Economical potential of unutilised agricultural area in Poland. Scenario of crop production resumption, the first approximate evaluation

Rafał Pudełko*, Małgorzata Kozak, Anna Jędrejek, Małgorzata Gałczyńska

Department of Bioeconomy and Systems Analysis
Institute of Soil Science and Plant Cultivation – State Research Institute, Poland
*rpudelko@iung.pulawy.pl

Paper prepared for presentation at the 167nd EAAE Seminar
European Agriculture and the Transition to Bioeconomy

September 24-25, 2018
Institute of Soil Science and Plant Cultivation – State Research Institute
Pulawy, Poland

Abstract

The study presents assessment of economic benefits possible to be obtained thanks to restoring agricultural production on fallowed/abandoned land located on arable parcels of medium-good and medium quality classes of land in Poland. Unused agricultural areas appeared in the 90s of XX century, after the political transformation. Currently, 1.3 million ha of arable land, 281 thousand ha of pastures and 39 thousand ha of orchards still remain uncultivated, which is 14.6% of total agricultural area. Modelling of potential benefits after restoring agricultural production was conducted by using spatial analysis in the scale of parcels. The main conclusions:

- in Poland there are over 442.8 thousand ha of arable land which can be effectively restored to crop production,
- after landuse change of the mentioned area, a potential increase in cereal production by 5.94% is expected, which can be equivalent to 1.77 million tonnes of triticale,
- besides, 1.59 million tonnes of straw can be produced for soil conservation, animal production and bioenergy purposes.

Keywords: unutilised agricultural area (UAA), land use change (LUC), GIS, modelling

Introduction

After the political transformation at the turn of 1990s the problem of abandoned agricultural land appeared. Agricultural farming on weak soils, in small agricultural holdings or those located in less developed regions became, for various reasons, unprofitable. Abandoned fields where succession of natural vegetation appeared became more prevalent in the landscape. The changes in landuse were irreversible to the point that until Polish accession to the European Union the problem remained unsolved. Despite the implementation of direct payments support scheme, 1.3 million ha of arable land, 281 thousand ha of pastures and 39 thousand ha of orchards still remain uncultivated (Pudełko et al., 2018). These areas, usually under natural succession, constitute a great untapped potential of the country: 14.6% of agricultural area, 5.18% of the country's area. Owing to geographical conditions, they should be converted into ecological land and woodland (the weakest soils) and industrial biomass plantations (medium quality soils). The best land in terms of production capacity should be returned for agricultural activity. Based on the conducted research, it was stated that the best and very good quality land (classes I and II according to Polish valuation) are only marginally affected by the problem of land abandonment (3.4 thousand ha of class I and 28.5 thousand ha of class II). Whereas, in case of medium-good quality land (class III - 250 thousand ha) and medium quality land (class IV 690 thousand ha), the problem is visible at the country level, and conversion of these areas to agricultural food production could have key importance for ensuring the national food security (Klikocka et al., 2016). The largest group among the abandoned land constitute bad quality land: class V - 623 thousand ha and class VI - 433 thousand ha. Class V, which consists of three complexes of agricultural usefulness of soils: 6 - weak rye soil complex, 7 - very weak rye soil complex (depending on water relations and culture) and 9 - cereal-fodder soil complex has a large potential for biomass cultivation for

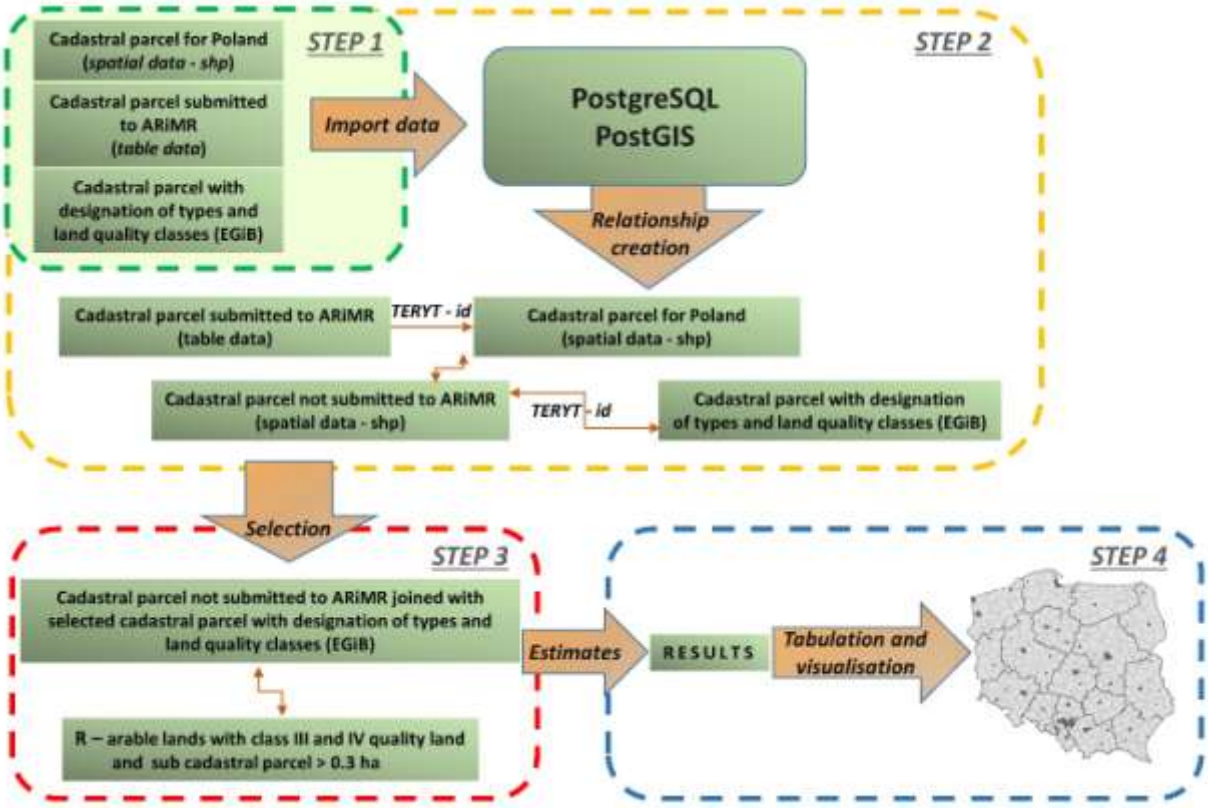
energy or industrial purposes (Stuczyński et al., 2000, Pudełko et al., 2012, Krzyżaniak et al., 2015). The weakest habitats (class VI) are fields located on marginal land (Józefaciuk et al., 1996) that should be afforested or left for rewilding (Ceausus et al., 2015).
The study presents assessment of economic benefits possible to be obtained thanks to restoring agricultural production on fallowed/abandoned land located on arable parcels of medium-good and medium classes quality land (III, IV).

Methodology

The analysis was carried out based on the geographical information system developed in the Institute of Soil Science and Plant Cultivation – State research Institute (IUNG-PIB) for assessment of the regionalization of unutilized agricultural area in Poland (Pudełko et al., 2018). As a source of information on rural landuse there were used data collected in the frame of the IACS (Integrated Administration and Control System), the most important tool for the management and control of payments to farmers made by the Member States in application of the Common Agricultural Policy (EU 2013). In Poland, IACS is managed by the Agency for Restructuring and Modernisation of Agriculture (ARiMR 2018). Spatial analyses were based on cadastral data - the digital map of the parcels, containing more than 34.7 million polygons and covered the whole rural area (> 18 million ha). As a source of information about land quality was used the tabular database specifying classes suitable for agricultural production - the complete list of this database consists of more than 67.3 million records. All the information was imported to the PostgreSQL relational database (Step 1, Fig. 1). Data in the GIS format can be imported thanks to PostGIS extension, which enables coupling of geometrical data with the tabular data structure. Both databases were joined in relation one polygon to many classes (each one has the attribute of area), using unique ID parcel numbers (Step 2, Fig. 1). Based on the geo-relation described above, the special range of unutilized agricultural sub-parcels was possible to be selected by criteria of cultivation suitability and size (Fig. 2). Unutilised area was defined as parcels not declared by farmers in the applications to ARiMR in 2016. It means that farmers have not received any subsidies for these agricultural plots this year. In the vast majority of cases, these plots are fallowed or abandoned land.
In the next step (3), unutilised sub-parcels, larger than 0.3 ha and located on medium-good and medium bonitation classes of arable quality land were extracted. The area of 0.3 ha was adopted as a reference value for determining the area directly affecting food production. Moreover, small cadastral parcels with attributes “arable, grassland, orchard” are often, in fact, building plots excluded from agricultural area and designated for housing. Another reason for limiting the size of an agricultural parcel is the provision of applicable law, Art. 1 of the Act on Shaping of the Agricultural System states that it cannot be applied to agricultural property covering an area of less than 0.3 ha – thus, defining the areas that may be subject to land use change, especially when allowed by land development conditions included in local land development plans (Dz.U. 2017). The algorithm which was applied for geoprocessing of the database is presented in part B of Figure 1.

Economical profits were calculated based on the average yield of triticale (4 t/ha) assumed after Noworolnik (2009) and economic data on average purchase prices of grain and straw in 2017 obtained from the agricultural internet services and published by the governmental statistical office: Statistics Poland: www.stat.gov.pl/en/ (step 4, Fig. 1).

A)



B)

CP = set of cadastral parcels (cadastrial.shp file)
CP.FALU (feature of agricultural land use) = {R, S, Ł, PS, Wsr, Lzr}*
where: R: arable, S: orchards, Ł: meadows, PS: pastures, Wsr: pounds, Lzr: wooded land
CP.BC (bonitation classes of arable quality) = {I, II, III, IVa, IVb, V, VI}**
CP.ARiMR (info from ARiMR database) = {1 – parcel subsided, 0 – parcel non declared}

‘* according to the nomenclature of the EGiB(OFU) (Dz.U 2001)
‘** according to the Polish System of Agricultural Land Quality (Dz.U.2012)

SELECT
Unutilised sub-cadastral parcels
FROM
CP
WHERE
CP.FALU = R
AND (CP.BC = “IVa” OR CP.BC= “IVb” OR CP.BC = “III”)
AND CP.area > 0.3 ha
AND CP.ARiMR = 0

Figure 1. Scheme of methodology

A) Flowchart of analysis. Step 1: databases import; Step 2: developing relational database; Step 3: geoprocessing; Step 4: visualisation by choropleth map. *TERYT – unique id number of a parcel. EGiB – national database of cadastres and buildings. ARiMR - Agency for Restructuring and Modernisation of Agriculture (the bureau developed LPIS in Poland).*
B) Algorithm of geoprocessing

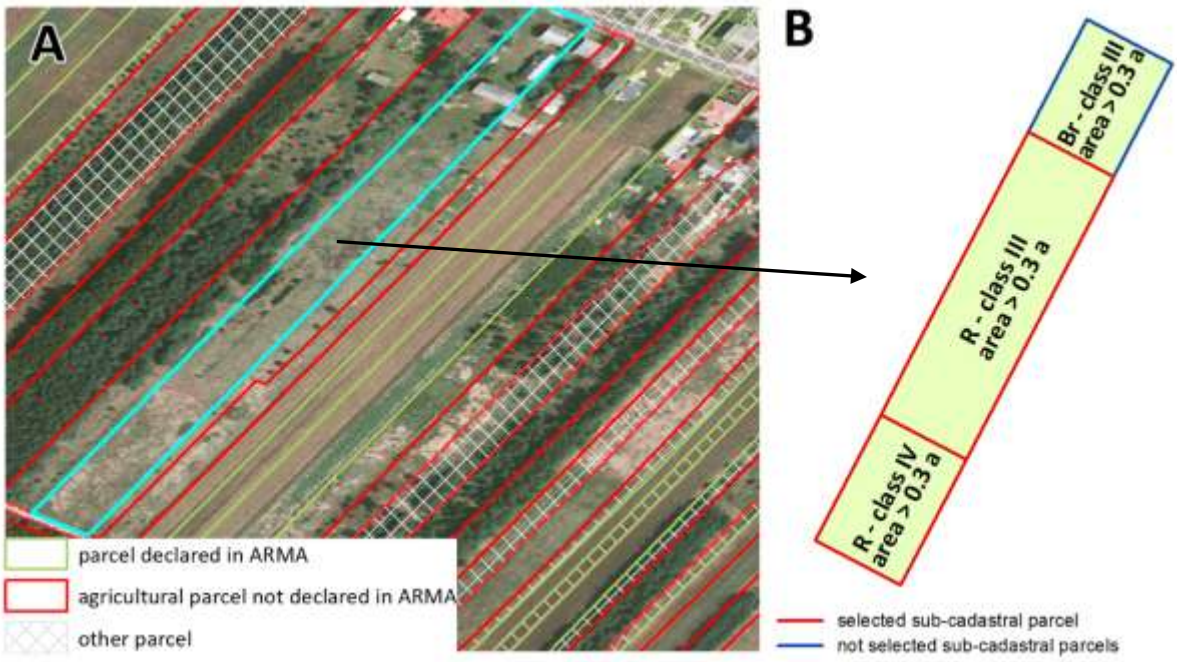


Figure 2. Example of designating an unutilized area by using assumed conditions of land suitability (arable land of IV or V bonitation class) and size (> 0.3 ha). A - the aerial photograph was imposed: a map of agricultural soil complexes and plots (parcels from the database 1); B – sub-parcel extraction method (sources: own research, ortophotomap: geoportal.gov.pl)

Results

As a result of the analyses carried out, the overall share structure of class III and IV quality land in the area of cadastral parcels was determined. Figure 3 presents a histogram showing the numbers of agricultural plots possible to be sectioned (as sub-cadastral parcels) for areas in the interval of 0.1 ha. Sub-parcels smaller than 0.1 ha do not fulfil the criteria for area payments, whereas for the purpose of economic potential assessment areas exceeding 0.3 ha were assumed based on assumptions described in the methodology section. In the country scale, 832,186 sub-parcels of fallowed land was found to meet the criteria, which constitutes an overall area of more than 442.8 thousand ha.
In case of returning these areas to agricultural use there is a possibility of obtaining yield equivalent to 1.77 million tonnes of triticale. According to purchase prices in 2017 (ca. 650 PLN/t) the worth of this production equals 1.15 billion PLN (ca. 274 million EUR; where 1

EURO ~ 4.20 PLN). In case of triticale, the ratio straw to grain is close to 0.9, thus additionally, 1.59 million tonnes of straw can be obtained as a by-product (Harasim, 2011). The market price of straw is very different. It depends on the quality, form of sub-product (bar, rollup) and local logistic system or demand. For our calculations we have accepted the amount of 130 PLN (31 EURO) per tonne as a mean price. Moreover, we assumed that in the frame of sustainable production, at least 30% of the total harvested straw should be used for soil conservation (BioBoost, 2015); and the rest, ca. 1.12 million tonnes, may be allocated to other agricultural and non-agricultural purposes (feedstock bedding and feeding, mushroom production, biogas, co-firing). Figure 4 presents a map of economic potential of particular poviats (NUTS 4) expressed in gross income, which may be obtained from the total sale of grain (for consumption/food purposes) and straw surplus (70% of total straw yield). In the national scale this potential is around 1.3 billion PLN (309 million EURO). The real income for farmers, after considering all costs, is significantly lower. According to the calculation of PODR (2018) in the regions of E-S Poland, from 1 ha of triticale cultivation, with an average intensity of agro-technology (yield 4.1 t/ha), the value of production can be estimated at 2540 PLN (605 EURO). However, all costs (seed material, plant protection chemicals, fertilizers, and other indirect costs) amount to approximately 3270 PLN (780 EURO). The comparison of costs and revenues shows that without obtaining indirect subsidies (ca. 220 EURO/ha) and proper straw management, a farmer managing weaker soils will not receive any income from such production. This calculation explains the main reason for the problem of the non-use of weaker soils, mainly in small-scale farms.

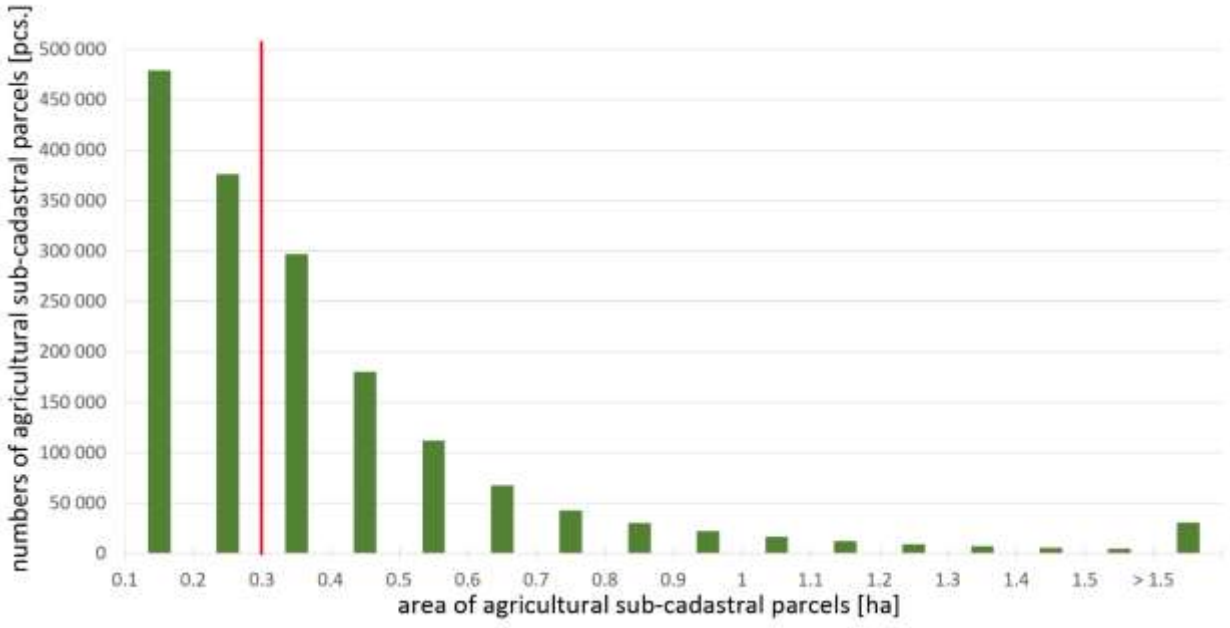


Figure 3. Number of polygons of class III and IV quality land in the structure of abandoned agricultural parcels with areas exceeding 0.1 ha (source: own research)

Discussion

Despite the great potential of fallowed/abandoned land, its restoration for agricultural production is an extremely complex issue. Demographic changes that occurred in rural areas make it virtually impossible to restore agricultural activity in small holdings characterized by high fragmentation of fields, mainly in the following voivodeships - NUTS 2: Podkarpackie (PL82 – see codes on the map, Fig. 4), Małopolskie (PL21), Lubelskie (PL81) and Świętokrzyskie (PL72). In this case the solution can be consolidation of agricultural estates and land reparcelling. This issue is described in more detail by Markuszewska (2016) and Mickiewicz, Mickiewicz (2017). At the legislative level, consolidation process is promoted by the regulation/act on the agricultural system (Dz.U, 2017). Land ownership fragmentation is not a typical Polish problem. It concerns many regions of Central and East Europe (Pasakomis and Maliene, 2010; Sabates-Wheeler, 2002).

As observed in recent years, the area payments scheme and Rural Development Programme packages (PROW) do not always succeed in restoring fallow land for agricultural production, but rather support the functioning holdings which maintain land in good agricultural condition. It can be proved by the fact that more than 2 million of agricultural land is still fallowed (Pudełko et al., 2018).

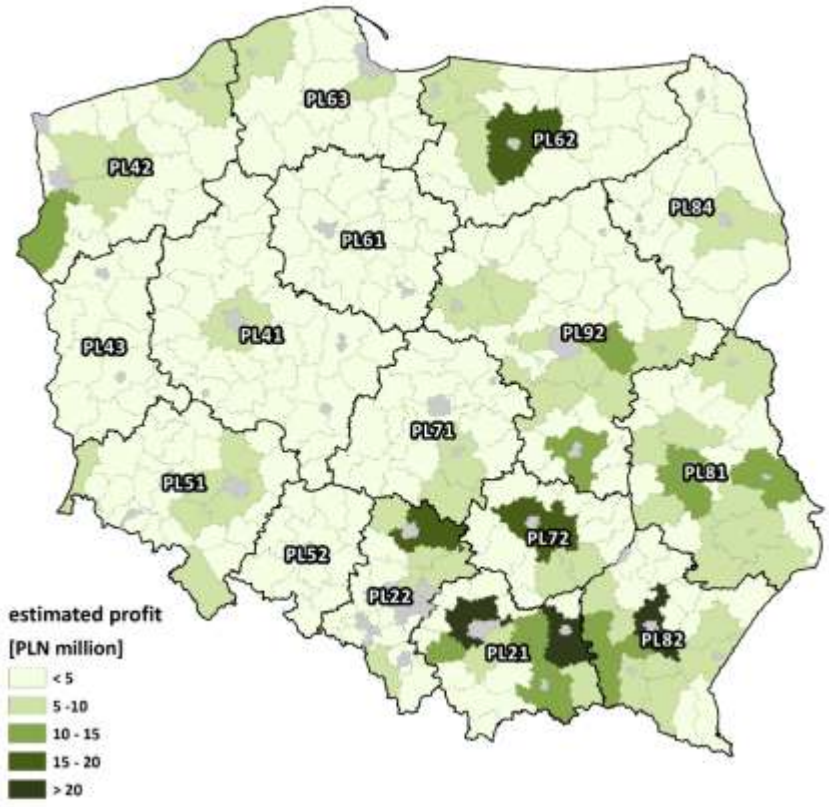


Figure 4. Map of economic potential of medium-good and medium agricultural areas aggregated for NUTS-4 level (poviats, the second administrative level in Poland). *Currency: 1 EURO ~ 4.2 PLN* (source: own research)

Another idea promoted by the EU for rural development was to focus production on biomass (Directive 2009/28/EC). Actually, many regions have a research and innovation strategies for smart specialisation based on the use of biomass (RIS). According to these strategical assumptions, changes in land use leading to the production of biomass for energy and industrial purposes are considered, as well as the use of existing resources in the form of by-products from agriculture, industry and nature conservation. Farmers are not interested in energy or industrial biomass production either (e.g. perennial plantations), mainly due to unstable policy of financing renewable energy, e.g. lack of guaranteed long-term contracts with biomass producers. Despite the considerable theoretical potential of this type of production it appears to bear a higher risk than a conventional food production (Krasuska and Rosenqvist, 2012; Pudełko et al., 2012).
Due to the above, no radical changes in management of abandoned land should be expected in the upcoming years. Anyway, arable land, which was abandoned in the early 90s, is now subject to advanced succession of natural vegetation. They constitute refuges for wildlife and fit well into the landscape, especially in regions with high fragmentation of farms and protected areas. They also favour the development of tourism and recreation (Figure. 5). The alternative and cost-efficient option for such land can be a supervised conversion to ecological land (e.g. apiarian) or even to natural afforestation or rewilding (Ceausus et al., 2015). In this case, however, new legal regulations would be necessary and new agri-environmental programmes should be introduced, which may or even should be implemented in the framework of the Common Agricultural Policy after 2020. The above scenarios should, however, apply to weaker land. In the light of the anticipated increase in global demand for food, land with high production values, as described in this work, will sooner or later be restored to agricultural production.

Figure 5. Landscape of the protected area "Kazimierski Park Krajobrazowy". AAL – abandoned arable land, AO- abandoned orchard, ABP – abandoned built parcel, AF – afforested arable land (sources: own research, air-photography R. Pudelko)

The works on bioeconomy scenarios for Poland are currently conducted within the project BioEcon (2018). They take account of the possible exploitable potential of abandoned land. Therefore, the research presented herein will be continued with the aim of modelling the economic potential of unutilised agricultural area in Poland in view of the agricultural, environmental and energy policy.

Conclusions

- In Poland there are over 442.8 thousand ha of arable land which can be effectively restored to crop production,
- After landuse change of the mentioned area, a potential increase in cereal production by 5.94% is expected, which can be equivalent of 1.77 million tonnes of triticale,
- Besides, 1.59 million tonnes of straw can be produced for soil conservation, animal production and bioenergy purposes,
- The economic theoretical potential of total agricultural production can be estimated at around 309 million EURO per year, but the real income for farmers, after considering all costs is significantly lower, amounting to approx. 140 million EURO (45%).

Acknowledgements. Studies on regionalisation of agricultural production in Poland are one of the tasks of the IUNG – PIB Multiannual Programme (Task 1.7).

References

1. ARMA (2018). Agency for Restructuring and Modernisation of Agriculture. http://www.arimr.gov.pl/o-arimr/information-about-the-agency.html
2. BioBoost (2015). The feedstock potential assessment for EU-27 + Switzerland in NUTS-3. Deliverable D1.2.; http://bioboost.eu/uploads/files/bioboost_d1.2_iung_feedstock_potential_vers1_0-final.pdf [accessed Apr 13, 2018]
3. BioEcon (2018). New Strategies on Bio-Economy in Poland. HORYZONT 2020, call ERA Chair, work programme 2014-2015, section „Spreading Excellence and Widening Participation (WIDESPREAD 2-2014: ERA Chair), http://bioecon.iung.pulawy.pl/
4. Ceauşu, S., Carver, S., Verburg, P.H., Kuechly, H.U., Hölker, F., Brotons, L., Pereira, H.M. (2015). European Wilderness in a Time of Farmland Abandonment, in: Pereira, H.M., Navarro, L.M. (Eds.), Rewilding European Landscapes. Springer International Publishing, Cham, 25–46.
5. Directive 2009/28/EC. The European Parliament and of The Council on the promotion of the use of energy from renewable sources amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
6. Dz.U, 2001, 38. Journal of Laws of 2001, No. 38, item 454 as amended – Appendix No. 7 Ordinance of the Minister of Regional Development and Construction of 29 March 2001 on Land and Buildings Register [in Polish]

7. Dz.U, 2012. Journal of Laws 2012.0.1246 [in Polish]
8. Dz.U, 2017. Journal of Laws 2017.0.2196 consolidated text – Act of 11 April 2003 on Shaping of the Agricultural System (as amended), [in Polish]
9. EU 2013 - Regulation No 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) No 352/78, (EC) No 165/94, (EC) No 2799/98, (EC) No 814/2000, (EC) No 1290/2005 and (EC) No 485/2008
10. GUS 2018. Statistics Poland http://stat.gov.pl/en/ [accessed Apr 13, 2018].
11. Harasim, A. (2011). Straw managment [Gospodarowanie słomą]. IUNG, 77 [in Polish].
12. Józefaciuk, Cz. (1996). Elaboration of the rules and criteria for the secretion of marginal soils in terms of natural conditions and environmental protection [Opracowanie zasad i kryteriów wydzielania gleb marginalnych z punktu widzenia warunków przyrodniczych i ochrony środowiska]. z. 2, IUNG, Puławy [in Polish].
13. Klikocka, H., Klikocki, O., Szostak, B. (2016). Assessment of food security of Poland in the context of agricultural production in 2010-2015 [Ocena bezpieczeństwa żywnościowego Polski na tle produkcji rolniczej w latach 2010–2015]. Polish Journal of Agronomy, 27: 9–20 [in Polish].
14. Krasuska, E. and Rosenqvist, H. (2012). Economics of energy crops in Poland today and in the future. Biomass and Bioenergy. 38: 23-33.
15. Krzyżaniak, M., Stolarski, M.J., Szczukowski, S., Tworkowski, J., Bieniek, A., Mleczek, M. (2015). Willow biomass obtained from different soils as a feedstock for energy. Industrial Crops and Products 75: 114–121.
16. Markuszewska, I. (2016). The outlook of land consolidation in Poland: Stakeholders' dilemmas and policy weaknesses. Badania Fizjograficzne, R. VII – Seria A – Geografia Fizyczna (A67): 119–132, DOI 10.14746/bfg.2016.7.9
17. Mickiewicz, B., Mickiewicz, A. (2017). The Importance of Land Consolidation in Poland for the Processes of Shaping Agrarian Structure. Proceedings of the 2017 International Conference "Economic Science For Rural Development" No 44 Jelgava, LLU ESAF, 27-28 April 2017, 126-135
18. Noworolnik, K. (2009). Effect of selected features of soil quality on yielding of winter triticale and winter rye [Wpływ wybranych cech jakości gleby na plonowanie pszenżyta ozimego i żyta ozimego]. Acta Agrophysica, 14, 1: 155-166 [in Polish].
19. Pasakomis, G. and Maliene, V. (2010). Towards Sustainable Rural Development in Central and Eastern Europe: Applying Land consolidation, Land Use Policy, 27, 2: 545-549
20. PODR (2018). Pomeranian Agricultural Advisory Center). http://podr.pl/wp-content/uploads/2018/07/Pszen%C5%BCyto.pdf [in Polish]
21. Pudełko, R., Kozak, M., Jędrejek, A., Gałczyńska, M., Pomianek, B. (2018). Regionalisation of unutilised agricultural area in Poland. Polish Journal of Soil Sciences. 51, 1: 119-132, DOI: 10.17951/pjss/2018.51.1.119
22. Pudełko, R., Borzecka-Walker, M., Faber, A., Borek, R., Jarosz, Z., Syp, A. (2012). The technical potential of perennial energy crops in Poland. Journal of Food, Agriculture and Environment, 10 (2): 781-784.
23. Sabates-Wheeler, R. (2002). Consolidation Initiatives after Land Reform: Responses to Multiple Dimensions of Land Fragmentation in Eastern European Agriculture, Journal of International Development, 14: 1005-1018, DOI: 10.1002/jid.905

24. Stuczyński, T., Budzyńska, K., Gawrysiak, L., Zaliwski, A. (2000). Valorization of the agricultural production area in Poland [Waloryzacja rolniczej przestrzeni produkcyjnej Polski]. Biul. Inf. 12 (I-II kw.). IUNG, Puławy, 80-82 [in Polish].