unemployment in farmer families, estimated for about 1 M people. At the same time there is a persistent unregistered employment in so called "grey zone" which annually generates about 20% of gross national product (GDP). Since 2003 Poland has had a positive and constantly growing balance of international turnover (exports-imports) of agri-food products and food products.

Results of research and prognostic studies conducted by IBMER [Szeptycki et al. 2005, Wójcicki 2006 and 2007a] and analyzes of Agricultural Census results from 1996 and 2002 [GUS 2003] point to the structural and economic changes occurring in rural areas and agriculture, which allow to predict the shaping of the model of agriculture and its infrastructure in closer and further perspective. The paper aims at presenting some results of these research and analyses as short-term (until 2010), medium-term (until 2020) and long-term (until 2030) forecasts.

SOCIO-ECONOMIC CHANGES IN AGRICULTURE

The analysis of socio-economic changes in the country and agriculture reveals that Poland has entered the sphere of a relative surplus production of raw materials and food products.

A decrease in domestic demand for food will be inhibited and its systematic increase will start at last, supported by a slight increase in the number of permanent and seasonal inhabitants of Poland (Tab. 1).

Production of agricultural raw materials for non-food processing will continue to develop, mainly for biofuel manufacturing and acquisition of other renewable energy resources (RER) in rural areas.

Therefore it may be assumed that since 2003 an average annual growth in agricultural global production (P_{gl}) and final output (O_{fnl}) of between 0.5 and 1.0% will happen. At the same time the value of generated gross national product (GDP) will increase annually by between 4 and 7%. In agriculture a similar increase in income parity is possible but in 20-25 years each commercial (developing) farm will have to produce food for at least 30–35 families (households) and not for 10–14 households as it does today. The number of such commercial farms will decline but their average farm area will grow. The arable area will be decreasing as a result of abandoning tillage of marginal soils and designing agricultural areas for afforestation or for municipal and other purposes.

Considering the above and using data obtained from GUS and Agricultural Censuses from 1996 (PSR'96) and 2002 (PSR'02), it was possible to develop one of the variants of short-term (until 2010), medium-term (until 2020) and long-term (until 2030) forecasts of changes in rural areas and in agriculture. Current study variant of the balanced forecast has been presented in the subsequent tables.

Table 1. Population and households in Poland and in agriculture

Specification	Number in thousand per year:				
	1996 PSR '96	2002 PSR '02	2010 forecast	2020 forecast	2030 forecast
Population in Poland – total	38639	38230	38800	39200	39500
Population in rural areas	14736	14620	14750	14850	14900
Farmer population (farms over 1 ha)	8245	7457	5750	3000	2000
Households in Poland	12501	13337	13540	13750	13800
Households in rural areas	4116	4375	4400	4450	4500
Farmer households (over 1 ha)	2047	1956	1200	700	530

Source: Prognostic studies IBMER, 2006

Table 2. Socio-production changes in agriculture (round off numbers)

Specification	Unit	Number of units per year				
		1996 PSR '96	2002 PSR '02	2010 forecast	2020 forecast	2030 forecast
Gross national product (GDP)	1996=100	100	120	160	230	300
GDP – prices 2002	milliard (10^9) PLN	644	773	1030	1480	1930
Share of agriculture in GDP	%	3.5	3.0	2.5	2.0	1.6
Agricultural GDP – prices 2002.	milliard PLN	23.2	23.2	25.7	29.6	31.0
Global agricultural production (P_{gl})	milliard JZ(*)	1100	1080	1200	1300	1360
Final agricultural output (O_{fnl})	million JZ	646	650	730	800	830
Global production intensity	JZ/ha	61	64	79	96	111
Final output intensity	JZ/ha	36	38	48	59	68

Source: Prognostic studies IBMER, 2006

(*) JZ = equivalent unit

Table 3. Changes in agriculture and AL structure (round off numbers)

Specification	Unit	Number of units per year:				
		1996 PSR '96	2002 PSR '02	2010 forecast	2020 forecast	2030 forecast
Number of households in Poland per 1 commercial farm (over 1 ha AL)	pcs.	10	14	18	25	35
Number of necessary commercial farms	thous.	1250	950	750	550	400
Commercial and other farms (over 1 ha AL) total	thous.	2047	1956	1200	700	530
In which: – farms to 10 ha AL	thous.	1651	1573	865	300	280
– farms 10 – 50 ha AL	thous.	383	363	310	270	220
– farms over 50 ha AL	thous.	13	20	25	30	30
Farms and agricultural allotments to 1 ha AL	thous.	1020	977	1030	1100	1020
Farms and agric. allotments total	thous.	3067	2933	2230	1800	1550
Sowed area (ploughlands)	thous. ha	12297	10764	10000	9300	8800
Fallows and idle lands on GO	thous. ha	1468	2303	1900	1300	800
Permanent meadows	thous. ha	2657	2531	2100	1800	1600
Permanent pastures	thous. ha	1211	1031	930	840	750
Orchards and multiannual plantings	thous. ha	249	271	270	260	250
AL in farms total	thous. ha	17882	16899	15200	13500	12200
Fallows, idle lands and other AL beside farms	thous. ha	592	851	700	400	200
AL in Poland total	thous. ha	18474	17500	15900	13900	12400

Source: Prognostic studies IBMER, 2006

Polarization of agricultural holdings to commercial estates, large commercial family farms, small independent farms and recreational-hobby farms leads to diversified regional agrarian changes. The number of production agricultural holdings decreases more than the statistical reports show. Due to taxation and insurance reasons (Agricultural Social Insurance Fund – KRUS) numerous craftsmen and service providers living in the country or possessing lands there register themselves as farmers. Our analyses reveal that positive agrarian transformations among commercial farms happen too dynamically and these processes should be slowed down, particularly if they take place during even faster diminishing of arable area used by farmers [Szeptycki *et al.* 2005]. Other researcher teams obtained similar results [Michna 2006, Wilkin et al. 2003, Zegar 2003 and others].

A slight increase in the number of rural households but a systematic decline in a total number of farmer population and population on farms with areas smaller than 1 ha AL should be expected on a macroscale of the whole country.

In comparison with the state from 2002 the percentage of farmer population in rural areas will decline from 51.0% to 13.4%, whereas the percentage of agrarian population in Poland will decrease from 19.5 to 5.1% in 2030.

In 20–25 years the arable land area (AL) per agricultural holding will diminish to about 12.2 M ha with increasing intensity of its use to about 68JZ/ha of final agricultural output. Mean agricultural holding area will increase to 23.0 ha AL.

The number of farms with area exceeding 1 ha AL will decline to about 530 thous. in 2030, but about 250 thous. of them will be holdings with area over 10ha AL. It may be estimated that about 400 thous. agricultural, horticultural and specialist holdings will be permanently developing ones. Almost 100 thousand farms will attempt to use organic methods of food raw material production (without application of chemicals). A part of such specialized small organic farms united in "healthy food" producer groups will be also regarded as developing farms [Golka, Wójcicki 2006].

So far observed and understandable reluctance of farmers for teamwork and developing cooperative forms of supply and provision of technical services for agriculture must disappear. Further development of social and technical infrastructure in rural areas is indispensable and the number of off-farm jobs in villages and local administrative, production and service units must grow.

ENERGY OUTLAYS AND ENERGY INTENSITY OF AGRICULTUTAL PRODUCTION

Research on material and energy outlays on agricultural production and prognostic studies conducted by IBMER (Tab. 4) reveal lowering of these outlays total in agriculture at simultaneous increase in energy units per 1ha AL and systematic decreasing energy intensity of final agricultural output (MJ/JZ). We forecast decreasing live labour outlays, fixed asset outlays and repairs, as well as direct energy carriers (mainly coal). The outlays of mineral fertilizers and other agro-chemicals but also the outlays of agricultural raw products (mainly fodders) will increase.

Developing farms will operate in the way allowing to pass on the agricultural environment to the future generation in a better ecological condition than present. Greater yields must be accompanied by higher organic and mineral fertilization and increment of soil organic matter resources. Cumulated material and energy outlays in agriculture together with live labour have been decreasing progressively and excluding live labours they will remain on a hitherto noted level of about 1000 PJ/year.

Table 4. Forecast of energy changes in Polish agriculture until 2030

Kind of energy carriers	Number of energy units (PJ) outlays per year:					
	1996 PSR '96	2002 PSR '02	2005 estimate	2010 forecast	2020 forecast	2030 forecast
Direct energy carriers	342	320	308	290	258	230
Fixed assets and repairs	195	195	187	170	151	135
Fertilizers and other agrochemicals	160	156	162	170	185	180
Direct carriers, fixed assets and chemical means total	697	671	657	630	595	545
Plant and animal agricultural raw products	358	350	360	380	405	415
Energy outlays total without live labour	1055	1021	1017	1010	1000	960
Live labour of people and horses	298	267	243	187	116	82
Total with live labour	1353	1288	1260	1197	1116	1042
Outlays indicators total: – per 1 ha UR (GJ/ha)	75.7	76.2	76.8	78.7	82.7	85.4
– per 1 JZ (MJ/JZ)	2094	1984	1867	1640	1395	1255

Source: Prognostic studies IBMER, 2005

Cumulated energy efficiency calculated as the ratio of obtained final output to the energy outlays still remains negative, irrespective of converters to energy units applied for this production. Calculations show that [Wójcicki 2006] on average 1.43 MJ of cumulated material and energy outlays were necessary to obtain 1MJ of final output and if we consider calorific (nutritional) value the use is on average 2.96 MJ/MJ.

Table 5 shows the structure of use of direct energy carriers in agriculture and farmer households and the share of renewable energy resources (RER) in them.

The use of timber and wood wastes, as well as other biomass in solid form (straw, energy plantations) is and will be dominant in the RER use in rural areas. Firewood resources become increasingly limited [Pawlak 2006, Wójcicki 2007a]. Forestry and timber industry need timber mainly for construction industry, furniture manufacturing and paper industry; wood wastes are better and better utilized, whereas timber from forest tending cuts is destined for firewood for rural populations. A grave hazard for balancing timber mass turnover in Poland has been posed by initiated obligatory timber and wood waste procurement for burning in a growing number of power plants. The purchasing prices are still profitable for farmers and some foresters, so not only firewood from forest tending cuts but also from the newly formed energy plantations is burned.

Table 5. Use of direct energy carriers in agriculture

Kind of fuel or energy	Energy consumption in years (PJ):				
	1996 PSR '96	2002 PSR '02	2030 forecast	structure % 2002	structure % 2030
Solid fuels	188	164	50	51	22
Liquid fuels	121	122	120	38	52
Gas fuels and thermal energy	3	4	20	1	9
Electricity	30	30	40	10	17
Energy carriers total	342	320	230	100	100
RER share [%]	13.7	14.4	35.7	-	-

Source: Prognostic studies IBMER, 2006

Suppliers of biomass for burning in power plants, like energy suppliers from small hydroelectric plants and wind power stations obtain unit profits higher than fees (PLN/kWh) for electricity consumed by households. Thus, electric power generation at the cost of tax payers reveals an improvement in RER use indicators. The logic of such payments is problematic, particularly in case of biomass because each burning uses oxygen (O) end emits carbon dioxide (CO_2) which is the main agent of greenhouse gases accumulation in the atmosphere. If the outcomes of biomass burning are not considered in the estimates of generation and absorption of greenhouse gases, the calculations may be erroneous. Biomass burning should be counted to all sources of CO_2 generation and only then its absorption by green plants, ocean waters and other should be deducted. Only then full balance of greenhouse gases cycling will be correct allowing for drawing correct conclusions.

MULTIFUNCTIONAL AND SUSTAINABLE DEVELOPMENT OF RURAL AREAS AND AGRICULTURE

Insufficient use of live labour potential and both registered and hidden unemployment will be observed in rural areas and on farms. Due to income parity there will be few farmer families deriving income solely from the sales of their own agricultural products. Implementation of evolutionary change strategy aiming at sustainable production on commercial farms integrated with the shaped rural environment and operating in the multifunctional rural development system, will affect the development of food economy and production, and services market, advantageous for the local communities. It concerns mainly local agri-food processing industries, technical infrastructure, agritourism, utilization of RER and creating new, off-farm jobs in villages and agricultural communes [Wójcicki 2007c].

The basis of multifunctional rural development is ensuring progressively better socio-economic conditions for rural communities at further proper shaping of forest, agricultural and municipal environment. Agricultural commodity production will concentrate on about 500 thous. of farms and agricultural enterprises which must undergo technological and ecological modernisation. These farms will specialize in certain directions of livestock, horticultural and general agricultural production. In order to achieve a satisfactory income parity they must intensify and increase their specialist commodity production. Intensification of production allows for cheaper utilization of modern technical means, introduction of the elements of new technologies, sustaining smaller losses and damages, for improving quality and in result also lowering unit costs of production and improving its market competitiveness. However, excessive and inconsiderate concentration, specialization and intensification of production on large commercial family farms may lead to ecological hazard to the environment and raw materials destined for food production. Therefore technological modernization, i.e. introduction to farms modern technologies resulting from the scientific progress must be connected with farm ecological modernization according to the agri-environmental programmes.

Agricultural holdings and rural households have been and still remain an important "pollutants" of their environment. In order to prevent further environmental pollution proper sanitation of rural areas is absolutely necessary, whereas agricultural space should be integrated with rural areas in such a way that intensification of plant and livestock production will be accompanied with systematically diminishing point and area sources of pollution of soil, water and air, plantings and housing estates. Integrated agriculture must use technologies of agricultural production adjusted to the accepted rural development strategy in Poland resulting from saving energy and the environment and observance of animal welfare.

Implementation of CAP and accepted agri-environmental programmes enforce agricultural holdings to apply Good Agricultural Practice rules in Agriculture (GAP), to observe the EU standards and change their production to sustainable production and in particular cases also to organic production [Golka, Wójciki 2006].

Developing family farms, commercial farms and commercial estates integrating with the local environment will have to introduce technologies of sustainable agricultural production. Sustainable production should enable obtaining large crop yields for many years with maintained soil abundance and fertility but also observing other requirements of environmental protection and ensuring satisfactory parity remuneration for farmer families.

There is a great potential to reconcile the requirements of production intensification with Good Agricultural Practice (GAP) rules in agricultural production among others by balancing the level of reproduction and degradation of soil organic matter at application of proper coefficients and converters of permissible level of organic and mineral fertilizer application to obtain determined main and side yields of various crops.

At large yields obtained owing to biological progress, chemical application and modern technologies, it is possible to apply high yet balanced doses of NPK treatment, magnesium, calcium, macro- and microelements. In highly productive and sustainable agriculture, beside priority application of biological and mechanical measures, also selective use of chemical crop and animal protection is permissible as well as the use of hormones, food preservatives, cleanliness means and other modern preparations. Raw materials for food production or direct agricultural products obtained in this way meet and will meet commodity market standards and will be considered safe, so "healthy" food products.

Ecological agricultural production is generated in the frame of sustainable production by implementing organic methods without the use of agricultural chemicals. Progress in the field of rational use of chemicals in crop and livestock production and food preservatives for storage and agri-food processing, but also biological progress considering genetic modifications is either treated reluctantly or rejected by the opinion making circles and a majority of the society who demands "healthy" food products from the producers and importers. These demands are justified and generally fulfilled because a larger part of procured raw materials for food production meets the quality standards, including so called "healthy" food requirements. Farmers are able to meet the public demand and supply the raw materials of above standard quality produced on organic farms, i.e. without mineral treatment, agrochemical use for crop or animal protection or food preservatives, hormones or genetically modified products [Golka, Wójcicki 2006]. However these will be products of extensive agriculture, low productive and labour consuming, therefore they will be definitely more expensive than the standard ones. Only few social classes in Western European countries can afford so expensive food. In Poland a common demand for so called organic food supply almost does not match its market demand and only minimal increases in its sales are noted.

It seems that further development of ecological agriculture should focus on teams of neighbouring farms localized in the protection zones of national parks, in landscape parks and in other protected areas where intensive agricultural production is not recommended or will be forbidden shortly. Ecological agriculture is and will remain a part, or strictly speaking a higher form of introducing sustainable production on farms integrating with rural environment and connected with multifunctional agriculture and rural development.

TECHNICAL INFRASTRUCTURE OF AGRICULTURE AND RURAL AREAS

The main reason for hitherto stagnation in rural areas and agriculture was unemployment, low profitability of agricultural production and lack of investment means for modernisation of farms and development of rural infrastructure. Boom, pre-accession programmes and announced inflow of the EU assistance funds have caused that since 2007 rural areas and agriculture will have sufficient financial means for reconstruction and development investments. A strategy focused on maintaining the hitherto existing number of rural households and polarization of farms and agricultural allotments to large commercial, organic, non commercial, recreational farms and other will be realized.

This strategy involves introduction of multifunctional model of Polish rural areas where both commercial farms and enterprises running sustainable agricultural production will be operating together with agri-food processing industries strictly integrated with rural environment. Pro-ecological endeavours will affect changes of crop and livestock production technologies, as well as local food and non-food product processing. The role of infrastructure, afforestation and maintaining biologically active terrains in rural areas will increase.

Technological and ecological modernization of potentially developing farms and agricultural enterprises conducting relatively highly commercial but sustainable agricultural production integrated with ecologically developed rural environment will inevitably take place in the 2005-2015 decade. Some of these commercial farms will have to undertake difficult in view o technologies, organic food production of above standard quality.

Standard quality agricultural production should be pursued according to GAP rules using technologies within the limits of permissible soil, water and air pollution and observing other rules or energy and environment saving. The future form of sustainable production of safe food products, integrated with the environment will involve introducing progressive methods of precision farming on large commercial farms [Wójcicki 2007b].

Agricultural production on farms is connected with the whole food economy and national economy through a network of enterprises, institutions and organizations surrounding these farms, which are collectively named technical infrastructure of agriculture. Because these and the other organizations of the infrastructure also influence living standards, cultural and other conditions of farmer families' and other rural inhabitants' lives, in their wider meaning they are called a social and technical rural infrastructure. Our studies and prognostic studies reveal significant interrelations between agriculture transformation, development of agricultural engineering, modernization of agriculture technical infrastructure and necessary changes in rural infrastructure. We are developing and will continue studies in this field strictly connected with studies on development and protection of the environment in agricultural areas.

Technical infrastructure of agriculture is a part of social and technical infrastructure of rural areas and small towns. It comprises appliances, organizations and enterprises directly connected with crop and livestock production and with technical and commercial services for agricultural holdings. A part of appliances and organizations of agricultural infrastructure occurs directly on farms or in their immediate rural surrounding (roads, domestic hydrophore units, electrical, water and sewer cross-connections, neighbourly services, informal technical and commercial services network for agriculture, etc.). Also houses and technical equipment of farmer households may be counted to "internal" infrastructure of agricultural enterprises.

A vast majority of appliances, constructions, institutions and enterprises of agricultural infrastructure occurs outside farms in individual villages, communes or microregion. It is impossible to determine strictly the limits of individual elements of farm, agriculture, village, commune or region infrastructure.

Fixed assets of mechanization and electrification of agriculture are localized mainly in agricultural enterprises but they become increasingly present in technical rural infrastructure. Some elements of internal and external infrastructure of agricultural holdings and allotments were presented by numerical data in Table 6.

Table 6. Forecast of changes in water and sewer infrastructure in rural areas and in agriculture

Specification	Number of households or appliances per year [thousand]				
	1996 PSR '96	2002 PSR '02	2010 forecast	2020 forecast	2030 forecast
Number of rural households	4116	4375	4400	4450	4500
In which farms and agricultural allotments	3067	2933	2230	1800	1550
Connection to water supply system	1455	1712	2150	2500	2800
On-farm water main from wells	807	739	580	520	430
Wells without water supply installations	561	357	290	180	120
Water supplies	24	81	50	30	10
Water main and wells total	2847	2889	3070	3230	3360
Sewer system without sewage treatment	28	31	40	30	30
Sewer system with sewage treatment	88	99	380	700	1100
Cesspit with sewage treatment	499	567	700	900	930
Cesspit without sewage treatment	1373	1561	1500	1300	1100
No drainage	859	631	450	300	200
Sewage drainage total	2847	2889	3070	3230	3360

Source: Prognostic studies IBMER, 2006

An example of necessary changes in water and sewer infrastructure in agriculture and rural areas presented above should be regarded in a wider context of the whole water management in Poland. Our water resources are insufficient and water consumption and wasting is growing all the time and may lead to its tragic deficit. Therefore necessary endeavours must be undertaken to diminish unit water consumption at simultaneous continuation of capital-intensive water and irrigation investments in small and large water retention systems, together with construction of big dams, reservoirs and hydroelectric plants and adequate pumping stations and flood embankments.

Changes in the number of tractors, cars and combined harvesters at the disposal of farms in Poland point to necessary introduction of modern aggregates to replace less efficient, fully worn out and outdated equipment. This applies to both tractors and all kinds of combined harvesters and other farm machinery.

Table 7. Changes in technical equipment in Polish agriculture

Kind of equipment	Number [thousand pcs.] of technical equipment in the years				
	1996 PSR '96	2002 PSR '02	2010 forecast	2020 forecast	2030 forecast
Tractors to 40 kW	825	865	775	635	390
Tractors over 40 kW	478	500	465	395	420
Lorries over 2 t	86	90	100	110	100
Lorries to 2 t	191	195	200	200	190
Combined harvesters	97	124	110	90	70
Potato harvesters	76	81	75	60	40
Sugar beet harvesters	27	32	30	23	12
Harvesters silos and other self-propelled ones	13	13	26	36	38

Source: Prognostic studies IBMER, 2005

Decreasing number of beetroot harvesters result from the fact that so far prevailing one-row harvesters became replaced by highly efficient multiple-row self propelled harvesters gathering over 30% of the sugar beet acreage [Szeptycki *et al*. 2005]. Decreasing numbers of farmers cultivating potatoes on larger acreages and using more efficient self-propelled machines will lead to quantitative decrease in the number of potato harvesters. On the other hand a dynamic increase may be expected in the number of harvesters silos and other self-propelled machinery (presses, gatherers and sheaf-loaders) for straw, soiling crop and other bulky feed gathering.

Most of the highly efficient self propelled harvesters silos, combined harvesters, lorries and all types of tractors will be utilized within the contractor or other services systems.

Analysis of the data presented above shows that investment needs connected with necessary technological modernization of Polish agriculture concerning acquisitions of new tractors, harvesters and other farm machinery are considerable and each year exceed the value of 1 ton of corn (10 JZ) per each 1 ha AL. If this value is supplemented by investment outlays necessary for modernisation of farm buildings, store-rooms and other constructions, as well as infrastructural appliances (roads, irrigation systems, water supply and sewer systems, etc.), a medium-sized farm will be unable to provide the necessary financial means for its modernization.

Complete technological and ecological modernization will be possible primarily on family farms which systematically extend their acreage of AL (through land acquisition or lease), increasing crop yields and productivity of their livestock, consequently diminishing accumulated energy-intensity and unit costs of their production, but also rationally utilizing direct payments and other EU subsidies, preferential investment and turnover credits secured by ARMA and banks [Wójcicki 2007a].

The number of such farms will be growing and one can expect a statistical modernization growing from 10 to 15 thousand farms per one year at present and from 40 to 45 thousand in 10-15 years. Among indicators of accelerated modernization of family farms there will be increasing the number of new tractor aggregates purchased by farmers every year. Farmers' demand for new tractors may increase in several years from between 25 and 30 thousand annually.

CONCLUSIONS

The analysis of sustainable and ecological agricultural production on the macroscale of the whole country allowed to determine needs and potential of technological and ecological progress in developing agricultural holdings and their infrastructure. While emphasizing the role and importance of rural technical infrastructure development, investigated were transformations of production services in agriculture and whole food economy, but also dynamics of utilization of renewable energy resources (RER) in agriculture and in rural areas.

The analysis of the hitherto existing state and prognostic studies on energy and environment saving in agriculture and rural areas allow to draw the following general conclusions:

– agricultural production conducted in the arable area (AL) diminishing do12.2 M ha and on decreasing to 400 thous. commercial farms will be sustainable and partly ecological, leading to lesser pollution of soil, water and atmospheric air at simultaneous decreasing of energy-intensity and increasing energy and economic effectiveness of agricultural raw materials for food production and others;

– because of declining number of farmer households, joint production and social consumption of basic energy carriers will be decreasing and their structure will change in favour of electricity and fuels obtained from renewable resources;

– production and social demand for all energy carriers used by enterprises, institutions and rural inhabitants will be increasing;

– increased energy demand of agriculture and rural areas will be to greater extent fulfilled owing to renewable energy resources, if the energy proves cheaper and more easily utilized than the conventional one;

– forecasted national economic development will cause a much higher demand for energy than possible to generate from RER, therefore the future of energy in Poland lies in atomic power stations, fuel cells and modern ecological methods of generating energy from coal.

Using the research methodology updated at IBMER for studies on the hitherto existing state and prognostic estimates concerning cumulated material and energy outlays calculated by means of rolling costs, we have drawn the following conclusions:

– unit energy-intensity of agricultural production calculated by the number of energy units (MJ) per a provisional corn unit (CU) has been decreasing systematically and will continue to decrease owing to rationalization of employment, agrochemical application, the use of fixed assets and reducing the hitherto consumption of solid fuels (mainly coal);

– energy efficiency (CU/MJ) of both crop and livestock production still remains negative and is the reason for insufficient use of biomass, biofuels and other renewable energy resources for energy production in rural areas;

– positive results of studies concerning balancing agricultural production and its integration with rural infrastructure, organic production of agricultural products and using RER and other unconventional energy, incline for predicting a people-friendly future model of rural area and agriculture operating in ecologically protected terrains.

It is necessary to undertake further interdisciplinary basic and development studies on energy saving and shaping the natural environment, which would among others determine real production and social standards and unify the attitudes of specialists from various ecological and energy options. These studies should determine the directions of future development of the model of Polish agriculture and rural areas, including also future model of agricultural engineering and complete rural infrastructure.

REFERENCES

Golka W., Wójcicki Z. *Ekologiczna modernizacja gospodarstwa rolniczego.* Monografia. Wydawnictwo IBMER, Warszawa 2006.

GUS. *Wstępne wyniki Powszechnego Spisu Rolnego.* Wydawnictwo GUS, Warszawa 2003.

Pawlak J. *Ekonomiczne i organizacyjne problemy mechanizacji i energetyki rolnictwa.* Monografia. Wydawnictwo IBMER, Warszawa 2006.

Szeptycki A. i in. *Stan i kierunki rozwoju techniki oraz infrastruktury rolniczej w Polsce.* Wydawnictwo IBMER, Warszawa 2005.

Wójcicki Z. *Postęp technologiczny w rozwojowych gospodarstwach rolniczych.* Problemy Inżynierii Rolniczej Nr 3 (53), Warszawa 2006.

Wójcicki Z. *Poszanowanie energii i środowiska w rolnictwie i na obszarach wiejskich.* Monografia. Wydawnictwo IBMER, Warszawa 2007a.

Wójcicki Z. *Rozwój rolnictwa zrównoważonego i precyzyjnego.* Problemy Inżynierii Rolniczej Nr 1 część II, Warszawa 2007b.

Wójcicki Z. *Technologiczna i ekologiczna modernizacja rolnictwa i obszarów wiejskich.* Infrastruktura i Ekologia Terenów Wiejskich (in print), Kraków 2007c.

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