ACTA SCIENTIARUM POLONORUM *Oeconomia 10 (1) 2011, 21–33*

TYPOLOGY OF TOBACCO-BASED FARMING SYSTEMS AT THE FARM LEVEL IN SOUTH-EASTERN POLAND

Ryszard Hryniewski, Wiesław Mądry, Dariusz Gozdowski
Warsaw University of Life Sciences – SGGW

Barbara Roszkowska-Mądra
Białystok University

Abstract. The aim of this paper is to analyse the diversity of the farming systems in tobacco farms within south-eastern Poland. The studied 151 tobacco farms are located in three provinces of Poland, i.e. Lubelskie, Podkarpackie and Mazowieckie. 15 diagnostic variables which characterize farming systems were selected for analyses. For multivariate evaluation of farm diversity and their grouping, principal component analysis (PCA) and cluster analysis based on 5 PCs were used. The farms were divided into five clusters which reflected five major types of farming systems in tobacco farms within the studied area. They were distinct mainly for farm size, utilization of the new agricultural know-how and technology, cattle density, fertilization, and also for the contribution of tobacco production to the farm incomes.

Key words: tobacco, farm typology, principal component analysis (PCA), cluster analysis

INTRODUCTION

Tobacco is the most important non-food crop in the world, grown by about 33 million farmers in more than 130 countries, in a wide range of environmental conditions [Warner 2000, FAO 2008, Chavez et al. 2010]. Among the most important producers of tobacco leaves are China, Brazil, India, USA, Turkey and Argentina [FAO 2008, Geist et al. 2009, Chavez et al. 2010]. In Poland, and the world in general, tobacco is grown mainly in rather small family farms [Altman et al. 1996, 1998, Fisher 2000, Geist et al. 2009, Chavez et al. 2010]. In those smallholder farming systems the growing of tobacco is an important fixed element of the farming structure and farm functionality, and ensure socio-economic and ecological sustainability of the systems [Fisher 2000, Warner 2000, Geist et al. 2009, Chavez

Corresponding author – Adres do korespondencji: Wiesław Mądry, Dariusz Gozdowski, Warsaw University of Life Sciences – SGGW, Department of Experimental Design and Bioinformatics, Nowoursynowska 159, 02-776 Warsaw, Poland, w.madry@agrobiol.sggw.waw.pl, d.gozdowski@omega.sggw.waw.pl

et al. 2010]. Poland is the second largest producer of tobacco leaves in Europe, cultivating primarily light cigarette tobacco. At present, about 60 thousand farmers are involved in the national production of tobacco leaves, which is carried out in about 14 thousand farms, on an area of 17.1 thousand ha. Tobacco is mainly grown in some parts of south-eastern Poland, i.e. the provinces of Lubelskie, Podkarpackie, Mazowieckie and Świętokrzyskie.

The production of tobacco leaves and its profitability are becoming consistently more and more uncertain, both in the world and in Poland. The global and domestic trends with respect to the level and stability of public subsidies for tobacco production are markedly decreasing [Altman et al. 1996, 1998, Fisher 2000, Warner 2000, Chavez et al. 2010]. Under these circumstances, tobacco growers in many countries, including Poland, are at the crossroads [Geist et al. 2009]. This generates a serious threat to the continuity of tobacco production in the country and to sustainable farming, and even to the survival of a number of tobacco farms, especially the less prosperous ones. In some developed countries vigorous attempts are made to create concepts of various forms of interventions by the state, local governments, tobacco companies, and also by central and local agricultural organizations, which can effectively support the tobacco farmers facing the negative effects of external threats for multi-functional and sustainable agriculture [Altman et al. 1996, 1998, Fisher 2000, Warner 2000, Geist et al. 2009, Chavez et al. 2010]. Following the example of other countries, it would be desirable to take similar supporting activities in Poland, too.

One of the most important conditions for ensuring high effectiveness of public interventions in agriculture and rural areas is its flexibility, that is, the creation and implementation of various options of support by the European Union, the state and local governments, suited to diverse (specific) farming systems in the area under consideration [Gibon et al. 1999, Caballero 2001, Dixon et al. 2001, Pardos et al. 2008, Blazy et al. 2009, Roszkowska-Mądra 2010]. This strategy of support interventions requires an assessment of the diversity and identifying types of farming systems (typology of the farming systems) in the respective study areas [Landais 1998, Duvernoy 2000, Köbrich et al. 2003, Blazy et al. 2009, Carmona et al. 2010, Chavez et al. 2010, Zawadka 2010].

The aim of this paper is to analyze the diversity in diagnostic variables that are characteristic of the farming systems (holistic description of agricultural production, non-agricultural activity and resources in farm households) in tobacco farms within south-eastern Poland, and to identify the typology of these systems with multivariate statistical methods, mainly for generating recommendation domains in farming systems research, e.g. to determining innovative structural and developmental adjustments in the identified types of farming systems and also for planning options of supporting these adaptation processes.

MATERIALS AND METHODS

The studied tobacco farms are located in three provinces of south-eastern Poland, i.e. Lubelskie, Podkarpackie and Mazowieckie, although in the last one there are only a few farms of this kind in its south-eastern part (Figure 1). In the last few years, about 50% of tobacco grown in Poland has been produced in the Lubelskie and Podkarpackie provinces.

The size of the population of the tobacco farms covered by the research in the provinces of Lubelskie, Podkarpackie and Mazowieckie in 2009 was 1133. From this popu-

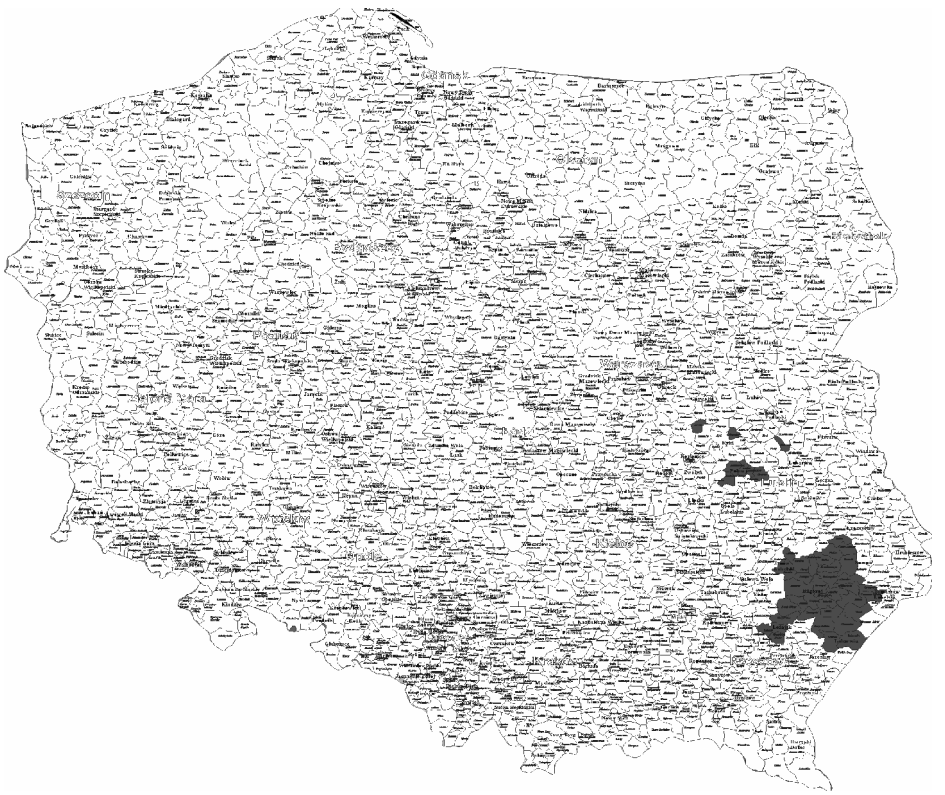

Fig. 1. The area of studying tobacco-based farming systems (the area studied is darker in colour)
Rys. 1. Obszar badań systemów produkcji rolniczej ukierunkowanych na specjalizację produkcji tytoniu (badany obszar jest oznaczony czarnym kolorem)

Source: Author's elaboration.
Źródło: Opracowanie własne.

lation, a random sample of farms was selected using the method of stratified sampling method, in which commune districts formed the strata [Milan et al. 2003, Tittonell et al. 2005, Sang and Birnie 2008, Blazy et al. 2009]. For each commune district, the number of farms to be included in the stratified sample was determined, being proportional to the total number of tobacco farms in that particular district. In order to select farms at random from each district, a computer program was used that randomly generated the numbers for farms located in the district. Among the 151 farms comprising the selected representative sample a survey was carried out by the first author of this paper in the second half of 2009 and at the beginning of 2010.

The survey required the first author of this paper to visit each farm personally and obtain answers to over 40 questions from the head farmer (the farm's manager). The questions related to natural, human and technical resources, production structure, production input and output, and income structure in the farm household. The answers to the ques-

tions were in the form of quantitative as well as categorized variables (nominal or ordinal, expressed on a discrete numerical (i.e. rating) scale. On the basis of the answers obtained in the survey more than 40 diagnostic variables were created.

Diagnostic variables

In order to identify the typology of the studied farms in terms of the farming systems, a relatively small number of key diagnostic variables is chosen, making sure that they are essential in every aspect of the farming systems for the specific purpose of identifying their typology [Kostrowicki 1977, Duvernoy 2000, Köbrich et al. 2003, Iraizoz et al. 2007, Blazy et al. 2009, Chavez et al. 2010, Zawadka 2010]. In addition, these variables should not be strongly correlated; they should, however, show significant variation, such that the coefficient of variation is not lower than 50% [Köbrich et al. 2003, Serrano Martínez et al. 2004a, Thapa and Rasul 2005, Ruiz et al. 2009]. Taking into consideration the aim of this work and the methodological and statistical principles, 15 diagnostic variables were chosen (Table 1).

Table 1. Definitions of the diagnostic variables included in the analysis of the diversity and typology of the farming systems on tobacco farms

Tabela 1. Określenie badanych zmiennych uwzględnianych w analizie zróżnicowania i typologii systemów produkcji w gospodarstwach rolniczych zajmujących się uprawą tytoniu

Variable	Variable designation	Definition of the variable	Units
Natural resources	X1	Soil quality (weighted average soil quality class)	rational number
	X2	Share of grasslands in utilized agricultural area (UAA)	%
Human Resources	X3	Farm owner's level of education [a)]	ordinal scale
	X4	Workers employed in farm agricultural production per 1 ha of UAA	rational number
Technical resources	X5	Number of innovative investments and production improvements made on the farm in the last 5 years	natural number
Structure of production	X6	Farm area	ha
	X7	Share of cereals in arable area (AA)	%
	X8	Share of tobacco in AA	%
	X9	Cattle density	LSU ha^{-1} AA
Production input	X10	Supply of organic fertilizers	ton $ha^{-1}yr^{-1}$
	X11	Supply of NPK fertilizers	kg $ha^{-1}yr^{-1}$
	X12	Agricultural production intensity index [b)]	
Yields	X13	Yield of dried tobacco leaves from 2009 harvest	ton $ha^{-1}yr^{-1}$
Income structure	X14	Contribution of agricultural production to total farm household incomes	%
	X15	Contribution of tobacco production to total farm incomes	%

[a)] 1 – elementary, 2 – vocational secondary, 3 – secondary, 4 – post-secondary, 5 – university

[b)] Agricultural production intensity index calculated on the basis of the normalized variables: cattle and pigs density, supply of NPK fertilizers, share of tobacco in AA (Herzog et al. 2006, Mądry et al. 2010)

Source: Author's elaboration.

Źródło: Opracowanie własne.

Statistical analysis of data

The methodology of the statistical analysis applied here consists of three stages [Köbrich et al. 2003, Serrano Martínez et al. 2004a, b, Blazy et al. 2009, Carmona et al. 2010, Mądry et al. 2010]. In the first stage, a descriptive assessment of the variation in each diagnostic variable was carried out, using univariate statistical parameters.

In the second stage, a Principal Component Analysis (PCA) was performed for all the 15 diagnostic variables chosen. The analysis consists in creating mathematically p uncorrelated linear functions (principal components, PCs) for p original (observed) variables (here diagnostic variables) of the objects under study, each of which explains (captured, account for) the largest possible portion of the objects' variance for all the variables being analysed. A large proportion of the variance can be explained by only a few factors, usually two or three ones. This can occur when the original variables are rather highly correlated. Each PC can be interpreted as a common factor, understood as a substantive source of variation, determining the variables which are correlated with that component as well as being mutually correlated. The PCA was conducted on 15 diagnostic variables after standardization in order to eliminate the effect of a different scale of the variables [Krzanowski 2000, Hair et al. 2006]. In the third stage, a cluster analysis was performed with the Ward's method, using squared Euclidean distance on the first five principle components, for which the eigenvalues were higher than 1 [Krzanowski 2000, Köbrich et al. 2003, Serrano Martínez et al. 2004b, Hair et al. 2006, Chavez et al. 2010]. This method enables us classifying studied farms into homogenous but distinct groups in terms of all the diagnostic variables under consideration. These groups are also homogenous in terms of the farming systems existing in the range of the farms. Then, each of these farm groups identifies a particular type of farming system within the population of the tobacco farms studied.

GENERAL CHARACTERISATION OF FARMS IN TERMS OF INDIVIDUAL DIAGNOSTIC VARIABLES

The estimates of the common statistical parameters for the 15 diagnostic variables (Table 2) indicate that tobacco farms in south-eastern Poland show highly variation for majority of the studied farming system descriptors.

Characteristics and interpretation of the most important principal components

The first Principal Component (PC1): **Intensification and specialization in cattle production**

The first principal component (PC1) accounted for 23% of the total variation in the surveyed sample of tobacco farms (Table 3). This most important principal component was significantly negatively correlated ($|r| > 0.5$) with the number of innovations (X5), farm area (X6), cattle density (X9), organic fertilizer use (X10), NPK fertilizer use (X11) and the production intensity index (X12). PC1 was also significantly positively correlated with contribution of tobacco production to total farm incomes (X15), which was negatively correlated with the important diagnostic variables just mentioned. For that reason, PC1, as factor 1, was called *Intensification and specialization in cattle production*.

Table 2. Statistical parameters for the 15 diagnostic variables of the surveyed tobacco farms
Tabela 2. Parametry statystyczne 15 zmiennych w zbiorze badanych gospodarstw tytoniowych

Variable designation	Variable	Mean	Minimum (Min.)	Maximum (Max.)	Standard deviation (SD)	Coefficient of variation (CV%)
X1	Soil quality	4.09	2.00	5.70	0.76	18.7
X2	Share of grasslands	18.05	0.00	58.00	13.55	75.1
X3	Level of education	2.24	1.00	5.00	0.86	38.5
X4	No. of agricultural workers	0.26	0.05	1.05	0.18	67.5
X5	No. of innovations	0.93	0.00	22.00	2.70	140.1
X6	Farm area	8.62	1.40	37.80	5.14	59.6
X7	Share of cereals	58.50	0.00	92.65	21.14	36.1
X8	Share of tobacco	31.34	3.89	100.00	20.38	65.0
X9	Cattle density	0.25	0.00	2.01	0.31	124.6
X10	Organic fertilizer use	4.21	0.00	30.00	4.26	101.2
X11	NPK fertilizer use	122.11	0.00	402.00	71.61	58.6
X12	Production intensity index	0.22	0.03	0.51	0.09	42.7
X13	Yield of tobacco leaves	2.43	0.90	4.10	0.56	23.2
X14	Contribution of agricultural production to farm household incomes	75.96	20.00	100.00	24.13	31.8
X15	Contribution of tobacco production to farm incomes	82.95	5.00	100.00	16.88	20.3

Source: Author's elaboration.
Źródło: Opracowanie własne.

Many studies on the diversity of farming systems indicate that farm area and the livestock density (mainly of cattle) are among the most important diagnostic variables describing the farming systems and the determinants of their ability to undergo adaptive transformations [Damianos and Skuras 1996, Kristensen 2003, Serrano Martínez et al. 2004a, Paul and Nehring 2005, Iraizoz et al. 2007, Carmona et al. 2010].

The first principal component defines the gradient of the farming systems intensification in tobacco farms within south-eastern Poland; the gradient is positively correlated with the production intensity attributes and negatively correlated with contribution of tobacco production to total farm incomes being diagnostic variables mostly discriminating the farms. It thus appears that large farms with more intensive and diversified, effective agricultural production derive their farm income from growing tobacco to a relatively smaller extent than farms using diametrically different production systems. This also means that incomes and development perspectives of large and intensive farms would be not likely to suffer much if they reduced or abandoned the production of tobacco. On the other hand, reducing or abandonment of growing tobacco in small, extensive farms with a poorly developed agricultural function may be a causal factor of a serious threat to their socio-economic and environmental viability and survival. The threat could be diminished or eliminated if those farms made appropriate adjustment of their farming systems through technical or structural change, agricultural and on-farm non-agricultural diversification, increased product value-added, or engagement with local and regional

Table 3. Correlation coefficients of the first three principal components with the diagnostic variables in the range of the surveyed tobacco farms
Tabela 3. Współczynniki korelacji trzech pierwszych składowych głównych ze zmiennymi diagnostycznymi w zbiorze badanych gospodarstw tytoniowych

Variable designation	Variable	PC1	PC2	PC3
X1	Soil quality	0.10	0.10	–0.28
X2	Share of grasslands	–0.45	0.04	–0.58
X3	Level of education	–0.02	0.01	0.47
X4	No. of agricultural workers	0.29	–0.58	–0.28
X5	No. of innovations	–0.57	–0.04	0.46
X6	Farm area	–0.51	0.39	0.47
X7	Share of cereals	–0.04	0.87	0.02
X8	Share of tobacco	0.14	–0.90	0.10
X9	Cattle density	–0.76	0.00	–0.53
X10	Organic fertilizer use	–0.75	0.03	–0.55
X11	NPK fertilizer use	–0.60	–0.39	0.40
X12	Production intensity index	–0.60	–0.69	0.08
X13	Yield of tobacco leaves	–0.37	–0.09	0.29
X14	Contribution of agricultural production to farm household income	–0.35	–0.21	0.01
X15	Contribution of tobacco production to farm incomes	0.65	–0.34	–0.11
Percentage of the overall variation among farms explained by the principal components		23.0%	19.2%	13.2%

Source: Author's elaboration.
Źródło: Opracowanie własne.

labour markets through pluriactivity [Altman et al. 1996, 1998, Fisher 2000, MacDonald et al. 2000, Warner 2000, Geist et al. 2009, Chavez et al. 2010].

The second Principal Component (PC2): **Farm labour resources and specialization in tobacco production**

The second principal component (PC2) accounted for 19% of the total variation among the tobacco farms surveyed. This principal component was significantly negatively correlated with the number of agricultural workers (X4), share of tobacco (X8) and the production intensity index (X12, but positively correlated with the share of cereals (X7). For that reason, PC2, as factor 2, was called *Farm labour resources and specialization in tobacco production*. The second principal component defines the gradient of labour resources in a farm and their exploitation in tobacco production; the gradient is positively correlated with the number of agricultural workers and the share of tobacco in the arable area, but negatively correlated with the share of cereals in the arable area.

The third Principal Component (PC3): **Grasslands and their utilization in cattle production**

The third principal component (PC3) accounted for 13% of the total variation in the tobacco farms. This principal component was significantly negatively correlated with the

share of grasslands (X2), cattle density (X9) and organic fertilizer use (X10). For that reason, PC3, as factor 3, was called *Grasslands and their utilization in cattle production*. This factor describes the gradient of the grassland area, cattle density and organic fertilization, which is positively correlated with these attributes of the farming system.

Cluster analysis and characterisation of the types of farming systems

The surveyed farms were divided into five clusters (homogeneous groups). The decision as to how to cut the branches of the dendrogram is a compromise between a sensible number of identified groups and intra- and inter-group similarities [Krzanowski 2000, Köbrich et al. 2003, Serrano Martínez et al. 2004b]. The identified homogeneous groups of farms are varied mainly for those diagnostic variables that define the first 3 principal components (i.e. with which they are most strongly correlated), the first principal component representing the strongest correlation. Then, assumed in the paper numbers of the distinguished groups of farms increase as the value of the first principal component (PC1) decreases, indicating an increasing gradient of the intensification and specialization in cattle production (Table 4). The characterisation of each homogeneous group of farms for the major discriminating variables makes it possible to identify and describe comprehensively the distinguished types of farming systems in the surveyed population of tobacco farms [Köbrich et al. 2003, Blazy et al. 2009, Chavez et al. 2010]. On the basis of a detailed analysis of group means for the most important diagnostic variables (Table 4), whose comparative results are presented in Table 5, a multi-dimensional characterisation of five specific types of farming systems found in tobacco farms in south-eastern Poland was made. It is presented as follows:

Type 1 farming system: **A system of extensive crop-oriented, small profitable agricultural production in moderate small, diversified in non-agricultural activity farms with a small share of tobacco in arable areas and low c**ontribution **of agriculture to farm household incomes, mainly tobacco-related.**

Type 2 farming system: **An extensive smallholder not-diversified system with large farm labour resources with a strong tobacco-oriented production and large c**ontribution **of agriculture to farm household incomes, mainly tobacco-related.**

Type 3 farming system: **A system of developing, moderately intensive, diversified crop-cattle production in rather large, slightly diversified in non-agricultural activity, farms with moderately large share of tobacco in arable areas and rather large contribution of agriculture to farm household incomes, mainly tobacco-related.**

Type 4 farming system: **A system of moderately intensive diversified crop-cattle production in large, poorly diversified in non-agricultural activity, farms with moderately large share of tobacco in arable areas and rather large contribution of agriculture to farm household incomes, mainly tobacco-related.**

Type 5 farming system: **A system with low farm labour resources and intensive diversified crop-cattle production in large, not diversified in non-agricultural activity, farms with a small share of tobacco in arable area and a large contribution of agriculture to farm household incomes, mainly not tobacco-related.**

Table 4. Means and standard deviations (SD) of the analysed diagnostic variables and principal components for homogeneous groups (clusters) of the tobacco farms and F-test values for assessing the significance of the differences between the group means

Tabela 4. Wartości średnie i odchylenia standardowe (SD) dla zmiennych diagnostycznych i składowych głównych w wydzielonych grupach jednorodnych gospodarstw tytoniowych oraz wartości dla testu F oceniającego istotność zróżnicowania między średnimi dla tych grup

Group number		1		2		3		4		5		F_{emp} F-ratio	p-value
Number and percentage of farms in a group		40 (26.5%)		13 (8.6%)		57 (37.7%)		28 (18.5%)		13 (8.6%)			
Variable designation	Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
X1	Soil quality	4.19	0.68	3.82	0.79	4.04	0.85	4.36	0.53	3.70	0.80	2.47	0.047
X2	Share of grasslands	13.92	11.76	8.07	10.48	14.25	9.93	32.77	10.41	25.70	15.17	19.60	0.000
X3	Level of education	2.18	0.93	2.15	1.21	2.47	0.85	1.96	0.64	2.08	0.49	2.02	0.094
X4	No. of agricultural workers	0.26	0.16	0.61	0.25	0.21	0.11	0.26	0.12	0.16	0.07	23.05	0.000
X5	No. of innovations	0.55	1.04	1.08	2.50	2.11	1.84	2.18	2.04	5.69	5.79	12.14	0.000
X6	Farm area	6.81	3.33	4.34	2.46	9.68	4.46	7.86	3.78	15.44	8.65	13.26	0.000
X7	Share of cereals	71.18	17.76	25.02	24.87	57.41	15.82	55.78	18.97	63.63	12.75	17.38	0.000
X8	Share of tobacco	18.51	8.41	70.50	27.40	33.44	13.60	33.30	19.12	18.26	10.06	31.99	0.000
X9	Cattle density	0.09	0.11	0.08	0.15	0.13	0.12	0.52	0.19	0.82	0.53	52.49	0.000
X10	Organic fertilizer use	2.28	2.00	1.77	2.17	2.72	1.92	7.46	2.73	12.08	7.32	42.09	0.000
X11	NPK fertilizer use	59.08	37.14	138.46	66.60	140.09	55.56	133.75	62.29	195.85	103.80	18.13	0.000
X12	Production intensity index	0.12	0.05	0.30	0.06	0.23	0.07	0.27	0.08	0.31	0.11	34.42	0.000
X13	Yield of tobacco leaves	2.25	0.59	2.44	0.58	2.53	0.57	2.31	0.39	2.81	0.52	3.49	0.009
X14	Contribution of agricultural production to farm household incomes	61.38	26.19	85.38	24.70	78.68	21.78	80.36	18.95	90.00	17.80	6.49	0.000
X15	Contribution of tobacco production to farm incomes	87.45	13.12	94.62	7.49	83.00	13.50	84.89	11.89	53.00	24.09	18.45	0.000
	PC1	1.56	0.87	1.23	0.70	0.08	0.88	–1.06	0.94	–4.10	1.97	89.73	0.000
	PC2	1.25	0.91	–3.33	1.33	–0.08	1.16	–0.36	1.59	0.60	1.23	36.57	0.000
	PC3	–0.27	0.80	0.18	1.59	0.76	1.02	–1.24	0.75	0.00	2.73	13.15	0.000

Source: Author's elaboration.

Źródło: Opracowanie własne.

Table 5. Characteristics of five types of farming systems in the tobacco farms surveyed
Tabela 5. Charakterystyka pięciu typów produkcji w badanych gospodarstwach prowadzących uprawę tytoniu

Diagnostic variables	Type 1	Type 2	Type 3	Type 4	Type 5
Share of grasslands	**	*	**	*****	****
No. of agricultural workers	***	*****	***	***	*
No. of innovations	*	**	***	***	*****
Farm area	***	*	****	***	*****
Share of cereals	*****	*	***	***	****
Share of tobacco	*	*****	***	***	*
Cattle density	*	*	**	****	*****
Organic fertilizer use	*	*	**	****	*****
NPK fertilizer use	*	***	***	***	*****
Production intensity index	*	*****	***	****	*****
Contribution of agriculture to farm household incomes	*	*****	***	****	*****
Contribution of tobacco production to farm incomes	****	*****	****	****	*

Relative levels of the variables: * very low, ** low, *** moderate high **** high, ***** very high

Source: Author's elaboration.
Źródło: Opracowanie własne.

CONCLUSIONS

1. The tobacco-based farming systems in farms located in south-eastern Poland vary mainly for mutually positively correlated farm size, utilization of the new agricultural know-how and technology, cattle density, fertilization, and also for the contribution of tobacco production in the farm incomes, which is negatively correlated with the mentioned attributes of the production intensity and its non tobacco-related specialization.
2. The tobacco farms surveyed do not vary much for the level of farmers' education, soil quality, yield of tobacco leaves and also contribution of agriculture in farm household incomes.
3. In each of the five types of farming systems with different agricultural production intensity and structure of mainly cereals, tobacco and cattle, and also with different diversification of non-agricultural activities, tobacco is an important or very important source of total farm incomes, irrespective of its different significance in the total farm household incomes.
4. Historically, the identified systems have formed on inherited family farms over a long period of time, mainly in response to environmental conditions, especially the proportion of grasslands, and the processes of adaptation to the demands of the cigarette industry, which emerged more than 50 years ago in the studied area.

5. The typology of the tobacco-based farming systems can be used to: to detect and understand major dimensions (diagnostic variables) of these systems diversity; to identify the most important advantages and disadvantages of the distinguished system types; to identify the recommendation domains, i.e. groups of roughly homogenous farmers with similar circumstances for whom experts can make more or less the same recommending alternative and innovative adaptive adjustments, mainly concerning diversification in crop and livestock production and in non-agricultural activities including also planning of respective options and tools of interventions to support effectively these adaptation processes.

REFERENCES

Altman D.G., Levine D.W., Howard G., Hamilton H. 1996. Tobacco farmers and diversification: opportunities and barriers. Tobacco Control 5, 192–198.

Altman D.G., Zaccaro D.J., Levine D.W., Austin D., Woodell C., Bailey B., Sligh M., Cohn G., Dunn J. 1998. Predictors of crop diversification: a survey of tobacco farmers in North Carolina (USA). Tobacco Control 7, 376–382.

Blazy J.M., Ozier-Lafontaine H., Doré T., Thomas A., Wery J., 2009. A methodological framework that accounts for farm diversity in the prototyping of crop management systems. Application to banana-based systems in Guadeloupe. Agricultural Systems 101, 30–41.

Caballero R. 2001. Typology of cereal-sheep farming systems in Castile-La Mancha (south-central Spain). Agric. Syst. 68, 215–232.

Carmona A., Nahuelhual L., Echeverría C., Báez A. 2010. Linking farming systems to landscape change: An empirical and spatially explicit study in southern Chile. Agric. Ecosyst. Environ. 139, 40–50.

Chavez M.D., Berentsen P.B.M., Oude Lansink A.G.J.M. 2010. Creating a typology of tobacco farms according to determinants of diversification in Valle de Lerma (Salta-Argentina). Spanish Journal of Agricultural Research 8, 460–471.

Damianos D., Skuras D. 1996. Farm business and the development of alternative farm enterprises: An empirical analysis in Greece. Journal of Rural Studies 12, 273–283.

Dixon J., Gulliver A., Gibbon D., Hall M. 2001. Farming systems and poverty: Improving farmers' livelihoods in a changing world. FAO and World Bank, Rome.

Duvernoy I. 2000. Use of a land cover model to identify farm types in the Misiones agrarian frontier (Argentina). Agricultural Systems 64, 137–149.

FAO, Food and Agriculture Organization of the United Nations, 2008. FAOSTAT Data. FAO, Rome, available online at http://faostat.fao.org/site/567/default.aspx.

Fisher L. 2000. Tobacco farming and tobacco control in the United States. Cancer Causes and Control 11, 977–979.

Geist H.J., Chang K., Etges V., Abdallah J.M. 2009. Tobacco growers at the crossroads: towards a comparison of diversification and ecosystem impacts. Land Use Policy 26, 106–1079.

Gibon A., Sibbald A.R., Flamant J.C., Lhoste P., Revilla R., Rubino R., Sorensen J.T. 1999. Livestock farming systems research in Europe and its potential contribution for managing towards sustainability in livestock farming. Livest. Prod. Sci. 61, 12–137.

Hair J.F., Black W.C., Babin B.J., Anderson R.E., Tatham R.L., 2006. Multivariate data analysis. 6th ed., Prentice-Hall International, New Jersey.

Herzog F., Steiner B., Bailey D., Baudry J., Billeter R., Bukacek R., De Blust G., De Cock R., Dirksen J., Dormann C.F., De Filippi R., Frossard E., Liira J., Schmidt T., Stockli R., Thenail C., van Wingerden W., Bugter R., 2006. Assessing the intensity of temperate European agriculture at the landscape scale. Europ. J. Agron. 24, 165–181.

Iraizoz B., Gorton M., Davidova S. 2007. Segmenting farms for analysis agricultural trajectories: A case study of the Navarra region in Spain. Agricultural Systems 93, 143–169.

Köbrich C., Rehman T., Khan M., 2003. Typification of farming systems for constructing representative farm models: two illustrations of the application of multi-variate analyses in Chile and Pakistan. Agricultural Systems 76, 141–157.

Kostrowicki J. 1977. Agricultural typology concept and method. Agricultural Systems 2, 33–45.

Kristensen S.P. 2003. Multivariate analysis of landscape changes and farm characteristics in a study area in central Jutland, Denmark. Ecological Modelling 168, 303–318.

Krzanowski W. 2000. Principles of multivariate analysis. Analysis: A user's perspective. University Press, Oxford.

Landais E. 1998. Modelling farm diversity: new approaches to typology building in France. Agricultural Systems 58, 505–527.

MacDonald D., Crabtree J.R., Wiesinger G., Dax T., Stamou N., Fleury P., Gutierrez Lazpita J., Gibon A. 2000. Agricultural abandonment in mountain areas of Europe: environmental consequences and policy response. Journal of Environmental Management 59, 47–69.

Mądry W., Gozdowski D., Roszkowska-Mądra B., Dąbrowski M., Lupa W. 2010. Diversity and typology of farms according to farming system: a case study for a dairy region of Podlasie province, Poland. Electr. J. Polish Agric. Univ. Economics, Vol. 13 Issue 2.

Milan M.J., Arnalte E., Caja G., 2003. Economic profitability and typology of Ripollesa breed sheep farms in Spain. Small Ruminant Res. 49, 97–105.

Pardos L., Maza M.T., Fantova E., Sepulveda W., 2008. The diversity of sheep production systems in Aragon (Spain): characterisation and typification of meat sheep farms. Span. J. Agric. Res. 6, 497–507.

Paul C.J.M., Nehring R. 2005. Product diversification, production systems, and economic performance in U.S. agricultural production. J. Econometrics 126, 525–548.

Roszkowska-Mądra B. 2010. Obszary wiejskie o niekorzystnych warunkach gospodarowania w aspekcie ich zrównoważonego rozwoju. Wydawnictwo Uniwersytetu w Białymstoku.

Ruiz F.A., Mena Y., Castel J.M., Guinamard C., Bossis N., Caramelle-Holtz E., Contu M., Sitzia M., Fois N. 2009. Dairy goat grazing systems in Mediterranean regions: A comparative analysis in Spain, France and Italy. Small Rumin. Res. 85, 42–49.

Sang N., Birnie R. 2008. Spatial sampling and public opinion in environmental management: A case study of the Ythan catchment. Land Use Policy 25, 30–42.

Serrano Martínez E., Lavín González P., Giráldez García F. J., Bernués Jal A. Ruiz Mantecón A. 2004a. Classification variables of cattle farms in the mountains of León, Spain. Spanish J. Agric. Res. 2, 50–511.

Serrano Martínez E., Giráldez García F. J., Lavín González P., Bernués Jal A. Ruiz Mantecón A. 2004b. The identification of homogeneous groups of cattle farms in the mountains of León, Spain. Spanish J. Agric. Res. 2, 512–523.

Thapa G.B., Rasul G., 2005. Patterns and determinants of agricultural systems in the Chittagong Hill Tracts of Bangladesh. Agric. Syst. 84, 255–277.

Tittonell P., Vanlauwe B., Leffelaar P.A., Rowe E.C., Giller K.E. 2005. Exploring diversity in soil fertility management of smallholder farms in western Kenya: I. Heterogeneity at region and farm scale. Agriculture, Ecosystems & Environment 110, 149–165.

Warner K.E. 2000. The economics of tobacco: myths and realities. Tobacco Control 9, 78–89.

Wilkinson W.C., Fisher L.R., Smith W.D., Jordan D.L. 2007. Effects of stand loss, planting date, and replanting method on yield and quality of flue-cured tobacco. Tobacco Science 47, 44–52.

Zawadka J. 2010. Evolution of agritouristic activity in Poland and typology of rural tourism farms (in Polish). Acta Sci. Pol. Oeconomia 9, 627–638.

TYPOLOGIA SYSTEMÓW PRODUKCJI ROLNICZEJ W GOSPODARSTWACH ZAJMUJĄCYCH SIĘ UPRAWĄ TYTONIU W POŁUDNIOWO-WSCHODNIEJ POLSCE

Streszczenie. Celem niniejszej pracy jest analiza zróżnicowania systemów produkcji w gospodarstwach zajmujących się uprawą tytoniu w południowo-wschodniej Polsce. Badania ankietowe wykonano w 151 gospodarstwach, znajdujących się w województwach: lubelskim, podkarpackim i mazowieckim. Wielowymiarową ocenę zróżnicowania gospodarstw i ich grupowanie (typologię) wykonano za pomocą analizy składowych głównych (PCA) i analizy skupień metodą Warda na pięciu pierwszych składowych głównych. Wydzielono 5 jednorodnych grup gospodarstw tytoniowych, odzwierciadlających odpowiednie typy produkcji rolniczej w tych gospodarstwach na badanym obszarze, które były zróżnicowane głównie pod względem powierzchni, wykorzystania nowych technologii produkcji, pogłowia bydła, nawożenia i udziału produkcji tytoniu w dochodach gospodarstw.

Słowa kluczowe: tytoń, typologia gospodarstw, analiza składowych głównych, analiza skupień

Accepted for print – Zaakceptowano do druku 20.02.2011