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METHODICAL BASES OF FAMILY FARM MODERNIZATION

Summary

Described were IBMER (Institute for Buildings Mechanization and Electrification of Agriculture (IBMER)) activities aimed at the development and verification of research procedures used for the assessment of commercial family farm activities and for evaluation of progress in their technological and ecological modernization.

Current assessment of agricultural farm activities has been conducted using an appropriate IBMER procedure [Wójcicki 2008], which comprises tables for parametric (numerical) description of commercial farm equipment and activities in 2008.

Development family farm is modernized on the basis of the project of its organization and mechanization in the nearest 5-7 years (e.g. until 2015). Such project may be developed using new IBMER technological and balance sheet procedure (methods), which has been currently (2009) elaborated and verified.

A comparison of the recent activities with the accepted organizational project allows to determine the level of progress in the sphere of technical and ecological modernization of the analysed farm and its infrastructure.

Both research procedures contain a number of common methodical bases, the part of which was synthetically compiled in tables concerning the assessment of modernization of a sample farm with farm area 40 ha AL, specializing in potato, milk and beef cattle production.

Key words: rural areas, agriculture, family, activities, modernization, assessment, methods

INTRODUCTION

In result of application of the EU socio-economic directives and realization of the hitherto existing and new (since 2013) Common Agricultural Policy (CAP), almost all commercial agricultural farms (enterprises) in Poland will

undergo a technological and ecological modernization. According to IBMER forecasts until 2030 the number of such farms will reach between 450 and 500 thousand. [Wójcicki 2007].

Modernization of each enterprise, particularly an agricultural farm is a continuous process lasting at for least several years. Modernization project, involving credit needs and usually called a business plan is developed according to conventional (educational) or special (EU or bank) procedures. IBMER uses also modern research procedures for the assessment of activities of commercial family farms and develops new methods for evaluation the progress in technological and ecological modernization of development agricultural farms and their service institutions (infrastructure). The procedures for determining the state, directions of changes and assessment of progress in modernization focus especially on proper selection and rational use of fixed assets, realizing that they serve the production, energetical, ecological and economic needs of development family farm [Golka, Wójcicki 2006, 2009, Szeptycki et al. 2003, 2005, Wójcicki 2007, 2008].

The publication aims to systematize the methodical bases and present the main elements of research procedures used for the assessment of modernized commercial agricultural farms on an example of a family farm collaborating with IBMER.

RESEARCH METHODS AND METHODOLOGIES

Restructuring Polish agriculture and modernization of new farms aims in an evolutional way at diminishing the number of farms and enlarging the agricultural farm areas at generally decreasing arable land (AL) area in Poland and moderate increase in the number and area of large farms using industrial methods of livestock or special crops production.

We are targeting at the integration of agricultural production with developed environment of rural areas and switching to systems of production resulting from:

- rules (code) of good agricultural practices,
- regulations for organic production without agrochemicals use,
- attempts at practical application of computerized precision farming.

Therefore, each plan of organization and mechanization of a farm must determine at least 5-7 years ahead:

- the land use structure, sown areas, crop rotation and crop yields,
- livestock density, its structure and animal productivity,
- balance of bulk feeds, and own protein feeds,
- balance of soil organic matter and fertilizer needs,
- fixed assets set and their maintenance costs,

– balance sheet of farm receipts, expenses and incomes,
– assessment of other investment and development potential of farm.

The assessment of hitherto existing farm organization is conducted by means of describing the equipment and activities of the studied object for the last (e.g.2008) year using methods, tables and procedures recommended by IBMER [Wójcicki 2008].

By comparing the resulting numerical parameters of the initial state (e.g.2008) with the parameters of the targeted state described in the organizational project (plan) the scale of modernization needs may be determined. On the other hand, in the subsequent years the results of actual state are compared with the assumed target results which allows to specify the level and dynamic of occurring technological changes on the analysed developmental family farm.

The organizational part of the project has been elaborated basing on the recent knowledge and agronomic recommendations (both for agriculture and animal husbandry). The project part concerning mechanization and organization should be prepared using technological (technological card) method, which is rather laborious but precise and enables control.

Balance sheet methods should be used for verifying the assumptions, variants and obtained results, which would allow to avoid "false results" or "wishful thinking" which may appear in agricultural programming or forecasting where intuition of the project makers still plays an important role.

THE ANALYSED AND ORGANIZED FARM

Methodical bases of assessment of the activities and evaluation of progress in modernization of family farm may be presented synthetically on an example of research procedures application on a farm collaborating with IBMER [Taraban 2008].

It is a farm with an area of 34.4 ha AL, which plans the enlargement of arable lands, simplification of plant and livestock production, introduction of rational crop rotation, increase in natural fertilizer production, diminishing the use of agrochemicals, decreasing the unit outlays on materials and energy and decreasing unit costs of production.

The potential of intensification and improvement of production effectiveness are on one hand inhibited by the farm localization on sandy soils with low (0.3) conversion indicator and quite severe climate in the south-western part of the Warmińsko-Mazurskie voivodeship.

On the other hand the farm is situated in the area well equipped with agricultural and rural infrastructure and may use agricultural services and efficient supplies and sales of its products.

Modernization assumes the enlargement of AL area to 40 ha by 2015 through reclamation of wastelands, renting and subsequently purchasing the land from neighbours (Table 1).

Cropping structure use so far (Table 2) will be reconstructed through introduction of 7-year crop rotation where rye with undersown serradella occurs twice as well as 2-year clover cultivation with grasses (Table 3). Such crop succession on 4 hectare plots will eliminate cereal monoculture, which will facilitate maintaining an adequate level of soil organic matter. Cultivation of clover and serradella will make easier balancing soil fertility and abundance and will diminish nitrogen (N) and phosphorus (P) losses through water leaching from the field unsown with crops.

The planned crop rotation will allow to increase the yields and raise (by 10.2t) cereal yields allowing to maintain a positive balance of farm own protein feeds. The crop rotation will also allow for diminishing the energy outlays necessary for ploughing and tillage, fertilization, tending and protection of crops.

Table 1. Farm area in 2008 and 2015

Kind of farmlands	Area [ha] in:		Cropping structure [AL] in:	
	2008	2015	2008	2015
Arable lands (AL)	22.0	28.0	64.1	70.0
Natural meadows (PG)	8.3	8.0	24.2	20.0
Natural pastures (PG)	4.0	4.0	11.7	10.0
Other (AL)	–	–	–	–
Arable lands total (AL)	34.3	40.0	100.0	100.0
Lands except AL	4.3	3.6	11.6	9.0
Farm area total (PO)	38.8	43.6	100.0	100.0

Table 2. Crop production in 2008

Crop or PG	Area [ha]	Main yield [t/ha]	Side yield [t/ha]	Final output Tonnes	
				main	side
Potatoes	2.0	22.0	–	44.0	–
Spring wheat	2.0	3.5	4.0	7.0	8.0
Rye	1.5	3.5	5.0	5.3	7.5
Spring barley	6.0	3.0	3.5	18.0	21.0
Triticale	4.0	4.5	5.0	18.0	20.0
Cereal mixture	6.5	3.0	3.8	19.5	24.5
Crops total	22.0	–	–	(67.8 tonnes of grain)	91.0
Natural meadows	8.3	40.0	–	332.0	–
Natural pastures	4.0	35.0	–	140.0	–
Total AL	34.3	–	–	–	–

Table 3. Crop production in 2015

Crop or PG	Area [ha]	Main yield [t/ha]	Side yield [t/ha]	Final output Tonnes	
				main	side
Potatoes	4.0	28.0	–	112	–
Rye with undersown serradella	8.0	4.5	6.5	36	52
Barley with undersown clover	4.0	5.0	6.0	20	24
Clover with grasses	8.0	60.0	–	480	–
Spring wheat	4.0	5.5	6.5	22	26
Serradella (undersown)	(8.0)	18.0	–	144	–
Crops total	28.0	–	–	(78 ton of grain)	102
Natural meadows	8.0	50.0	–	400	–
Natural pastures	4.0	45.0	–	180	–
Total AL	40.0	–	–	–	–

The farmer has also decided to simplify his livestock production (Table 4) through elimination of pig production and enlargement of the barn to 25 milk cows and cattle production in a closed circle with calf rearing to breeding heifers and young beef cattle.

The livestock density will increase from 46.7 to 70.0 BU thus increasing the livestock density index from 1.36 BU/ha to 1.75 BU/ha AL. Therefore natural fertilizer production will increase:

- farmyard manure from 380 to about 470 tonnes,
- slurry from 385 to about 480 tonnes.

Rotten and fermented farmyard manure will be used in spring under potatoes, barley and wheat while fermented liquid manure and slurry will be used at an appropriate time on meadows and pastures, under clover and under rye with the undersowing.

Modern roofed manure plate and leakproof containers for liquid manure and slurry will be necessary. Processing of natural fertilizers in an agricultural biogas plant has been planned for the future.

Elaborated balance of bulk and protein feeds for the animals on the farm is positive ensuring full utilization of additional green forage, hay and ensilaged hay, wheat and barley. The excess of rye will be sold and the protein components and special feeds for calves and dairy cows will be purchased.

Milk production will increase from 94.5 t to 150 t/year, of which 120 tonnes will be acquired by the dairy plant. Market livestock production will raise from 12.3 t to 15.5 t/year, sold as animals for slaughter or breeding animals (heifers).

Table 4. Livestock density in 2008 and 2015

Category and group of animals	Conversion factor [BU/heads]	Average annual state per year			
		2008		2015	
		item	DJP	item.	DJP
Dairy cows	1.2	21	25.2	25	30.0
Calves below 2 months	0.15	4	0.6	5	0.8
Calves 2 – 6 months	0.25	5	1.3	8	2.0
Heifers 6 – 15 months	0.4	8	3.2	12	4.8
Heifers 15 – 24 months	0.9	2	1.8	10	9.0
Young beef cattle 6 – 15 months	0.6	8	4.8	13	7.8
Young beef cattle (fattened) 15 months	1.0	3	3.0	12	12.0
Rejected fattened cattle	1.2	1	1.2	3	3.6
Cattle total	–	52	41.1	8	70.0
Sows	0.35	2	0.7	–	–
Piglets below 2 months	0.02	9	0.2	–	–
Piglets 2 – 4 months	0.08	18	1.4	–	–
Porkers 4 – 7 months	0.15	22	3.3	–	–
Pigs total	–	51	5.6	–	–

BALANCE SHEETS OF MODERNIZED FARM ACTIVITIES

A balance sheet pointing to a degradation or reproduction of soil organic matter is a productive and ecological basis for modernization and technical-economic activity of the future farm. In our model example this balance (Table 5) is definitely positive (+1.33 t/ha AL), which ensures obtaining continuing yields and proper utilization of natural and mineral fertilizers.

The inventory of fertilizer needs for cultivated crops (Table 6) shows, that despite high organic fertilization, cereal nitrogen (N) needs will have to be supplemented by means of top dressing or foliar fertilization. Fertilizer needs of potassium (K) and phosphorus (P) will be supplemented together with service calcium-magnesium fertilization (dolomite and other).

The designed and applied technological cards reveal the balances of life traction force labour. In result of modernization the farmer family labour outlays will decrease from 5304 man-hr/year to 4600 man-hr/year in 2015 (from 135 to

115 man-hr/ha). Comparative balance sheet of receipts (Table 7) shows that while using the prices from 2008/09 in 2015 the farmer's family will achieve greater receipts total per 1 ha AL and per 1 man-hour of their own labour.

The expenditure will be higher, too (Table 8), although the outlays on depreciation of technical means and liquid fuel consumption will also decrease. Simplified production and simplified technologies and increased utilization of production services will lead to lowering the reproductive value of necessary technical set but also the costs of their maintenance (amortization) and utilization (fuels). Electricity consumption will increase despite greater use of solar energy and most probably also biogas.

Comparative balance sheets of the farm activity and development investment activities have been presented in Table 9.

Table 5. Balance of soil organic matter on modernized farm 40 ha

Crops	Organic matter renewal coefficient [t/ha]	Sown area		Result of farm assessment [t/ha · % AL]	Organic matter degradation or reproduction level [t/ha / 100%]
		[ha]	[% UR]		
Table potatoes	– 1.40	4	10	– 14.0	– 0.140
Winter rye	– 0.53	8	20	– 10.6	– 0.106
Spring barley	– 0.53	4	10	– 5.3	– 0.053
Spring wheat	– 0.53	4	10	– 5.3	– 0.053
Aftercrop – serradella, mulch	0.45	(8)	(20)	9.0	0.090
Clover with grasses	1.96	8	20	39.2	0.392
Permanent grasslands	0.95	12	30	28.5	0.285
Total AL	–	40	100	41.5	0.415
Farmyard manure fertilization	0.070	470 t	–	32.9	0.822
Liquid manure-slurry fertilization	0.008	480 t	–	3.8	0.096
Level of degradation or reproduction of organic matter	–	–	–	x	1.333

Table 6. Inventory of NPK fertilizer needs on modernized farm 40 ha AL

Crop or agricultural land	Requirements [kg/t] for:			Aggregate yields	Joint annual requirement for [kg] for:			
	nitrogen N	Phosphorus P	Potassium K		Nitrogen N	Phosphorus P	Potassium K	Total NPK
Table potatoes	3	1	5	112	336	112	560	1008
Winter rye	20	10	21	36	720	360	756	1836
Spring barley	20	9	16	20	400	180	320	900
Spring wheat	22	9	15	22	484	198	330	1012
Aftercrop – serradella, mulch	2	1	2	144	288	144	288	720
Clover with grasses	3	1	3	480	1440	480	1440	3360
Permanent grasslands	3	1	3	580	1740	580	1740	4060
Total AL	x	x	x	x	5408	2054	5434	12896
Farmyard manure fertilization	6	3	6	470	2820	1410	2820	7050
Liquid manure-slurry fertilization	2	1	2	480	960	480	960	2400
NPK from wastes, mineralization, from microorganisms and other [kg/ha]	30	3	15	40	1200	120	600	1920
Excess (+) or deficiency (–)	x	x	x	x	– 428	– 44	– 1054	– 1526

Table 7. Receipts of modernized family farm 40 ha AL (prices 2008)

Receipts	Value of gross receipts in:					
	2008			2015		
	total thous. PLN	per 1 ha AL PLN/ha	per 1 man-hour PLN/man-hour	total tys. PLN	per 1 ha UR PLN/ha	per 1 man-hour PLN/man-hour
Crop production sales	5.6	166	1.07	35.5	888	7.72
Livestock production sales	125.5	3665	23.66	213.0	5325	46.30
Household consumption and gifts	9.9	289	1.87	7.5	187	1.63
Receipts from agricultural production total	141.0	4118	26.58	256.0	6400	55.65
Receipts from services and non-agricultural production	2.1	61	0.40	21.0	525	4.57
Credits, donations, pensions and other	25.5	745	4.81	43.0	1075	9.35
Gross receipts total (balance sweet)	168.6	4925	31.79	320.0	8000	69.57

Table 8. Expenditure of modernized farm 40 ha AL (prices 2008)

Kind of expense	Expenditure value in:			
	2008		2015	
	total thous. PLN	per 1 ha AL PLN/ha	total thous. PLN	per 1 ha AL PLN/ha
Purchases of agricultural products	7.2	210	31.2	780
Chemicals	21.9	639	29.8	745
Fuels and electricity	32.0	933	38.8	970
Fees and exploitation materials	11.6	338	22.7	567
Services and other non-material	0.6	17	20.6	515
Taxes and other non-material expenses	5.7	166	17.0	425
Wages for hired labourers	2.1	61	15.0	375
Investments in renewal and development	33.0	962	35.0	875
Expenditure total (without own labour)	114.1	3326	210.1	5252

Table 9. Balance sheet of modernized farm activities in 2008 and 2015 (prices 2008)

Kind of receipts, expenses or income	Turnover value in:			
	2008		2015	
	total thous. PLN	per 1 man-hour of own labour PLN/man-hour	total thous. PLN	Per 1 man-hour of own labour PLN/man-hour
Gross receipts (balance sheet)	168.6	31.79	320.0	69.57
Material expenses (without household expenses)	65.7	12.39	133.1	28.95
Taxes, insurances and other non-material	5.1	0.96	13.9	3.02
Gross income of agricultural farm	97.8	18.44	273.0	37.61
Remuneration for hired labour	2.1	0.40	15.0	3.26
Production investment expenses	33.0	6.22	35.0	7.61
Gross income of farmer family	62.7	11.82	123.0	26.74
Consumption of own products and gifts	9.9	1.87	7.5	1.63
Household expenses on operation and investments	8.2	1.54	13.1	2.85
Net income of farmer family	44.6	8.41	102.4	22.26
Difference between estimated depreciation and incurred investment expenses	+ 0.7	+ 0.13	– 1.4	– 0.30
Average (25%) interest rate of renewal value of fixed assets and land	47.4	8.94	53.0	11.52
Balance profit (+) or loss (–) from family farm operation	– 2.1	– 0.40	+ 48.0	+ 10.44

ASSESSMENT OF THE ACTIVITIES OF THE MODERNIZED FARM

The use of the research procedures suggested by IBMER allows to assess the whole year activities of a family farm in the initial year of its modernization (e.g., 2008) and in the final year of this process (e.g., 2015) and to follow the modernization progress in the intermediate years. On the basis of balance sheets concerning the activities and equipment of the farm it is possible to estimate whether it is an object:

- where future development in the social and production aspect is possible
- able to conduct sustainable production;
- capable of changing to organic production;
- where simplified technologies of crop and livestock production may be easily introduced;
- possessing adequate technical equipment, which may be supplemented or reduced through the use of services;
- possessing buildings and constructions which may be easily adapted to the production undertaken after the modernization;
- where remuneration for family own labour is increasing with the simultaneously growing potential for undertaking production investments.

While designing and testing modernization of our sample farm of 40 ha AL we may state that considering the family (the heir) and natural conditions it is a developmental farm where sustainable production should be introduced by using the appropriate crop rotation (crop succession) and improvement of soil fertility and abundance. High livestock density allows to use over the norm fertilization with natural and green (mulch) materials, which at some diminishing of crop yield would make possible abandoning mineral fertilization and switching to organic farming excluding the use of basic agrochemicals.

Application of the proper crop succession and undersowing of serradella and clover with grasses simplifies crop production technologies through abandoning ploughing and a number of other cultivation and plant tending measures. Bulk feed crops is facilitated by the use of agricultural presses and silage bales wrappers.

A number of machines which so far have been inadequately used on the farm may be removed from its technical equipment. The farm will start using mechanization, transport and other services, including complex supply and sales. Switching to cattle husbandry will allow for relatively cheap adaptation of farm buildings necessary for milk, cattle for slaughter and breeding heifer production.

A comparison of balance sheets for the farm activities (Table 9) reveals that after the modernization the gross remuneration for farmer's family work will grow over twice in conversion per 1 man-hour of productive work, reaching 26.74 i.e. over twice exceeding so called parity remuneration of non-farmer families currently estimated for about 12 PLN/man-hour.

The investigated farm has a positive investment ability already in 2008, since it invested more than the estimated depreciation value of possessed fixed assets and obtained remuneration for their own labour approximating the value of parity remuneration. During and after the modernization the farm investment potential will be growing because aside from the estimated depreciation investment outlays may be increased by the amounts from the balance sheet profit (+48.0 thous. PLN) and limited remuneration for own work (net 22.26 PLN/man-hour) to the value of (12 PLN/man-hour) of the parity remuneration (Table 9).

CONCLUSION

Presented inventories and analyses reveal that the technological and ecological modernization of developmental agricultural farm may be conducted on the basis of the project of its organization and mechanization realized for between 5 and 7 years (e.g. to 2015). This project (business plan) should be best developed using technological method based on prepared technological cards for individual kinds of crop and livestock production. The technological cards show the needs for manpower, energy inputs and necessary machinery aggregates: own or supplied by service providers.

By balancing the generated and sold production and owing to expenditure and income balance sheets we may estimate the results of annual activities of the analysed family farm.

The appropriate research procedures suggested by IBMER must be further upgraded and verified on a larger set of different agricultural farms. Future methodology for investigating technological progress on family farms in a possibly wide range should consider practical applications of information technologies.

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