

AFFORESTATION OF AGRICULTURAL LAND AND WATER MANAGEMENT IN THE CONTEXT OF AGRICULTURAL PRODUCTION ON THE EXAMPLE OF POLAND^[1]

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ABSTRACT

In the last decades (1946-1989) in Poland there was a conviction that "each hectare must give crop" the consequence of which was a duty of an agricultural use of farmland. That opinion grew in the period when the quantity of food production depended straight and directly on the amount of the possessed agricultural land. In those times it was forbidden to afforest agricultural land freely. Contemporarily it is assumed that not only the amount of the land but its quality and the way of their use decide upon the size of food production. Such a situation creates favourable conditions for afforestation. The proof of the claim is that each agricultural land can be afforested no matter what quality it has while, at the same time, there is no free putting forest area into agriculture.

The main thesis of this paper is that afforestation of the right agricultural land in Poland influences not only the protection of this land positively but the water management and agricultural production on adequate and sufficient resources of agricultural areas.

The aim of this paper is to develop an algorithm of keeping valuable agricultural lands while afforesting those lands in the aspect of bettering water management.

The article understands afforestation of agricultural land as starting forest farming on lands, which have been out of forest cultivation (not included in the forest area).

Keywords: Afforest, water management, agricultural production.

1 INTRODUCTION

A continuous development of industrialisation and urbanisation processes influences the natural environment negatively, including the agricultural lands, which are an important factor of the biosphere. That negative influence on agricultural lands may be observed both in the quantity aspect (a systematic decrease of agricultural lands surface) and in the quality one (worsening of the agricultural and forest production value). Agricultural lands in the aspect of shaping farming production space should be taken under protection consisting in their preservation, restitution and which is most important - ensuring the permanence of their use. The more so, their protection and shaping is justified as they are a basic means of production in agriculture and they are characterised by, among other, non-transferability, non-enlargeability and they have been irreplaceable so far and, what is more, we have less and less of them in Poland each year. [see table 1, chart 1].

Proper management of agricultural lands in Poland is connected with their optimal use for farming, forest and other purposes. Transferring lands into non-agricultural purposes is practically irreversible. So while taking a decision on that subject one should bear in mind an economical management of farmland as it is a non-multiplicable resource.

Table 1 The surface area of agricultural lands per one Polish inhabitant in the years 1983-1997

Year	General surface area of the country [ha]	Agricultural lands		Population [thousands]	The surface of agricultural lands for one inhabitant. [ha]
		Total [ha]	The share in the total surface area in the country [%]		
1	2	3	4	5	6
1983	31.268.330	18.878.650	60,38	36.745,0	0,51
1984	31.268.330	18.875.673	60,37	37.063,3	0,51
1985	31.268.330	18.843.685	60,26	37.341,0	0,50
1986	31.268.330	18.803.856	60,14	37.571,7	0,50

1987	31.268.330	18.791.257	60,10	37.764,3	0,50
1988	31.268.315	18.797.979	60,12	37.885,0	0,50
1989	31.268.300	18.804.700	60,14	38.038,0	0,49
1990	31.268.300	18.783.800	60,07	38.183,2	0,49
1991	31.268.500	18.759.564	60,00	38.309,2	0,49
1992	31.268.500	18.740.884	59,94	38.418,1	0,49
1993	31.268.500	18.712.799	59,85	38.504,7	0,49
1994	31.268.500	18.689.685	59,77	38.580,6	0,48
1995	31.268.500	18.663.821	59,69	38.609,4	0,48
1996	31.268.500	18.632.581	59,59	38.639,0	0,48
1997	31.268.500	18.607.762	59,51	38.660,0	0,48
Total in the years 1993 - 1997		- 270.888	- 0,87	+1.915,0	-0,03

Source: own calculations on the basis of source materials

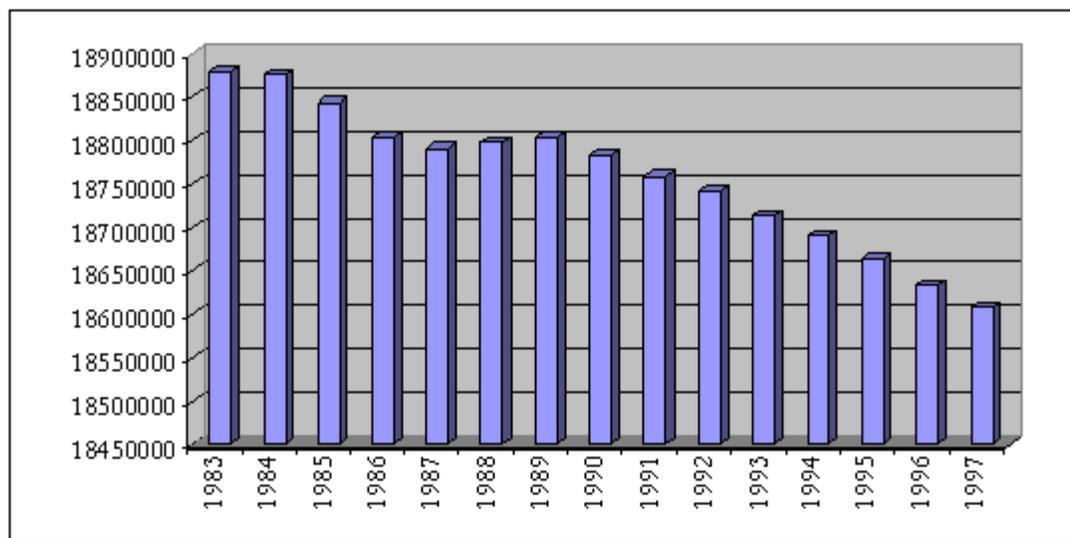


Figure 1 Total surface of farmland in Poland in the years 1983-1997 [ha]

2 MATERIALS AND METHODS

The subject of the paper places itself within the widely understood set of problems connected with shaping the agricultural-forest production space. It concerns the extremely important issue appearing in shaping the natural environment and in planning and arranging work, which is protection and shaping farm and forest land in the aspect of bettering water management.

Empirical studies gave the basis for developing an algorithm that would be important while afforesting farmland in the aspect of water management. That is why my own quality analysis is prevailing in the whole article. The method of double cross information was used. The data received from one source were confronted with the data from other sources. The method used in the study is based upon logical and comparative analyses while using statistical and descriptive techniques.

The main thesis of the work is that afforestation of the adequate land in Poland influences not only the protection of this land but the water management and the agricultural production on adequate and sufficient resources of agricultural land.

The objective of this work is developing an algorithm of agricultural land afforestation in the aspect of bettering water management. That algorithm, which a general one, was developed assuming that the land fulfils its main function of running agricultural production on it. The developed algorithm concerns describing the degree of effectiveness of protection (preservation) of valuable farmland. It makes it possible to determine how much valuable farmland should stay for farming.

The research held concerned the data for Poland from the years 1983-1997. The choice of data from those years was purposeful. The accepted period is characteristic both for the whole national economy of Poland and for agriculture and protection of natural

environment with water management within. The events enumerated below were important taking into consideration their influence on protection and shaping farm- and forestland in the aspect of water management:

- two acts of Parliament come from that period of time: from 1983 (annulled) and from 1985 (valid) on protection of agricultural and forest land;
- development of market economy in the place of already not functioning system of command-distributive economy;
- from the shortage of food supplies to their abundance on the market;
- from a compulsory use of all agricultural lands for the purpose of agricultural production (sanctioned by their loss or relevant penalties) to their voluntary use for the same purpose;
- from the period when agricultural land was protected more than forest area to the time when forest land is protected more than the agricultural one;
- future Polish membership in the European Union.

The work refers to the rule sustained development, which is the aim to be reached (it is rather the realisation of the rule of sustained development, which is talked about now).

The work uses the published and unpublished data concerning the widely understood issue of protection and shaping agricultural land. The data on the above issue is published in various sources, but it is not always comparable. This fact made collecting and selecting it difficult additionally. So, to achieve the objective of the study, while collecting the data I selected it on the basis of obtaining unanimous and comparable data. The data included in this work com from various available sources: The Main Statistical Office, Voivodship Statistical Offices, The Ministry of Agriculture and Rural Development, The Ministry of Environment, The Main Land Surveyor's Office and from The Institute of Forestry Research.

3 AFFORESTATION OF AGRICULTURAL LAND AND WATER MANAGEMENT

Until 1989 there was a common belief in Poland that "each hectare must give crop" [Wos, 1992], the consequence of which was, among other, the duty of agricultural use of farmland. The conviction was consolidated in the period when the quantity of food production depended directly on the amount of the possessed farmland. Nowadays it is supposed that not only the quantity of farmland but also its quality and the way of its use decide about the quantity of food production. After 1990 new social and economy conditions appeared in Poland favouring afforestation of agricultural land.

For the sake of this paper afforestation is understood as setting forest farms on the land which were out of forest farming before, that is on the land not included to the surface of forests.

Afforestations of farmland in Poland play a limited role in bettering water management while running agricultural production correctly at the same time. Moreover, they influence farmland protection positively as well. The positive influence on water management appears when we afforest the land of the lowest bonitation classes, i.e. farmland of the 6th and 7th classes and more rarely of the class 5. It does not mean that as a result of afforestation the surface area of land used for farming decreases because there are about 1.8mln hectares of uncultivated and fallow land in Poland [see table 2] and the next 1.5mln hectares should not be used for food production because of various reasons [Szot, 1997].

Table 2 Selected data on agricultural land in Poland in the years 1995-1996

Uncultivated and fallow land within agricultural area [3]		Agricultural land		
		Total in thousands of hectares	From the general %	
In thousands of hectares	% of plough area		Plough area	Individual farms

Poland	1799,2	12,8	18622,2	76,7	81,7
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Source: own calculations on the basis of source materials

About 10 years ago it was estimated, however, that about 800-900 thousand hectares of farmed land not giving profitable production at that time should be assigned for afforestation [Grochowski, 1988]. The above data shows that during the last decade the area of land predestined for setting forest farms was increased.

There is a positive influence on water management when we afforest the poorest plough land created from loose sands and loam belonging to soil-farming complexes n°7 and 6. Moreover, it is positive when we afforest agricultural land on which there are advanced processes of soil erosion and its considerable overdrying. Such a situation exists mainly in Polish central belt and in the belt of the mountains and foothills where forests limit the flow of ground waters [Szot, 1997].

Afforestation has a positive influence on economy through:

- bettering the water balance, mainly by the increase of retention and alleviation the extensive states of river flows,
- preventing the phenomena of soil erosion,
- purifying the air, water and soils from chemical substances,
- the influence of forests as a soil creating and a soil degradation preventive factor,
- a beneficial modification of microclimatic system on the adhering agricultural land.

The above analysis of establishing forest farms takes the process in its potential dimension. They are only the agricultural lands, which are predestined for afforestation because of their low farming use effectiveness or because of soil erosion and its high degree of overdrying. As the data of The Institute of Forestry Research until 2020 show the area of forests in Poland is to increase by about 700 thousand hectares and until 2050 by the next 1200 thousand hectares [Szot, 1997]. It is supposed, that enlarging the area of forests including the voluntary afforestation will take place at the cost of the agricultural land area.

The actual taking of agricultural land for the above purposes must consider some important organisational and spatial conditions, ecology and landscape factors, etc. To describe the afforestation process of agricultural land on a given area one should consider the following conditions of the given area:

- the up-to-date state of afforestation,
- the quality of agricultural production space,
- danger of erosion

Because of the procedure of starting forest farms one may enumerate two categories of land afforestation [Hernik, 1997]:

1. obligatory,
2. voluntary.

3.1 Obligatory afforestations

Obligatory afforestations are carried out in the situations, when:

- 1 forests were deprived of tree-stand - then the National Forests and the owners of those forests are obliged to introduce forest woodland vegetation (forest farms) in those forests again within two years - art. 13 pass. 1 point 2 of the act on woods. [Ustawa, 1991];
- 2 agricultural land was assigned for afforestation according to the plan of spatial development which is in force in a given community. Such afforestation, according to art. 14 pass. 2 of the act on woods may take wasteland, agricultural land that is useless for agricultural production and other land suitable for afforestation (including agricultural land), with especially:
 - grounds situated at water-heads of rivers and streams, on watersheds, along river banks and on the shores of lakes and water bodies,
 - quick sands and sand dunes,
 - steep slopes, hillsides, precipices and hollows,

- heaps and the area after sand, gravel, peat and clay excavation.

The obligation of afforesting such area lies on forest inspectors - in relation to the grounds owned by State Treasury taken by National Forests - and on owners of those grounds (art. 14 pass. 4 of the act on woods) [Ustawa, 1991].

3.2 Voluntary afforestation

Voluntary afforestation takes place on the basis of the articles present in the Parliamentary act on agricultural and woodland protection. Nowadays each agricultural land, no matter of its agricultural and natural value, might be afforested. Then there is no need of obtaining a decision allowing its exclusion from agricultural production. Farmland afforestation causes a change in the way of using the agricultural land. The land loses its agricultural character and becomes woodland or a wooded area. It is worth noticing that according to the parliamentary act, afforestation of agricultural land does not mean its assignment for non-agricultural or non-forest purposes because there is no other use of land as agricultural or forestlike. It was implied by the obligation of agricultural use of farmland and by a simplified procedure allowing assigning woodland for agricultural land. After 1991 there have been serious changes in legal solutions concerning the protection of those lands. As a result of those changes woodland area is protected more than farmland. Nowadays farmland can be freely afforested while woodland can be transformed into farmland only in a justified and exceptional situation. The legislator gives the priority to woodland before farmland in this field of protection.

4 AFFORESTATIONS AND AGRICULTURAL PRODUCTION

The institution of agricultural land afforestation is included in modern concepts of rural areas development. Those concepts stress ecoforestry, which is a specific symbiosis of agriculture and forestry [Wos, 1992]. The act from 1995 on protection of agricultural and forestlands should facilitate the development of rural areas, especially on the land of poor bonitation classes, by, among other, transferring them for forest area. It should be noticed, however, that afforestations (apart from the given above positive characteristics) add to the decrease of the area of agricultural land. According to Wos [1992], although afforestations diminish the amount of land used by agriculture but they do not decrease the agriculture production potential [see table 3, chart 2]. On the contrary, the potential increases as a result of a cumulative action of two factors:

- beneficial influence of forests on biocenotic balance, which favours the increase of agricultural land productivity,
- running agricultural production on a smaller area of agricultural land but on good and average land, which influences its increase in comparison with running a bigger area with a smaller productivity potential.

5 THE DEGREE OF EFFICIENCY OF VALUABLE AGRICULTURAL LAND PROTECTION

It should be stressed, that the problem of protection and shaping agricultural land still remains the issue of a social meaning because of the need to ensure an adequate area of land for food production. It requires rational management of the best land.

The act on protection of agricultural and forestland allows free afforestation of each agricultural land, even of class 1-3. Such a solution may be supposed as too liberal because there is little land of classes 1-3 in Poland and, what is more, they are characterised by a high environmental value apart from their agricultural worth. One may suggest freedom while assigning agricultural land with classes 4-6 to afforestation but not all agricultural lands.

In order to preserve the best agricultural lands for their main objective, i.e. agricultural production and having in mind the betterment of water management an algorithm of determining the degree of efficiency of valuable agricultural land protection (preservation). It allows to determine the tendency to protect valuable agricultural land for agricultural production.

Calculations of valuable agricultural land protection efficiency for Poland for the analysed period of 1983-1997 were carried out. The publications concern the analysed period in reference to the amount of agricultural land within particular bonitation classes in Poland from the years 1980, 1985 and 1990 [see table 4].

Table 3 The change in the surface area of agricultural land in Poland in the years 1983-1997

Year	Total surface area of farmland	Loss of farmland in compared with the previous year		Excluded farmland and forest lands ¹		
				Total	Farmland	
		Surface area	%		Surface area	% of the total area of farmland

1	[ha]	[ha]	[%]	[ha]	[ha]	[%]
2	3	4	5	6	7	
1983	18.878.650	38.238	0,2	9.428	8.409	0,0499
1984	18.875.673	40.266	0,21	8.557	7.484	0,0453
1985	18.843.685	31.070	0,17	7.686	6.676	0,0354
1986	18.803.856	29.309	0,16	7.710	6.376	0,0339
1987	18.791.257	27.354	0,15	8.926	7.538	0,0401
1988	18.797.979	28.669	0,15	8.486	7.436	0,0396
1989	18.804.700	29.984	0,16	8.045	7.334	0,0390
1990	18.783.800	20.860	0,11	6.630	5.936	0,0316
1991	18.759.564	24.277	0,13	4.576	4.193	0,0224
1992	18.740.884	18.680	0,01	6.243	5.707	0,0305
1993	18.712.799	28.085	0,15	7.683	7.079	0,0378
1994	18.689.685	23.114	0,12	6.074	5.360	0,0287
1995	18.663.821	25.864	0,14	2.287	1.419	0,0076
1996	18.632.581	31.240	0,17	1.693	1.211	0,0107
1997	18.607.762	24.819	0,13	*1.183	982	0,0053
For the years 1983 - 1997	- 270.888	- 1,43	95.207	83.140	0,44 **	

Source: own calculations on the basis of source materials

1 – following the procedure of farmland and woodland protection

* - without woodland

** - compared to 1983

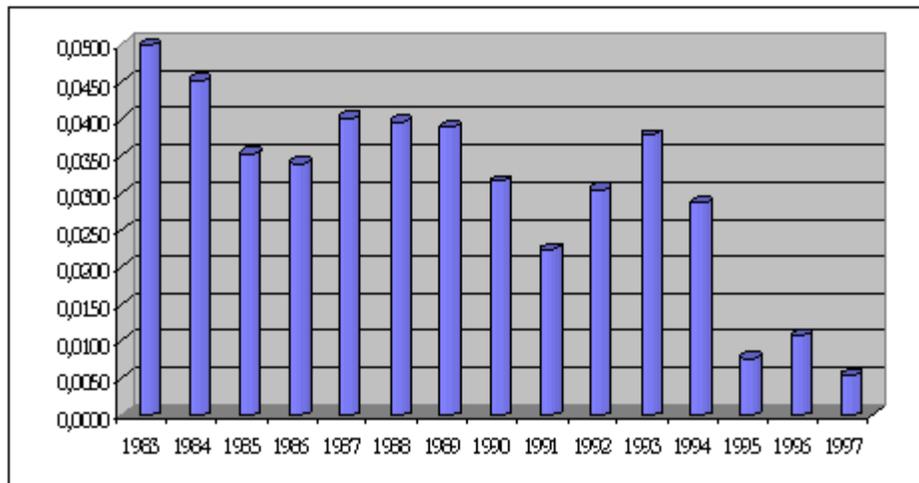


Figure 2 The change of the area of agricultural land excluded from agricultural production in comparison to their total area in Poland in the years 1983-1997

Table 4 Bonitation classes of agricultural lands in Poland and in five voivodships in the years 1980-1990

Year		Bonitation classes of agricultural lands [%]					
		I	II	III	IV	V	VI
1980	POLAND	0,4	2,9	21,7	39,6	23,1	12,3
1985	POLAND	0,4	2,9	22,2	39,8	22,1	12
1990	POLAND	0,4	2,9	22,3	39,8	22,7	11,9

Source: own calculations on the basis of source materials

In those years there were no considerable changes in bonitation classes of agricultural land. While calculating of the above degree

of efficiency for Poland for the years 1983-1984 the data on the amount of agricultural land of classes 1-3 from the year 1980 was taken and for the next calculations for the years 1985-1989 the data from the year 1985. The calculations of the degree of efficiency of valuable agricultural land protection for Poland for the years 1990-1997 was carried out on the basis of the data for 1990. Moreover, a simulation of the amount of agricultural land of classes 1-3 for the years not covered by the above bonitation statistics was carried out with the use of Microsoft Excel computer software. It appeared, however, that there is only a small difference between the calculations of the efficiency of valuable agricultural land protection carried out on the basis of the published data on the amount of agricultural land according to bonitation classes and the calculations on the basis of the simulation data. That is why the calculations were performed on the basis of the published data on the amount of agricultural land according to bonitation classes.

Table 5 presents the amount of agricultural lands of classes 1-3 excluded for non-agricultural purposes in Poland for the analysed period 1983-1997. The table shows the data of those excluded areas together for all three classes (1-3) which is caused by its presentation in statistical publications.

Table 5 *Agricultural land of classes 1-3 excluded¹ for non-agricultural purposes in Poland in the years 1983-1997 [in hectares]*

Years	Poland
	1983
1984	1039
1985	920
1986	1065
1987	1374
1988	1217
1989	1210
1990	1196
1991	678
1992	1377
1993	1854
1994	1248
1995	876
1996	812
1997	760

Source: own calculations on the basis of source materials [81].

¹ – following the procedure of farmland and woodland protection

Next the calculations determining the efficiency of valuable agricultural land protection were carried out [see table 6] with the use of own coefficient of the efficiency of agricultural land protection (W_{sour}), according to the formula below:

$$W_{sour} = \frac{P_w}{P} \times 1000, \text{ where}$$

W_{sour} - the coefficient of the efficiency of valuable agricultural land protection in the surveyed region (Poland);

P_w - the % of the excluded valuable agricultural land area in the surveyed region (Poland);

P - the % of valuable agricultural land area in the surveyed region (Poland).

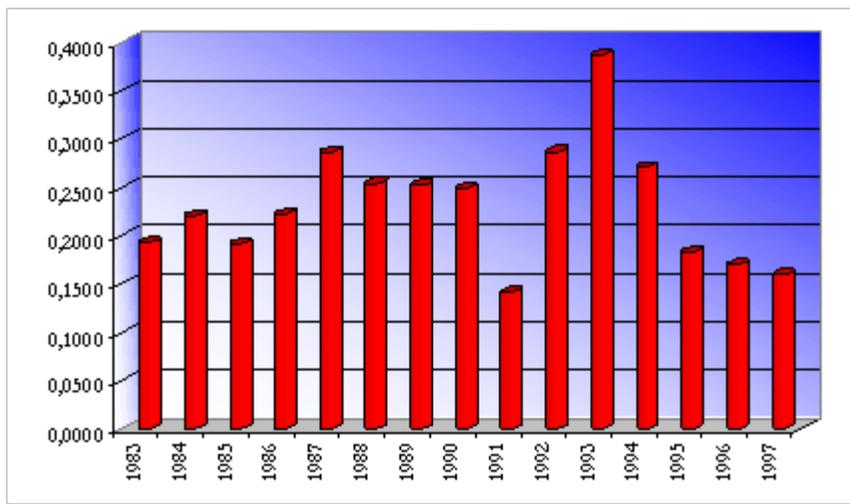


Figure 3 The tendency of valuable agricultural land protection efficiency (*Wsour*) for Poland in the years 1983-1997

Table 6 The coefficient of the efficiency of valuable agricultural land protection (*Wsour*) for Poland in the years 1983-1997

Years	Poland
1983	0,1926
1984	0,2202
1985	0,1915
1986	0,2221
1987	0,2867
1988	0,2539
1989	0,2524
1990	0,2487
1991	0,1412
1992	0,287
1993	0,387
1994	0,2608
1995	0,1834
1996	0,1702
1997	0,1595

Source: own calculations on the basis of source materials

A general interpretation of *Wsour* coefficient for the sake of this article is as follows: the lower the value of this indicator *the more efficiently the valuable agricultural land is protected*.

The calculations imply that in the years 1983-1997, in Poland, there is generally a slow increasing tendency within the efficiency of valuable agricultural land protection and within shaping of those lands (see chart 4). In the case of Poland the value of the agricultural land protection efficiency coefficient in 1997 was almost three times smaller compared with 1983.

6 CONCLUSIONS

It was shown that afforestation of the suitable agricultural lands in Poland influences not only the protection of those lands but the water management and agricultural production on adequate and sufficient resources of agricultural land as well.

Afforestations of agricultural lands, as it was proved, influence water management positively as well. Besides positive results afforestations cause decreasing the area used for agricultural production. However, it should be mentioned, that afforestations do not decrease the productive potential of agriculture in Poland. On the contrary, the potential increases. In such a context it was shown that afforestation of suitable agricultural lands in Poland, with preservation of the valuable agricultural lands, may add to two positive results:

- bettering of water management and
- bettering of running agricultural production on good and average lands in better environmental conditions.

Such objectives would find it beneficial to use the algorithm of preserving the best agricultural lands for their main purpose, i.e. agricultural production considering betterment of water management. It makes it possible to determine the tendency in valuable agricultural lands protection for agricultural production. The carried out calculations imply that in the analysed period of 1983-1997 in Poland there is a general tendency of a slow increase within the efficiency of valuable agricultural land protection.

7 REFERENCES

- Grochowski, Z., 1988. Warunki i mozliwosci wzrostu produkcji rolniczej (próba prognozy). Zagadnienia Ekonomiki Rolnej, 2, 42–71.
- Hernik, J., 1997. Zalesienia a ochrona gruntów rolnych. ZN AR Cracow.
- Szot, E., 1997. Ratunek w zalesianiu. Rzeczpospolita nr 46 (4603). Warsaw.
- Wos, A., 1992. Strategie rozwoju rolnictwa. PWN, Warsaw.
- Ustawa from 26 March 1982 r. on protection of agricultural and forest land , 1982. (Dz. U. Nr 11, poz. 79, z poz. zm.).
- Ustawa from 28 September 1991 r. on woods. 1991.(Dz. U. Nr 101, poz.444 z póź. zm.).
- Ustawa from 3 February 1995 r. on protection of agricultural and forest land 1995. (Dz. U. Nr 16, poz. 78, z poz. zm.).

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[3] state in June 1995