

## **POSSIBILITIES OF SMART DEVELOPMENT OF RURAL AREAS – CASE STUDY OF THE GRÓJEC COUNTY IN POLAND**

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### **ABSTRACT**

The study objective was to determine the development opportunities for the functions that currently exist in the Grójec County, and to identify areas with the possibility of implementing new functions as part of multifunctional development with the application of smart technologies. It was assumed that using smart technologies according to the Smart Villages concept would increase the productivity of the areas, minimise costs, and enhance the protection of the natural environment, including soils.

The study also seeks to describe a new concept proposed by the European Union, namely the idea of Smart Villages. It is based on the local strengths of a given area, and has a significant impact on the development of rural areas as well as on the improvement of the quality of life and working conditions. The paper discusses new trends in rural development. It provides examples from Poland and other countries regarding possible strategies of implementation of innovation and modern technologies in farming for the improvement of the standard of public services and local resource utilisation

The study presents the characteristics of the Grójec County. The SWOT analysis was developed based on the identified factors, presenting the development opportunities for the region. It permitted the determination of opportunities for growth, and provided the basis for defining strategic development goals and actions. The study presents the development opportunities for the county in the context of its close proximity to large agglomerations, allowing for the growth of the economic and tourist zones and an increase in the income to the national budget, resulting in both infrastructural and social regional development. The study identifies areas requiring strengthening of the local resources and their management, those with the possibility of developing the existing functions, and those with the possibility of introducing new ones.

Financial solutions from various sources, e.g. European, national, and communal, are suggested. The paper also offers recommendations for updating the study of conditions and directions of spatial planning, considering all of the conditions that may affect the use of given land.

**Keywords:** Smart Villages, rural area, rural development.

### **INTRODUCTION**

The Smart Villages concept is based on the use of innovative tools and digital technologies for the improvement of the quality of life and elevating the standard of public services for rural communities [1]. The Smart Villages concept is a response to the search for methods of implementation of sustainable development in the context of intensifying problems and challenges in rural development, particularly in peripheral

areas [2]. It is not a universal concept. Its implementation requires an individual approach with consideration of the local conditions [3]. No guidelines exist regarding the type of analyses required for the choice of solutions most suitable for a given area [4]. Promotion of Smart Villages and offering support is an important element of budgeting European funds for the upcoming years.

The implementation of the Smart Villages concept aims at among others facilitation of transfer of knowledge and innovation in rural areas. The European Network for Rural Development (ENRD) designated areas of smart measures in three main areas of smart solutions [5]:

- public services, including: energy production (RES), safety (video monitoring), remote education, raising awareness among residents, public transport, e-health
- management, including: public e-administration, waste management (fill-level sensors in containers), spatial planning, quality monitoring
- environment (air quality sensors), meetings and online consultations with residents
- entrepreneurship, including: precise agriculture, e-commerce (sale of local produce), rural tourism (based on smart solutions), sharing equipment (specialist equipment), rural incubators.

There are many interesting examples of innovative solutions applied in the scope of the Smart Villages concept in various areas of activity, including: local development, farm's performance, restructuring and modernisation, biodiversity restoration, preservation and enhancement, agri-food chain integration and quality, innovation and cooperation, diversification and job creation, links with research and innovation. According to data of the European Network for Rural Development (ENRD), approximately 900 projects implemented to date involved the participation of 28 European countries. In the scope of these funds, Poland implemented 41 projects [6]. Moreover, Poland has been implementing Smart Village projects in the scope of national funds since 2017 [7].

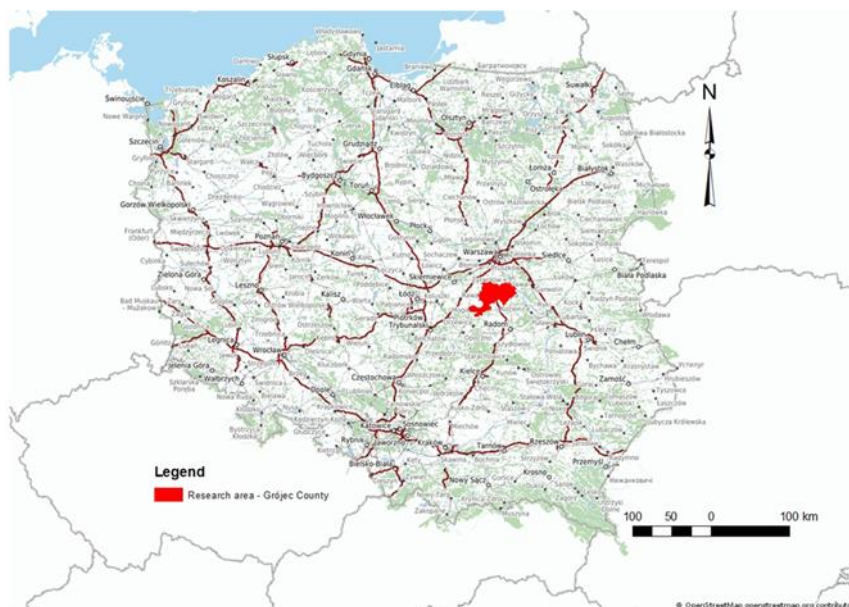
The study objective was to determine the possibilities of development of the existing functions occurring in the study area, and identification of areas with a potential for introduction of new functions in the scope of multifunctional development with the application of smart technologies. It was assumed that the use of smart technologies pursuant to the Smart Villages concept would contribute to an increase in the productivity of the areas, minimisation of costs, and strengthening of the possibilities of protection of the natural environment.

## **MATERIALS AND METHODS**

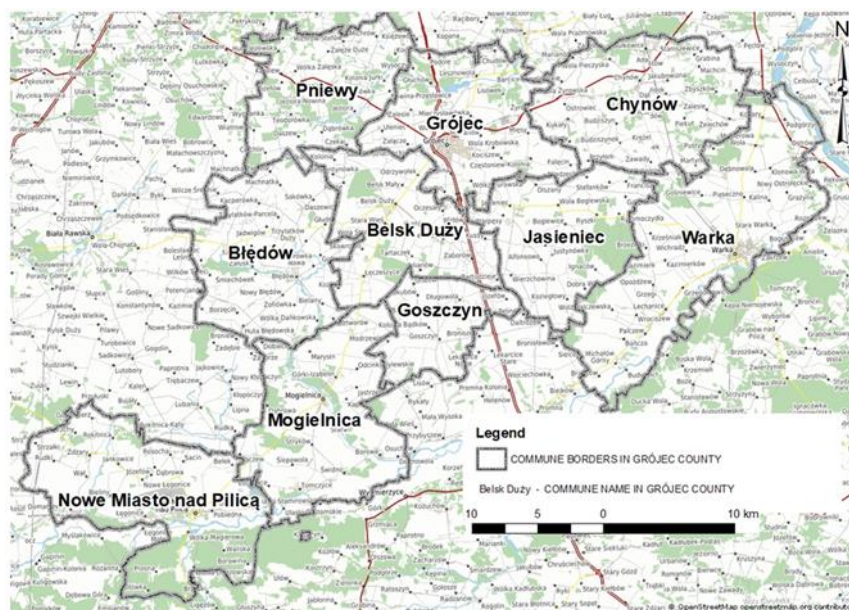
### **Study area**

The study was conducted in the Grójec County in the central part of Poland, in the Mazovia Voivodeship (Fig. 1). It covers an area of approximately 1,268 km<sup>2</sup>. Its population is 98,173, accounting for population density at a level of 78 persons/km<sup>2</sup>. The urbanisation rate is 35.3%. (GUS 2020). The location of the Grójec County approximately 50 km south of Warsaw, the capital city of Poland, offers enormous opportunities in the scope of infrastructure and social development of the area. The Grójec County borders on the Vistula River (largest river in Poland) to the east, and the Pilica River attractive in tourist terms to the south. The Grójec County covers 10 communes (Fig. 2). The most important ecosystems for the Grójec County include forests and forest land. The total surface area of forest land in the Grójec County reaches approximately 13% of the study area. Around 66 nature monuments are subject to protection. Natura 2000 network areas

occupy approximately 10% of the territory of the Grójec County (Development Strategy of the Grójec County) [8].



**Figure 1.** Location of the research area - the Grójec County  
Source: Own study based on the OpenStreetMap



**Figure 2.** Location of the research area, division into 10 communes  
Source: Own study based on the OpenStreetMap

The primary area of economy in the county is agriculture, whereas the main direction of production is horticulture. Orchards occupy approximately 33% of the arable land in the county. The Grójec County, called “the largest orchard of Europe”, boasts more than 500 years of horticulture traditions dating back to the times of Queen Bona who received vast amounts of land in this part of the country in the 16th century, and established a royal fruit tree plantation dominated by apple trees. The average production of apples here is at a level of 700-800 thousand tonnes, accounting for approximately 45% of the national production. The horticulture tradition in the Grójec County determines the directions of

development of the region, and is the primary place of employment for county residents. Apple production is provided by around 7,500 farms with an average surface area of 7.0 ha (including orchard area of 4.2 ha).

The remaining sectors of the economy of the Grójec County include:

- wholesale and retail sale, repair of car vehicles (36%),
- construction (11%),
- transport and warehousing (9%).

The Grójec County is largely dominated by individual farms, constituting more than 99% of all agricultural farms. In the period 2010-2020, the number of the large farms belonging to groups of arable fields with an area of more than 15 ha increased. The size structure of agricultural farms in 2020 was dominated by small farms with an area of up to 5 ha [9].

### **Study methods and materials**

The study employed the method of analysis of scientific literature regarding rural development and the Smart Villages concept. It was also based on information published on websites of relevant governmental units. The SWOT analysis for the Grójec County was developed based on own research and observations. The spatial scope covers the area of the Grójec County, Mazovia Voivodeship in Poland.

The following data sources were used:

- Strategy for the development of the Grójec County 2018-2023,
- Strategy for the development of the Mazovia Voivodeship 2030+ innovative Mazovia,
- Spatial development plan for the Mazovia Voivodeship
- Strategy for the Development of all (10) communes in the Grójec County
- Studies of conditions and directions of spatial planning of all (10) communes in the Grójec County
- the National Register of Boundaries (NRB), covering the borders of communes in the Mazovia Voivodeship
- OpenStreetMap and Topographic Objects Database, for the communication network and land cover
- the Central Statistical Office (Statistics Poland), characterising the population and economic situation of the communes.

The study used the basic and advanced functionalities of Esri's ArcGIS Desktop software package, allowing for the collection, analysis, and processing of spatial data.

## **RESULTS AND DISCUSSION**

### **Determination of the possibilities of rural development in the study area**

The Grójec County primarily fulfils agricultural and industrial-service functions, with a small share of the tourist function. A survey conducted in 2014 [10] showed that most farms of the Grójec County featured specialist objects for storing fruit. Approximately 75% of them also had specialist cold storages for storing fruit, and 13% had storerooms. Processes related to the restructuring of agriculture will provide conditions for increasing the number of business entities related to agricultural services and agricultural-food processing [11]. Strengthening of the role of producers and producer groups in the market of agricultural products, as well as "ecologisation" of agriculture will also generate new jobs [12]. Owing to the global trend of growing ecological social sensitivity, demand for high quality healthy food products is on the rise. Organic food is increasingly valued, primarily in large cities, where residents are eager to pay for it more (...). High dynamics

of export of products from the Grójec County point to their competitiveness in the European and global market. The county requires strengthening of information and consultancy support for organic farmers, particularly in the scope of information, marketing, and popularisation of innovative technologies. Strengthening of the position of farmers in the Grójec County in the food supply chain and promoting short supply chains deserves particular attention with regard to such activities. The primary objective of such activities is reducing the route of products from farm to table, and support of local producers and farmers. Owing to its specific and unique properties, food produced and sold locally is a flagship of the heritage of the region it comes from, but its importance has an even deeper meaning. The primary direction of activities will be the elimination of weaknesses of the county, and particularly:

- activation of farmers of the Grójec County;
- promotion of openness towards control and certification proceedings guaranteeing higher product quality;
- creating the appropriate image of individual farms active in the retail market;
- creating sales networks with a coherent image;
- cooperation of producers for shared promotion and distribution for the purpose of increasing their competitive advantage;
- increasing commercial resources and product improvement;
- management of the quality and flow of information from farmers and producer groups to consumers with consideration of feedback;
- support of retail sale of food in local and regional sales strategies.

An increase in efficiency will be obtained by means of the application of smart systems of precise agriculture. Digital technologies can support farmers in the Grójec County in obtaining greater efficiency while reducing costs. It offers a solution to the current and future challenges in the scope of climate change, responsible use of limited natural resources, and food safety. The existing and new technologies will contribute to greater effectiveness of processes and permit development of new products and services.

The development of the holiday and recreation function can be based on the local resources of the natural environment. This particularly concerns the presence in the county of areas predisposed for the introduction of recreation facility development, implemented in response to the demand of residents of the Warsaw metropolis. The use of these resources may be related to legal allocation of land of investment. The developed local plans of spatial development stipulate and enable the implementation of such services. The primary direction of development is combining the functions of agricultural production in selected areas with the development of services related to agriculture, small entrepreneurship, and recreation and agritourism while improving the state of both technical and social infrastructure.

The county features a low level of use of renewable energy sources (RES) in housing, public purpose buildings, and enterprises. The determined primary direction of development of the RES sector in the study area was energy production based on the use of wind and co-incineration of biomass in large systemic power plants and heat power plants. The Grójec County is located in the central region with mean total annual solar radiation of 1000-1050 kWh/m<sup>2</sup>. Mean total insolation in a year is in a range of 1900-2000 h/year. Therefore, the county provides good conditions for the development of solar energy production. The preferred direction of development of solar energy production in the county should be mounting individual small photovoltaic installations on residential and public purpose buildings [8], [9].

### SWOT analysis

The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is one of the most popular analytical techniques for classifying information. It is applied in all areas of strategic planning as a universal tool at the first stage of strategic analysis. The SWOT analysis provides a valuable analytical result, and is an effective method of identification of categories of weaknesses and strengths as well as opportunities and threats. It allows for using collected information for the development of e.g.: development strategy based on strengths and opportunities, with simultaneous elimination or limitation of weaknesses and threats, marketing strategy, and positive brand image.

Factors in the SWOT analysis were classified in the paper as follows:

- **STRENGTHS:** internal factors with a positive effect on the development of the Grójec County that make it positively stand out in the surroundings, providing the basis for its future development, increasing its attractiveness and competitiveness in the perception of residents, investors, tourists;
- **WEAKNESSES:** internal factors with a negative effect on the development of the county that inhibit the development and implementation of plans; gaps in potentials that reduce the position of the county both in the perception of the resident and external entities;
- **OPPORTUNITIES:** external factors favouring the development of the Grójec County and obtaining the designated objectives, allowing for elimination of weaknesses, increasing strengths, and initiating new directions of development;
- **THREATS:** external factors inhibiting the development of the county and obtaining the designated objectives, constituting barriers in overcoming the current difficulties, and blocking the possibilities of undertaking activities in various areas important from the point of view of the development of the county.

Table 1 presents the SWOT analysis for the Grójec County. The analysis concerns the current situation of the county.

**Table 1.** SWOT analysis for the Grójec County

| STRENGTHS  | WEAKNESSES  |
|--|---|
| <ul style="list-style-type: none"> <li>• Favourable location of the county and good transport connections</li> <li>• Highest level of development of horticulture production and the related services in Poland</li> <li>• High level of development of the tourist structure (water courses, cycling paths, walking paths, etc.)</li> <li>• Considerable cultural heritage resources</li> <li>• Good conditions for the development of agritourist farms</li> </ul> | <ul style="list-style-type: none"> <li>• Low level of development of the accommodation offer</li> <li>• Aging society</li> <li>• Low level of use of the tourist and cultural potential</li> <li>• Insufficient support for local business</li> <li>• Lack of local spatial development plans, progressing uncontrolled urbanisation and defragmentation of cultural landscape</li> </ul>       |
| OPPORTUNITIES  | THREATS   |
| <ul style="list-style-type: none"> <li>• Introduction of innovativeness in the scope of horticulture and processing</li> <li>• Development of export of fruit and food products</li> <li>• Development of agritourism</li> <li>• Efficient use of the cultural heritage, promotion of regional products and brands</li> <li>• Development of service and commercial activity</li> </ul>  | <ul style="list-style-type: none"> <li>• Migration of persons at productive age to cities due to the lack of attractive job offers</li> <li>• Neglect of the cultural heritage due to the lack of resources and preventive procedures</li> <li>• Low activation in the context of creating new non-agricultural jobs</li> <li>• Pollution and degradation of the natural environment</li> </ul> |

**Recommendations for updating planning studies in the study area**

The study allowed for formulating recommendations for updating studies of conditions and directions of spatial planning of communes of the Grójec County in the scope of possibilities of development of functions existing in the county, and indication of areas with a possibility of introduction of new functions in the scope of multifunctional development with the application of smart technologies.

Obtaining harmonious, comprehensive, and sustainable development of the Grójec County providing for economic stability, spatial order, preservation of the environmental and landscape values, complete provision of equipment and infrastructure, proper service in the scope of transport, meeting current needs of residents, providing conditions for a constant increase in the level of quality of life, and meeting the needs of future generations requires the following:

- provision of relevant possibilities of development of the city as a regional centre of administration, housing, services, etc.;
- strengthening of the leading role of horticulture and the related infrastructure, warehousing, processing, etc.;
- use of the opportunity of creating an economic zone within the county,
- development of a network of objects of transport services on the existing routes of national and regional roads;
- development of the functional-spatial structure adjusted to the ecological systems;
- development of functions in line with the existing environmental conditions;
- protection of special environmental and cultural values, as well as values for the development of recreation, holiday stays, and tourism;
- treatment of environmental protection as an integral part of all development processes;
- conducting rational management of resources, particularly waters, forests, agricultural production space, etc.

natural or cultural resources justify the determination and indication of activities in the communes of the Grójec County providing the basis for updating the study of conditions and directions of spatial development. Smart development of strategic objectives of rural development and activities stipulated for implementation will increase the settlement, investment, and tourism and recreation competitiveness of each commune of the Grójec County.

Table 2 and Table 3 presents the proposed directions of development and priority measures for particular communes of the Grójec County (Fig. 2), with consideration of the natural resources of the county that constitute a valuable element contributing to the development of the region.

**Table 2.** Proposed directions of development and priority measures for the urban–rural communes of the Grójec County

| Name of commune of the Grójec County       | Directions of development of the commune  | Priority measures supported by intelligent solutions  |
|--|---|---|
| Urban–rural Commune Grójec                 | <ul style="list-style-type: none"> <li>• Creating a fruit and vegetable logistic centre</li> <li>• Development of agricultural-food industry based on own resources</li> <li>• Offering the highest quality agricultural production</li> </ul>  | <ul style="list-style-type: none"> <li>• The use of the “Grójec apple” for the purposes of promotion of the region in Poland and abroad</li> <li>• Initiating and strengthening economic bonds with Polish and foreign partners</li> <li>• Emphasising agricultural products and services in the business offer of the commune</li> </ul>   |
| Urban-rural Commune Warka                  | <ul style="list-style-type: none"> <li>• Development of agricultural-food industry</li> <li>• Development of modern production methods in local agriculture</li> </ul>  | <ul style="list-style-type: none"> <li>• Increase in accessibility through creating a market information system for local agriculture</li> <li>• Introduction of modern techniques and machines</li> <li>• Creating specialist companies providing services to local farmers</li> </ul>   |
| Rural-urban Commune Nowe Miasto nad Pilicą | <ul style="list-style-type: none"> <li>• Development of tourist-recreation functions through the use of the environmental-landscape and historical-cultural values</li> <li>• Modern and open tourist economy</li> <li>• Development of tourist and related infrastructure for the development of tourism</li> <li>• Improvement of the innovativeness, attractiveness, and quality of tourist products and services</li> </ul> | <ul style="list-style-type: none"> <li>• Promotion of priority areas of the commune (e.g.: year-round strategy of promotion in social media, Facebook page, Instagram profile, YouTube videos)</li> <li>• Use of modern instruments of financing tourism and innovative enterprises of the tourist sector</li> <li>• Inclusion of local and regional communities in the development of products and services of regional tourist economy</li> <li>• Preparation of educational paths<br/>Creating a tourist base</li> </ul> |
| Rural-urban Commune Mogielnica             | <ul style="list-style-type: none"> <li>• Intelligent development of agriculture and horticulture</li> <li>• Development of infrastructure, regional and local transport routes</li> <li>• Development of service-administrative functions related to agriculture, education and culture, health protection, and social care</li> </ul>  | <ul style="list-style-type: none"> <li>• Use of tools and instruments and improving technological quality of information e-systems</li> <li>• Use of the close proximity of outlets in the county and creating own outlet (e.g. e-commerce, digital marketing)</li> <li>• Preparation of promotion material on websites of the city and commune, and creating own websites by residents</li> </ul>  |



**Table 3.** Proposed directions of development and priority measures for the rural communes of the Grójec County

| Name of commune of the Grójec County | Directions of development of the commune   | Priority measures supported by intelligent solutions  |
|--------------------------------------|--|---|
| Rural Commune Belsk Duży             | <ul style="list-style-type: none"> <li>• Development of competitive economy through support of local entrepreneurs and increasing investment attractiveness</li> <li>• Use of local environmental values to preserve the environment</li> <li>• Development of public infrastructure, modernisation and renovation of roads</li> </ul>                                 | <ul style="list-style-type: none"> <li>• Consultancy in obtaining external resources for business activity</li> <li>• Increase in the use of energy from renewable energy resources on residential and public purpose buildings</li> <li>• Raising the ecological awareness of residents</li> </ul>   |
| Rural Commune Błędów                 | <ul style="list-style-type: none"> <li>• Development of precise agriculture</li> <li>• Ecological education of residents and aesthetisation of rural areas</li> <li>• Development of entrepreneurial attitudes and support for business initiatives</li> </ul>   | <ul style="list-style-type: none"> <li>• Striving for using high quality modern electronic and computer solutions for controlling many processes and management in an enterprise</li> <li>• Promoting the commune at the supralocal scale</li> <li>• Promotion of healthy food</li> </ul>   |
| Rural Commune Chynów                 | <ul style="list-style-type: none"> <li>• Development of agriculture and agricultural-food processing with introduction of precise agriculture</li> <li>• Strengthening the role of producers and producer groups in the agricultural product market</li> <li>• Development of public infrastructure and services of the public social sphere</li> </ul>                | <ul style="list-style-type: none"> <li>• Promotion and support of investments in the scope of agricultural-food processing</li> <li>• Marketing activities promoting local agricultural production</li> <li>• Support and promotion of export of fruit</li> <li>• Preparation and popularisation of information on support opportunities</li> <li>• Improvement of the quality of medical benefits and services</li> </ul>  |
| Rural Commune Goszczyn               | <ul style="list-style-type: none"> <li>• Modernisation and restructuring of agriculture, and agricultural farms in the commune</li> <li>• Development of pro-ecological investment</li> <li>• Protection of the natural environment</li> <li>• Rational land management</li> </ul>   | <ul style="list-style-type: none"> <li>• Increase in the diversity of production in agricultural farms</li> <li>• Ecological education of residents and aesthetisation of rural areas</li> <li>• Construction of processing plants and cold storage facilities</li> <li>• Modernisation of horticulture production with technologically innovative equipment</li> </ul>   |
| Rural Commune Jasieniec              | <ul style="list-style-type: none"> <li>• Development of production aimed at export in the industry of advanced and medium-advanced technologies</li> <li>• Expansion and modernisation of infrastructure</li> <li>• Increase in the level of education of residents and preservation of the natural environment</li> <li>• Improvement of health protection</li> </ul> | <ul style="list-style-type: none"> <li>• Running all possible information channels presenting the potential of the area</li> <li>• Construction of a new health centre with telemedicine solutions and a rehabilitation ward</li> <li>• Increase in the number of cultural events for each age group</li> <li>• Ecological education of residents, e.g. through running educational workshops for each age group</li> </ul> |
| Rural Commune Pniewy                 | <ul style="list-style-type: none"> <li>• Development of modern methods used in agriculture</li> <li>• Strengthening of position in the region through opening to innovation</li> <li>• Development of tourism and recreation based on the natural and landscape values</li> </ul>  | <ul style="list-style-type: none"> <li>• Promotion of investment land</li> <li>• Preparation of materials promoting the values of the commune online, mobile applications, and traditional promotion materials</li> <li>• Emphasising environmental and cultural values</li> <li>• Undertaking activities towards the development of digitisation</li> </ul>  |

## CONCLUSIONS

Rural areas in the Grójec County require undertaking activities for the improvement of possibilities of development of particular communes to strive for an increase in their competitiveness. Achieving economic success is related to the development of the region and giving activities an innovative character. Smart solutions increase the ability of the economy to initiate economic processes and technological progress. When innovative business becomes dynamic and evolves, it creates new situations and new means of production, modifying the existing ones. Emphasis needs to be put on the diversity of undertakings in rural areas, interactions between agriculture and other types of business activity, and combining undertakings at the local scale.

Adopting a direction of activities based on territorial competitiveness engaging the self-government administration as well as the local community in creating and using modern technologies considerably stimulates greater development possibilities of the county.

The collected data and information on the communes are of various importance for the further process of development of strategic documents. Changes in legal regulations and adopting new European standards affect documents passed locally, and indicate the direction of their updating. The changing spatial policy of communes necessitates changes in planning documents. Moreover, it contributes to promotion of rural areas, because provisions of the documents constitute information both on what the commune has, and regarding further plans on conducting the spatial development policy.

Development of modern technologies is an opportunity for the communes of the Grójec County, and a chance for an increase in innovativeness in Poland. A tool accelerating development are European Union programmes and financial resources offered in their scope, allowing for farmers to apply for subsidies for modern equipment and planned investments.

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